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CONDUCTED by Wm. W. PAYNE,

DIRECTOR OF CARLETON COLLEGE OBSERVATORY.

NORTHFIELD, MINN.
CARLETON COLLEGE OBSERVATORY.
1884.

ILLUSTRATIONS.

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The Sidereal Messenger.

Conducted by WM. W. PAYNE, Director of Carleton College Observatory.
Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

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THE NUCLEUS OF THE GREAT COMET OF 1882.

BY H. C. WILSON.

The following tables give the results of my measures of the nucleus or nuclei of the Great Comet of 1882. The measures were made with the filar micrometer of the 11-inch equatorial, and generally with an eye-piece magnifying 90 times. I frequently examined the nucleus with a magnifying power of 450, but found it easier to make the measures with power ninety.

The parts of the nucleus are designated n_0, n_1, n_2 and n_3 in the order of their passage through the field of the telescope. n_0 is the preceding end of the nucleus, n_1, n_2 and n_3 three bright points. n_1 and n_2 had perceptible discs which were visible in the dawn for some time after the remainder of the comet was invisible. On October 5, I estimated their diameters with power 450, to be 1.″5 (n_1) and 3″ (n_2), which would be equivalent to about 900 miles and 1,800 miles.

The discs were plainly visible October 4, 5, 6, 12 and 13. After October 13 the hazy envelope around them became so thick that they were indistinct. The bright points n_1 and n_2 could, however, be recognized up to November 29, and n_2 was visible on January 31 and February 8. n_3 was very minute and obscured by a mass of hazy matter which seemed to be emitted sometimes from n_2 and sometimes from n_3 n_0 was easily seen from October 4, to November 3, but was very difficult of measurement. Between n_1 and n_0 the nucleus was continuous and appeared very much like a tail to n_1. Within this at times I saw two other very bright minute points.

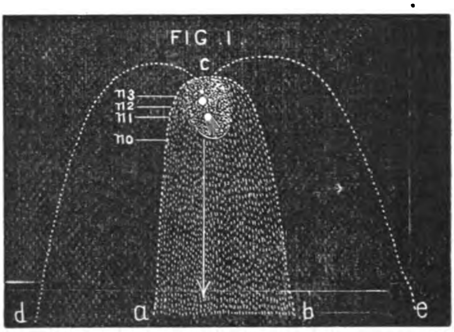


Figure 1 gives the outlines of the head and nucleus on October 19. *a c b* is the head of the bright part of the comet. The matter included by the curves *c d* and *c e* was very faint, but I saw it distinctly from October 13 to November 7. The arrow shows the direction of the motion through the field of the telescope, or position angle 270°.

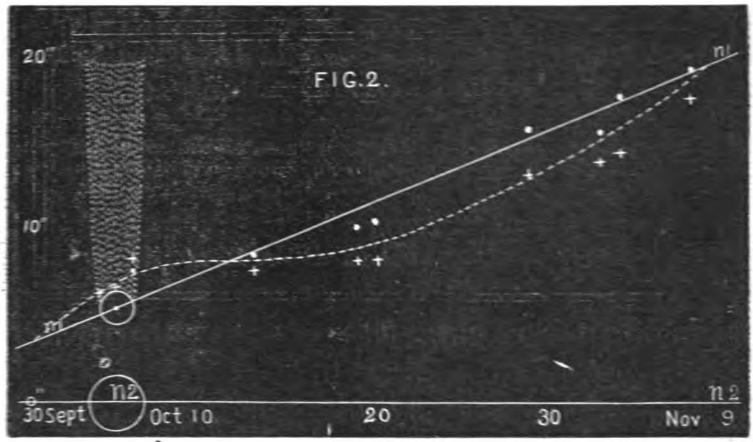
In the table p is the observed position-angle and s the observed distance of the parts of the nucleus; p_0 is the computed position angle of the radius vector prolonged. $p-p_0$ is therefore the apparent angular deviation of the parts of the nucleus from the direction toward or opposite the sun. φ is this deviation reduced to the plane of the comet's orbit: Δ is the distance of the parts reduced to the same plane. The measures of distance for n_2 n_1 and n_3 n_2 were quadruple measures, those for n_1 n_0 single.

Greenwich M .T.	p	$p_\circ$	$p-p_\circ$	s	φ	Δ
October 5.937	280°.4	265°.3	+ 15°.1	30.″est	+ 22°.9	
6.971	281 .9	265 .7	+ 16 .2		+ 23 .4	
12.971	285 .2	268 .1	+ 17 .1		+ 21 .6	
13.923	288 .1	268 .[illegible]	+ 19 .7	16. 1	+ 23 .0	0.000267
19.937	293 .7	271 .1	+ 22 .6	29. 6	+ 22 .7	0.000507
20.964	290 .9	271 .4	+ 19 .4		+ 20 .4	
			n_2 n_1			
4.951	277 .0	264 .9	+ 12 .1	10.	+ 20 .5	
5.937	278 .6	265 .3	+ 13 .3	5. 60		
5.965	280 .2	265 .3	+ 14 .9	5. 40	+ 21 .9	0.000082
6.971	281 .9	265 .7	+ 16 .2	7. 58	+ 23 .4	0.000120
12.971	285 .2	268 .1	+ 17 .1		+ 21 .6	
13.923	285 .2	268 .4	+ 16 .8	8. 35	+ 21 .0	0.000130
19.937	286 .6	271 .1	+ 15 .5	10. 03	+ 17 .8	0.000150
20.964	286 .6	271 .5	+ 15 .1	10. 20	+ 17 .2	0.000151
29.930	293 .2	275 .4	+ 17 .8	15. 84	+ 16 .3	0.000248
Nov. 2.981	295 .2	278 .2	+ 17 .0	15. 90	+ 15 .1	0.000233
3.947	294 .7	278 .8	+ 15 .9	17. 65	+ 14 .1	0.000264
7.926	303 .3	281 .3	+ 22 .0	19. 15	+ 16 .8	0.000320
			n_3 n_2			
October 4.951	274 .0	264 .9	+ 12 .0		+ 20 .5	
5.937	277 .4	265 .3	+ 12 .	6 .26	+ 20 .0	0.000088
6.971	281 .9	265 .7	+ 16 .2		+ 23 .4	
12.971	285 .2	268 .1	+ 17 .1		+ 21 .6	
13.923	285 .2	268 .4	+ 16 .8	9 .89	+ 21 .0	0.000154
19.93	286 .6	271 .1	+ 15 .5	9 .01	+ 17 .8	0.000185
20.964	290 .6	271 .5	+ 19 .1		+ 20 .2	

Elongation of the whole nucleus.

Greenwich M. T.	p	$p_\circ$	$p-p_\circ$	φ	Ratio of length to width.
September 18.287	°	°	°	°	1 : 1
18.978					1 : 1
24.962					1 :
October 4.951	277.0	264.9	+ 12.1	+ 20.4	
5.937	280.0	265.3	+ 14.7	+ 22.5	
6.971	281.9	265.7	+ 16.2	+ 23.4	4 : 1
12.971	285.2	268.1	+ 17.1	+ 21.6	4 : 1
13.923	286.7	268.4	+ 18.3	+ 22.0	
19.937	290.4	271.1	+ 19.3	+ 20.6	6 : 1
20.964	289.4	271.5	+ 17.9	+ 19.3	
29.930	293.2	275.4	+ 17.8	+ 16.3	5 : 1
November 2.981	295.2	278.2	+ 17.0	+ 15.1	5 : 1
3.947	294.7	278.8	+ 15.9	+ 14.3	
7.926	303.3	281.3	+ 22.0	+ 16.8	138″ : 65″
20.995	315 ±	291.3	+ 24 ±	+ 15 ±	
January 31.003	51.0	49.6	+ 1.4	+ 0.8	
February 8.602	70.2	59.8	+ 10.4	+ 14.0	173″ : 71″
28.631	69.2	78.0	− 8.8	− 11.6	
March 2.613	72.9	79.4	− 6.5	− 12.2	2 : 1

Comparing these results, it seems to me that they agree best when reduced to the plane of the orbit, this indicating that the parts of the nucleus were in that plane. The minus signs of the last two angles φ would perhaps indicate the contrary; but the comet was so faint on those dates that little reliance can be placed on the measures then made. On the whole there seems to have been a gradual decrease in the angle of deviation from the radius vector.



The distance between the parts of the nucleus increased at an almost uniform rate. If we plot the distance for n_2 n_1 we find that they may be represented approximately by a straight line. If we extend this line backward we find it meets the zero line about September 20, which suggests the inference that the division of the nucleus took place at about that time. The first recorded observation of the divided nucleus which I have been able to find, however, was on the morning of September 30, and it has been stated definitely by various observers that the nucleus was not divided previous to this date.

In my observations of the position of the nucleus I generally took the transits of all the parts of the nucleus, but measured the declination of only n_2. From the differences in time of transit we may also derive the distances of the nuclei by the formula $S = d\alpha \cos\delta \operatorname{cosec} p$. The results thus obtained are shown in the following table:

	$d\alpha$			Number of Transits	$s = d\alpha \cos\delta \operatorname{cosec} p$		
	$n_0\, n_2$	$n_1\, n_2$	$n_2\, n_3$		$n_0\, n_2$	$n_1\, n_2$	$n_2\, n_3$
	s	s	s		"	"	"
October 4		0.40		9		6.0	
5		0.42	0.42	6		6.3	6.3
6	1.17	0.54	0.36	10	17.7	8 2	5.4
13	1.64	0.49	0.45	6	24.6	7.4	6.8
19		0.53		6		8.0	
20		0.53		8		8.0	
29		0.85		14		13.0	
November 2	3.21	0.89	0.79	20	50.0	13.8	12.2
3	3.85	0.92	0.81	10	59.6	14.2	12.5
7	3.96	1.05		10	65.9	17.4	
20	3.86			6	73.4		

These distances show about the same rate of increase as the direct measures. It is curious however that, with the exception of the first three of $n_1\, n_2$, they are all less than the direct measures by about the same amount. On figure 2 these distances of $n_1\; n_2$ are plotted, the direct measures being represented by dots and the measures by transits by crosses. The circles represent the size of the discs n_1 and n_2 as estimated by me October 5. The direct measures are fairly represented by the straight line $n_1\, n_1$ which crosses the zero line at about September 20. Excepting the first three, the measures by transits might be represented by another straight line parallel to the former and distant from it about 2″, which would be my *personal equation* for the two methods of measurement. Combining two sets of measures, they seem to indicate a curve something like the dotted line. This curve is quite similar to that obtained by Dr. Schmidt of Athens from his measures of $n_0\; n_2$ (*c b*; Astronomische Nachrichten No. 2499).

Variable Stars.—The large telescope, Harvard College observatory, has been recently used in observing variable stars, too faint to be visible with the west equatorial. The collection of data for charts of the immediate neighborhood of many variable stars has also been undertaken with the large telescope.

THE ZONE OF ASTEROIDS AND THE RING OF SATURN.*

PROFESSOR DANIEL KIRKWOOD.

Evidence in support of the following theses was published by the present writer in 1866-7.

I. In those parts of the zone of minor planets where a simple relation of commensurability would obtain between the period of an asteroid and that of *Jupiter*, the original planetary matter was liable to great perturbation. The result of such disturbance by the powerful mass of *Jupiter* was the necessary formation of gaps in the asteroid zone.

II. The great division in the ring of *Saturn* may be explained by the disturbing influence of the satellites, and the more narrow division discovered by Encke may be regarded with much probability as the effect of a similar cause.†

The recent able and noteworthy papers of General Parmentier‡ of Paris and Dr. Meyer,§ of Geneva, have invested these older discussions of the same subjects with fresh interest and importance. The actual discovery of chasms in the asteroid ring was the result of a previous theoretical determination of the parts where void spaces would be produced by *Jupiter's* influence. The definite claims of the writer then are:

(1.) To have designated the theoretical positions of gaps in the zone of asteroids.

(2.) To have shown that these divisons actually exist; and

(3.) To have first assigned a physical cause for the divisions of *Saturn's* ring.

A restatement of the principal evidence, showing the har-

*Read before the American Philosophical Society, Oct. 5, 1883.

†See Proc. A. A. A. S, 1866 and 1875; Met. Ast. Ch. xii; Monthly Notice, R. A. S. Jan. 1869; Proc. A. P. S., vol. xii, p. 163; Smithsonian Rep. 1876; London Observatory, July, 1882.

‡L'Astronomie, for June, 1883.

§Astr. Nach., No. 2527.

mony of recent discoveries with the conclusions announced seventeen years since, is given below. The portions of the ring in which the periods would be commensurable with that of *Jupiter* are

1. *The distance 3.2776.* At this distance a planetary mass would make precisely two revolutions while *Jupiter* completes one. Hence, as has been frequently shown, a chasm in the ring would be the probable consequence of *Jupiter's* disturbing influence. How far is this theoretical inference sustained by facts?

An examination of the table of distances shows:

Between 3.083 and 3.220	37	asteroids
" 3.220 and 3.357	0	"
" 3.357 and 3.494	8	"

That is, the part of the zone just within the distance at which a planet's period would be one-half that of *Jupiter*, contains the extraordinary number of thirty-seven minor planets, while the next space of equal breadth (that containing the distance 3.2776), is a total blank, not a single asteroid having yet been found within it. The exterior space immediately adjacent, and of the same extent, contains eight. The confirmation of the theory is thus most striking in precisely that part of the zone where we have most reason to expect it.

2. *The distance 2.5012.* Here an asteroid's period would be one-third that of *Jupiter*. The order of commensurability would be less simple, but the results of perturbation would be of the same nature. The part of the zone included between the distances 2.30 and 2.80 contains 143 minor planets; 45 within the critical distance and 98 exterior to it. The average interval between adjacent members is 0.00349, while that containing the distance 2.5012—between Thetis and Hestia—is 0.05386, or more than fifteen times the average. Or, if we take spaces adjacent to the chasm and of equal breadth with it, we find twenty asteroids in the interior and eighteen in the exterior.

3. *The distance 3.70.* Here five periods of a minor planet would be equal to three of Jupiter. The distance falls in

the wide hiatus interior to the orbits of Hilda and Ismene.

4 *The distance 2.82.* At the distance 2.82 five periods of an asteroid would be equal to two of *Jupiter.* The difference between the two terms of the ratio is three, and hence the conjunctions would occur at angular intervals of 120°. Between the distances 2.753 and 2.803 we find twenty-three minor planets. In the next space of equal breadth, containing the distance 2.82, there is but one. This is No. 188, Menippe, whose elements are still somewhat uncertain. Between 2.853 and 2.903 we find ten asteroids.

Several other gaps have been noticed, but they become less distinctly marked as the cases of commensurability become less simple. Those considered are the only cases in which the conjunctions would occur at less than four points of the asteroid's orbit.

The orbit of Hilda is doubtless nearly, if not quite, the outer limit of the zone. Its mean distance is 3.9523, and in the space immediately beyond—at the distance 3.9683—an asteroid's period would be two-thirds of *Jupiter's.* It may be observed, moreover, that at the distance 2.063, just within the orbit of Medusa, a minor planet would make four revolutions to *Jupiter's* one.

Are the gaps in the zone accidental?—In 1870, before half the asteroids now known had been discovered, Mr. Proctor, the well-known astronomer, wrote:

"The question may be suggested, however, is it not possible that the gaps thus apparent are merely accidental, and their accordance with the mean distances simply another accidental coincidence? It may seem, at first sight, that we have not as yet determined the orbits of a sufficient number of asteroids to decide very positively on this point. If another hundred were discovered, it might well happen, one would suppose, that the gaps would be filled up. But, in reality, the doctrine of chances is wholly opposed to this supposition. A law, such as that exhibited in the figure,* does not present itself without a cause. Irregularity is to

*Mr. Proctor's diagram was mearly a graphic representation of the groups and chasms of the zone.

be observed in all chance combinations, and the figure may be said to exhibit irregularity. But irregularities resulting purely from accident, never by any chance (when a fairly large number of cases is taken) simulate, so to speak, the operation of law. Therefore we may assume that when many more asteroids have been discovered, the law exhibited in the figure will appear even more distinctly."*

One hundred and twenty minor planets have been added to the list since this passage was written, and, as was then predicted, the chasms in the zone have been rendered the more obvious.

In three portions of the ring the clustering tendency is distinctly evident. There are from 2.35 to 2.46, from 2.55 to 2.80 and from 3.05 to 3.22; containing forty-three, ninety-six, and forty asteroids, respectively. We have thus an obvious resemblance to the rings of Saturn; the partial breaks or chasms in the zone corresponding to the well-known intervals in the system of secondary rings.

The rings of Saturn.—In the writer's Meteoric Astronomy published in 1867. the same principle employed to explain the chasms in the ring of minor planets was shown also to account for Cassini's division in *Saturn's* ring; and in a paper read before the American Philosophical society, on the 6th of October. 1871, the division discovered by Encke was explained in like manner. The details of these calculations need not here be repeated, especially as Dr. Meyer has quite recently discussed the whole subject, not only confirming the conclusions of the present writer, but indicating also other parts of the ring where the satellites unite in exercising special disturbing influences. So exhaustive is Dr. Meyer's discussion that "the correspondence between calculations and observation, as to the division of *Saturn's* rings, would now seem to be complete."

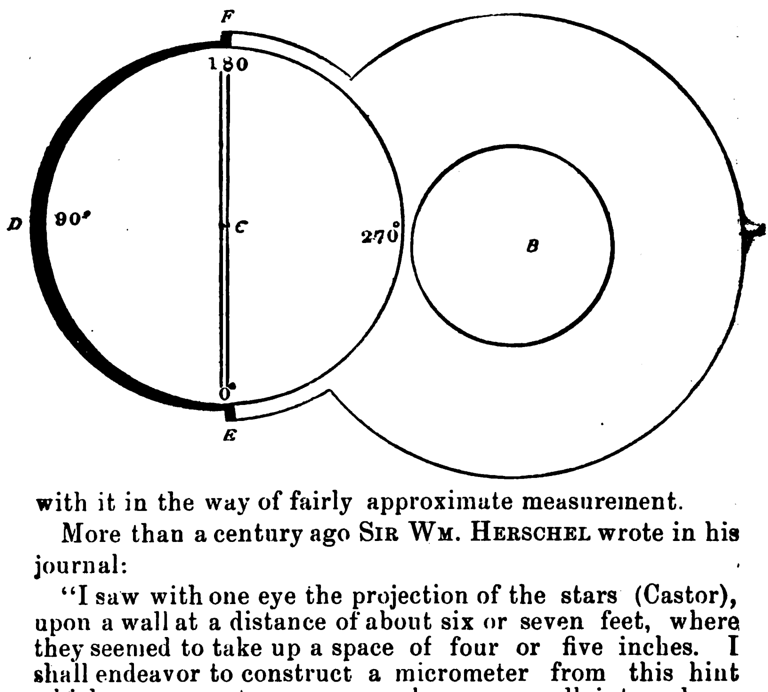
The discovery of a comet reported from Key West, on the morning of January 16, was a mistake. The Pons-Brooks' comet was the one seen.

*Intellectual Observer, vol. iv. p. 22.

A HANDY MICROMETER.

BY NEWTON M. MANN.

This article is not written for professional observers with ample equipments. Their derision is deprecated at the outset, and the plea is put in that the suggestions to be made are only for amateurs, having telescopes of moderate aperture, equatorially mounted, and either fixed or capable of being readily placed in good position. The instrument I shall propose has not the accuracy of the filar micrometer. Still it is very convenient, and from somewhat extended experiment I venture to think that something can be done



with it in the way of fairly approximate measurement.

More than a century ago SIR WM. HERSCHEL wrote in his journal:

"I saw with one eye the projection of the stars (Castor), upon a wall at a distance of about six or seven feet, where they seemed to take up a space of four or five inches. I shall endeavor to construct a micrometer from this hint which may serve to measure such a very small interval exactly."

This phenomenon which is often taken advantage of by microscopists to trace under one eye beside the microscope an outline of the object seen with the other through the instrument, and which is explained by Professor LE CONTE, (see "Sight" p 245) as "the heteronymous shifting of the two fields of view," I had often noticed before seeing this note of HERSCHEL'S; and I presume it is familiar to most persons who use a telescope. It occurred to me that it might afford a means of taking, at least roughly, the position angle of a double-star, and, after various experiments, I hit upon the following as the best device:

A sheet of brass is cut in the form of the figure *a d*, opposite, and fastened to the end of the large tube of the telescope. the tail-piece passing through the orifice *b*. On the arm *f d e* is laid a circle, graduated to degrees, and turning on the pivot *c*. This circle is blackened, and crossed by two bright parallel lines running from 0° to 180°. (In practice it may be covered with bright lines, parallel to these.) The graduation is in the reverse way from the ordinary position micrometer. At *e* and *f* are the indexes with fixed verniers. The instrument is fastened firmly on the telescope so that a line, drawn through the centers, *b c* shall be in the plane of the declination axis.

Now, with a small lamp behind us shining upon the circle, we turn our telescope upon a double-star. The image of the pair, of which HERSCHEL speaks, falls upon the circle, which we revolve until the two lie exactly between the parallel lines. We then take the reading from the index, *e*. In this case we use the right eye. When the telescope is turned over in the other position, it is necessary to use the left eye; the index *f* is then to the north, and the reading is taken from it.

An optical discrepancy remains to be guarded against. If you take an opera-glass, place your right eye to the left eyepiece, leaving your left eye free, and look at a bright line on the wall, or the top of a gilt picture frame, and, by this same heteronymous shifting of the two fields of view, try to bring the shadowy image of that line to the line itself as seen by your left eye, you will find that they cannot be made to coincide. The left end of the shadowy image drops below the line. Put the glass to the left eye in the same way, and the right end of the image falls below. This interesting experiment the reader can make without moving from his chair.* The angle of deflection is about 2½°— rather more, in my case 2°.7. In other words, a line, to appear horizontal to the right eye, must have the left end raised 1¼°, or a little more. To appear horizontal to the left eye, it must have the right end raised to the same extent. Thus in the use of our instrument, the direction of a line joining the stars, seen by one eye is deflected one way 1¼°; and the parallel lines on the circle, as seen by the other eye, appear turned 1¼° in the opposite way, making the reading when the right eye is at eye-piece 2½° too great; when the left eye is at the eye-piece 2½° too little. This is remedied by moving the index, *e*, 2½° farther from *d*, and the index, *f*, 2½° nearer *d* than they would fall if placed at right angles with a line joining the centers, *b*, *c*.

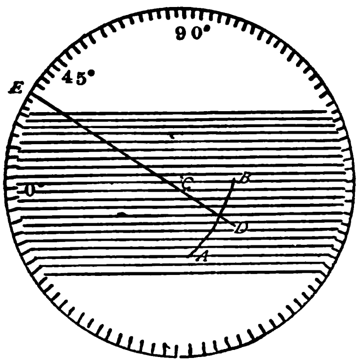
Measurements of distance may also be obtained with this instrument, attachments for this purpose will readily occur to any one who undertakes to use it.

HERSCHEL's method was to project the image of the stars upon a screen ten feet distance, where he found with a power of 460 the scale was one-fourth of an inch to the second. Suppose our instrument be one foot from the eye; then, according to this, the distance suptended by one second should be $\frac{1}{10}$ π of ¼ inch, = .00795 inches. With a power of 230 this would be ten seconds to the millimetre. Probably eyes differ, and each observer would need to make

*This optical phenomenon I have not found anywhere well cleared up. PROF. LE CONTE, in the work already referred to, pp. 197, 198, represents Helmholtz as saying that "the *apparent* vertical meridian does not coincide with the *real* vertical, but makes with it in each eye an angle of 1¼°", as I find to be the case. But he adds, "The *horizontal* meridians of the eyes, both real and apparent, coincide perfectly." "In order that a line shall appear perfectly vertical to one eye it must incline 1¼°", etc "*But a horizontal line appears truly horizontal.*" This is certainly not the case with me, but the superposed image of a horizontal line has the same inclination as that of a vertical line. If there are eyes with which this is not so, of course the instrument above described would be found inaccurate in certain positions of the observer to the extent of 2½°.

his own scale. With the last named above conditions I take much less than ten seconds to the millimetre. The method I have taken for distance is simple, and may be briefly described; premising that it is only for convenience in rough approximations.

Fig. 2.



Let Fig. 2 represent our graduated circle covered with fine parallel lines as before indicated the central line through *c* being conspicious. We have taken the position of a pair, let us say, whose angle is 0°, and revolved the circle one quadrant. The distance spanned by stars 90″ apart (with the eye-piece commonly used) has been carefully found by experiment, and the point *a* is made at this distance, and in a line perpendicular to the parallels, from the center. *c*. The pointer, *d e*, turns on the pivot, *c*, and has the longer arm a semi-diameter of the circle. Knowing the distance coresponding to 1″ as *m*, and the sine of 1° on the graduated circle as *n*, the distance *c b* is made to *c e* as *m* is to *n*. The points *a* and *b* are then joined by a curve of sines. The short arm of the pointer terminates in a silver wire which sweeps this curve, and the distance of its intersection therewith from the parallel passing through *c* may be read in seconds from the pointer *e* on the graduated periphery from 1″ up to 90″, each degree counting as one second. Such measurements, however, are attended with much more difficulty and uncertainty, as every change of position is likely to vary the distance of the disengaged eye from the surface on which the image appears.

ROCHESTER, N. Y. Dec. 26, 1883.

MINIMA OF ALGOL FOR 1884.

BY C. W. IRISH.

The following is a table of Algol's Minimum times for 1884 in 90th meridian.

Day	Time.	Day	Time.	Day	Time.	Day	Time.
Jan.	h m	Apr.	h m	Aug.	h m	Nov.	h m
2	5 48 a m	2	11 48 p m	7	3 35 a m	4	0 48 a m
5	2 36 "	5	8 37 "	10	0 24 "	6	9 37 p m
7	11 24 p m	20	4 41 a m	12	9 13 p m	9	6 26 "
10	8 13 "	23	1 30 "	30	2 06 "	21	5 41 a m
25	4 16 a m	25	10 17 p m	September		24	2 30 "
28	1 06 "	28	7 05 "	1	10 55 p m	26	11 19 p m
February		May		4	7 44 "	29	8 08 "
2	6 44 p m	13	3 09 a m	19	3 48 a m	December	
14	5 59 a m	15	11 58 p m	22	0 37 "	14	4 12 a m
17	2 48 "	18	8 47 "	24	9 26 p m	17	1 01 a m
19	11 36 p m	June		30	3 04 "	19	9 49 p m
22	8 25 "	5	1 00 a m	October		22	6 37 p m
March		7	10 30 p m	9	5 30 a m	January	
8	4 29 a m	25	3 23 a m	12	2 19 "	1885	
11	1 18 "	30	9 01 p m	14	11 07 p m	3	5 53 a m
13	10 07 p m	July		17	7 55 "	6	2 44 "
16	6 55 "	18	1 53 a m	November		8	11 31 p m
31	2 59 a m	20	10 42 p m	1	3 59 a m	11	8 21 "

It is proper to say that I have used the period as discovered by Goodricke in 1783, $2^d\ 20^h\ 48.^m8$. Fifteen of these periods are equal to $43^d\ 00^h\ 13^m$ so that at whatever time of day a minimum of Algol is seen, another can be observed at about the same time of the day six weeks one day and thirteen minutes after that. I observed a minimum on Dec. 21, 1883, at 6:30 p. m., with which I took considerable pains to be certain, and it is from this date and time that I have calculated the foregoing table.

I observe that Mr. E. F. SAWYER reports one as having occurred on Nov. 28, 1883, at about 7 p. m. I sought to check my own observation by his, but found a difference of one hour between us, his being just one hour earlier than my time. As my time was for this meridian I conclude that his was Washington time, or else one of us have made a mistake of one hour in observing.

ASTRONOMY IN HIGH SCHOOLS.

BY THE EDITOR.

Teachers who instruct in the natural sciences, in the high school or in college, usually have had experience in the class-room and know the wants of students. In the elements of chemistry, natural philosophy, or physiology, for example, experiments and varions ways of illustration are used to make clear, vivid and real the fact or principle before the student's mind. Every successful teacher deems such helps necessary, and it is noticeable that officers in charge of the best schools will not allow studies of this class to be taught, without such important aids. This is as it should be. The results of such work judiciously done are always stimulating. Such instruction awakens in the mind of the student an ardent desire for knowledge. It makes him willing and anxious to study and observe that he may know for himself. And these are habits of mind in which the best work can be done as every one knows. In such lines of activity the text-book is chiefly a guide, or hand-book containing information about themes in nature which is to be verified in personal experience and so made personal property as far as possible.

In much the same way, the elements of astronomy may be studied and taught, in the high school and in the academy most profitably. Not even good results, as the writer thinks, can be obtained by keeping a student closely at a text-book and expecting from him only carefully prepared recitations. It is possible that a student may master the elements of a well written book, and still not be able to recognize the most common of celestial objects that meet the gaze at night. Such knowledge is of little account. It lacks certainty, it is only temporary, and at best, will be very soon forgotten. It is far better to attempt less and master fully and naturally what is undertaken.

These suggestions are made in the hope of interesting teachers of the elements of astronomy in every grade of school in regular study of the heavens by observation.

To do such work most effectively a systematic plan of reading and observation should be adopted and followed faithfully. Such a plan need not consume much time daily. A half-hour every clear night would be ample time to secure large results in the course of a single year. With this amount of observation the student would have gained enough knowledge of the heavens, and such facility in observation as to feel confidence in his own work. He ought then to be able to undertake original work of value to science if he has nothing more than a cheap star atlas and an opera-glass, and these every teacher of astronomy ought to have for the benefit of his classes if nothing more.

We propose now to give a brief outline to indicate a way of beginning the work in mind, and we will suppose the student has little or no knowledge of the geography of the heavens in the outset:—

1. With a star-map before him, a few directions will give him a start, so that with the naked eye he may trace and study the constellations.

(1). The zodiacal constellations locating the equinoxes, solstices, celestial equator, ecliptic, etc.

(2) The northern constellations, colures, prime vertical, prime meridian, pole of the equinoctial, pole of the ecliptic, a general idea of diurnal motion, etc.

(3). As many of the southern constellations as may be seen favorably.

In tracing constellations for the earlier part of this study, it is not desirable to locate stars smaller than the third magnitude, except when necessary to fill out the outline of figures to fix them in mind; in such cases it may be needful to use fourth magnitude stars. Very little attention needs to be given to the limits of constellations, for these are always traced from the star-map.

In connection with this outline study of the constellations, it is very helpful to make simple sketches of the figures and locate on the same the stars that have been identified indicating magnitude of all, and the name of those of the first and second magnitudes that can be known. These drawings should be uniform in size, on paper prepared for that purpose, and be submitted to some competent person for inspection and suggestion.

When this naked-eye survey of sky is completed the student has a foundation or frame-work for further and more particular study. The opera-glass may now be used with such advantage as to profit, surprise and greatly please the observer in the re-survey of the work already done. Of the particulars of this more will be said later.

To further this elemental study of the heavens, if a sufficient number of teachers of astronomy in the United States will engage in it, and provide themselves with the necessary inexpensive outfit to carry it on, consisting mainly of a cheap star-atlas and an opera-glass, blanks for observations and drawings, those in charge of the MESSENGER will prepare and print from month to month:—

(1). An outline of work.

(2). Will prepare and print a cheap star-atlas for this work,—not to exceed the cost of one dollar per copy.

(3). Will prepare and forward blanks tor observation and drawing.

(4). Will review written work at regular intervals if desired.

(5). Will give directions for the purchase of opera-glasses, that the best may be obtained, and at special rates.

Teachers and other persons interested are invited to correspond with the MESSENGER and send in their names for membership of "The circle for star-studies with the opera-glass."

THE RED SUNSETS.

BY THE EDITOR.

[Continued from page 296, Vol. II.]

At the close of our last, we were speaking of cosmic dust in the atmosphere as the probable cause of the brilliant sunsets which have been so frequent during the last four months, and which still continue with undiminished splendor.

January 9. Mr. BARNARD, Nashville, Tenn., was observing with the telescope in the immediate vicinity of the *Sun*, and saw numbers of small bright particles passing swiftly across the field. He says: "At 3 o'clock P. M., I caught a pretty bright one and followed it for a distance of ten degrees, horizontally towards the north. It was not round, it was not a point, very white; it grew dimmer and dimmer until it faded from view, at the above distance from the *Sun*. Power, fifty-two diameters. The focus of the instrument was adopted sharply to an object less than a mile distant. So whatever the object was, it could not have been more than a few hundred feet above the *Earth*."

Mr. BARNARD further says: "There is scarcely a day but that these objects are visible close to the *Sun*."

There is a very general agreement among physicists and astronomers in the thought that these phenomena are caused either by volcanic or meteoric dust in the atmoshere. All known observations and nearly all theories point to one or the other of these two causes. There is only one prominent exception known to the writer, and that is contained in the suggestion of Professor DANIEL KIRKWOOD, Bloomington, Ind., which is so important and so well stated that we give his own words as follows:

"The prominent facts to be accounted for in the recent twilight phenomena are:—

1. The general diffusion of the matter by which the appearance is produced; so far as known it completely envelopes the atmosphere.

2. Its great altitude; it has been visible two hours after sunset, indicating a height of between fifty and seventy miles.

3. Its persistence; it has been seen continuously, in favorable conditions of the atmosphere, for four or five months.

4. Its rarity; I am not aware that its barometric effect has been perceptible.

The theory which assigns the origin of the phenomena to the volcanic eruption in the Sunda straits on the 26th of August, or to that near the coast of Alaska at an earlier date, or to both, has been received with favor. The difficulties, however, in the way of its adoption are by no means inconsiderable. No similar results, at least to any great extent, had been known to follow volcanic eruptions. If the matter started from Java, August 26, its rate of motion through the atmosphere till its appearance in Brazil was 109 miles an hour. Or, if it be assumed that the appearance in South America was derived from the Alaska outburst we have the additional improbability that results before unknown followed volcanic eruptions in opposite hemispheres at nearly the same time. Again, what force could have maintained the volcanic matter at an altitude of fifty or sixty miles?

Without considering the meteoric hypothesis let us inquire whether any other explanation of the remarkable phenomena is available.

The outer parts of the zodiacal light extend as far as to the *Earth's* orbit. The particles of which it is composed must revolve round the *Sun* in different periods according to Kepler's third law; the parts on the outer rim with nearly the same direction and velocity as the *Earth.* There is nothing absurd in supposing that the latter may sometimes encounter the former and attach more or less of the nebular matter to its own atmosphere. May not the telescopic meteors seen by Mr. Brooks on November 28, have been derived from the zodiacal light?

Professor H. A. Newton, Yale college, has given the subject of meteoric phenomena considerable attention in years past. In a recent private letter he expressed the opinion that the red twilight skies might be due either to volcanic or meteoric material in unusual amounts in the upper air. As to the latter cause, no evidence appears showing that there has come into the atmosphere during the last six months any unusual amount of meteoric matter. The August meteors were not specially abundant; there has been no large meteoric shower, and the number of sporadic and large meteors has not been noticeably great. He further says: It is true that the *Earth* crossed the path of the Biela meteors in November and December; but the red skies began in September nearly three months before we reached the node, and Biela's comet, (what is left of it) is not due at the node till 1885.

On the other hand the volcanic outbursts in Java and Alaska give to the hypothesis of volcanic origin the support of a known active cause occurring at the proper time, and apparently adequate to produce the phenomena."

Professor S. P. LANGLEY, Allegheny observatory Pa., in a late issue of the *N. Y. Tribune* expressed the following view respecting the meteoric theory:

"At first I supposed the sunset matter a local phenomenon, but when the reports showed it to have been visible all over the world, it was obvious that we must look for some equally general cause. We know but two likely ones, and these have been already brought forward. One is the advent of an unusual amount of metoric dust. While something over ten millions of meteorites are known to enter our atmosphere daily, which are dissipated in dust and vapor in the upper atmosphere, the total mass of these is small as compared with the bulk of the atmosphere itself, although absolutely large. It is difficult to state with precision what this amount is. But several lines of evidence lead us to think it is approximately not greatly less than 100 tons per diem, nor greatly more than 1,000 tons per diem. Taking the largest estimate as still below the truth, we must suppose an enormously greater accession than this to supply quantity sufficient to produce the phenomenon in question; and it is hardly possible to imagine such a meteoric inflow unaccompanied with visual phenomena in the form of 'shooting stars,' which would make its advent visible to all. Admitting then, the possibility of meteoric influence, we must consider it to be nevertheless extremely improbable.

A VAST DUST ENVELOPE.*

PROFESSOR S. P. LANGLEY.

In 1878 I was on the upper slopes of Mount Etna, in the volcanic wastes, three or four hours' journey above the zone of fertile ground. I passed a portion of the winter at that elevation engaged in studying the transparency of the *Earth's* atmosphere. I was much impressed by the fact that here, on a site where the air is supposed to be as clear as anywhere in the world, at this considerable altitude, and where we were surrounded by snow-fields and deserts of black lava, the telescope showed that the air was filled with minute dust particles, which evidently had no relation to the local surroundings, but apparently formed a portion of an envelope common to the whole *Earth*. I was confirmed in this opinion by my recollection that Professor Piazzi Smyth, on the Peak of Teneriffe, in mid-ocean, saw these strata of dust rising to the height of over a mile, reaching out to the horizon in every direction, and so dense that they frequently hid a neighboring island mountain, whose peak rose above them, as though out of an upper sea. In 1881 I was on Mount Whitney, in Southern California, the highest peak in the United States, unless some of the Alaskan mountains can rival it. I had gone there with an expedition from the Allegheny observatory, under the official direction of General Hazen, of the Signal Service, and had camped at an altitude of 12,000 feet, with a special object of studying analogous phenomena. On ascending the peak of Whitney, from an altitude of 15,000 feet the eye looks to the east over one of the most barren regions in the world. Immediately at the foot of the mountain is the Inyo Desert, and on the east a range of mountains parallel to the Sierra Nevadas, but only about 10,000 feet in height. From the valley the atmosphere had appeared beautifully clear. But from this aerial height we looked down on what seemed a a kind of level dust ocean, invisible from below, but whose depth was six or seven thousand feet, as to the upper por-

*N. Y. Tribune.

tion only of the opposite mountain range rose clearly out of it. The color of the light reflected to us from this dust-ocean was clearly red, and it stretched as far as the eye could reach in every direction, although there was no special wind or local cause for it. It was evidently like the dust in mid-ocean from the Peake of Teneriffe—something present all the time, and a permanent ingredient in the *Earth's* atmosphere.

At our own great elevation the sky was of a remarkably deep violet, and it seemed at first as if no dust was present in this upper air, but in getting, just at noon, in the edge of a shadow of a range of cliffs which rose 1,200 feet above us, the sky immediately about, the *Sun* took on a whitish hue. On scrutinizing this through the telescope it was found to be due to myriads of the minutest dust particles. I was here at a far greater height than the summit of Etna, with nothing around me except granite and snow-fields and the presence of this dust in a comparatively calm air much impressed me. I mentioned it to Mr. Clarence King, then director of the United States Geological Surveys, who was one of the first to ascend Mount Whitney, and he informed me that this upper dust was probably due to the "loess" of China, having been borne across the Pacific and a quarter of the way around the world. We were at the summit of the continent, and the air which swept by us was unmingled with that of the lower regions of the *Earth's* surface. Even at this altitude the dust was peculiarly present in the air, and I became confirmed in the opinion that there is a permanent dust shell inclosing the whole planet to the height certainly of about three miles (where direct observation has followed it,) and not improbably to a height even greater; for we have no reason to suppose that the dust carried up from the *Earth's* surface stops at the height to which we have ascended. The meteorites, which are consumed at an average height of twenty to forty miles, must add somewhat to this. Our operations with special apparatus on Mount Whitney went to show that the red rays are transmitted with greatest facility through our air and rendered it extremely probable that this has a very large share in the colors of a cloudless sky at sunset and sunrise, these colors depending largely upon the average size of the dust particles.

It is especially worth that notice, as far as such observations go, we have no reasons to doubt it as the finer dust from the earth's surface is carried up to a surprising altitude. I speak here, not of the grosser dust particles, but of those which are so fine as to be individually invisible, except under favoring circumstances, and which are so minute that they might be an almost unlimited time in settling to the ground, even if the atmosphere were to become perfectly quiet. I have not at hand any data for estimating the amount of dust thrown into the air by such eruptions as those which recently occurred in Java and Alaska. But it is quite certain, if the accounts we have are not exaggerated that the former alone must have been counted by millions of tons and must in all probability have exceeded in amount that contributed by meteorites during an entire year. Neither must it be supposed that this will at once sink to the surface again. Even the smoke of a conflagation so utterly insignificant, compared with nature's scale, as the burning of Chicago was, according to Mr. Clarence King, perceived on the Pacific Coast; nor is there any improbability that I can see in supposing that the eruption at Krakota may have charged the atmosphere of the whole planet (or at least of a belt encircling it) for months with particles sufficiently large to scatter the rays of red light and partially absorb the others, and to produce the phenomenon that is now exciting so much public interest. We must not conclude that the cause of the phenomenon is certainly known. It is not. But I am inclined to think that there is not only no antecedent improbability that these volcanic eruptions on such an unprecedented scale are the cause, but that they are the most likely cause which we can assign.

Professor H. C. Wilson's observations and drawings of the Pons-Brooks' Comet, for January, contain new and interesting features. They will appear next month.

EDITORIAL NOTES.

Our leading article on the nucleus of the Great Comet of 1882, by Professor H. C. WILSON of the observatory of Cincinnati is esteemed an important part of the comet's history. The illustrations and table-work make its reading easy and meaning clear.

WILLIAM C. WINLOCK, assistant astronomer, Naval observatory, Washington, D. C., recently published a full series of observations of the Great Comet of 1882, extending from Sept. 19, 1882 to April 4,1883. Five full pages of lithograph plates show beautifully the character and changes of the nucleus, and the outlines of the 'outer envelopi' and the tail.

At the December meeting of the Royal Astronomical Society,* Mr. RAYNARD read a paper "On a Narrow Belt on the Planet *Saturn*." With an 18-inch glass reflector, it was seen to stretch across the disc slightly fading away towards either limb. It was almost as easily observed as the Cassini division on the ring. It has been recently seen by different persons at different times. This is an important observation because narrow belts are very rare on *Saturn*. We are not aware that such phenomena have been before noticed at all in the recent study of the planet.

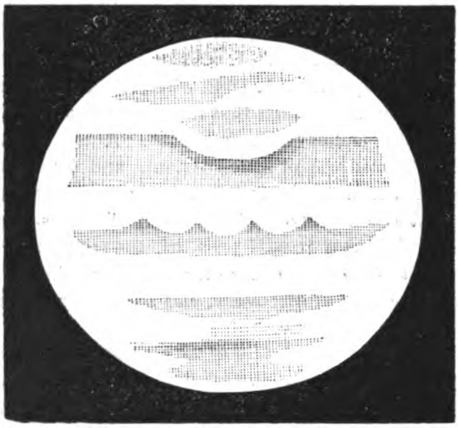
Mr. MATTIEN WILLIAMS of England is inclined to the view that our red sunset displays are due to clouds of meteoric dust. He has collected as much as seventy-five ounces of snow and tested the same with hydrochloric acid and he finds the usual indications of iron, except that the color is more green than that obtained from pure iron. The presence of nickel is suspected, though not yet proved. There was also the presence of the magnetic oxide of iron which was clearly shown by the decided action of the magnet on the larger granules of the deposit. The precipitate from snow-fall ought to give important evidence in determining whether this atmospheric dust is of the terrestrial or the meteoric kind.

Text-books on astronomy very generally compare the belt formations on the planet *Jupiter* to that of clouds in the *Earth's* atmosphere, and convey the impression that great changes in them are common, and that new belts may form in a very few hours. Observations do not warrant this view. The physical condition of the planet, in all probability, is not like that of the *Earth*, but rather more nearly like

*Observatory.

that of the *Sun*, a gaseous semi-liquid or viscious mass; elliptical in form, definite in outline with a disc, at least, partly self-luminous. Changes in the configuration of the surface that appear from hour to hour are mainly due to the rapid rotation of the planet on its axis, and also to the fact that the disc is nearly a hemisphere, and that objects seen on the limb look very different while passing the central meridian.

The accompanying cut represents a view of *Jupiter* as seen by R. M. LUTHER of Philadelphia, Pa, Dec. 23, 1883, at 11^h in the evening. Aperture of telescope, 2.857 inches; powers 130 and 180.



TELESCOPIC (INVERTED) VIEW.

The color of the great equatorial belt had a yellowish tinge, and the depression in the southern limit of it opposite the faint great spot is very marked, more so than in any other drawing, that we have seen for 1883. The great spot has remained nearly stationary, but the southern limit of the great equatorial belt has drifted to the south, apparently piling itself up around the spot, at a considerable distance away, as if obstructed by some repelling influence from the spot.

There are other interesting features of change in the surface derived from a careful study of the small white spots by the aid of the telescope and the micrometer.

β^1 CAPRICORNI.

The remarks of Mr. SAWYER in the January MESSENGER prove what I had no doubt of, and that is the duplicity of the 7th magnitude star just preceding Beta *Capricorni*. I believe the star is Beta^1 *Capricorni*. I hope the observations of Mr. SAWYER and myself will cause the star to be examined with some of the larger instruments when it is again favorably situated. E. E. BARNARD.

The comet is moving rapidly southward, and away from the *Earth* and the *Sun*, and hence its brightness will slowly diminish from day to day until lost to sight or below the horizon in northern latitude. Its chief physical characteristics to be observed at this return are already a matter of record, and not much more of special interest may be expected in its waning departure, even to observers in southern latitudes who may follow it with the telescope during the whole of next month. It was discovered by PONS of Marseilles, July 20, 1812, was visible about ten weeks, being seen by the naked eye early in September of that year. The orbit then computed by ENCKE made its period 70.6 years which fixed the next passage of perihelion in September, 1884, with a few years of uncertainty. It will be remembered that Professor BROOKS first saw it September 1, 1883, when it was exceedingly faint. It was however soon ascertained that the comet was the old visitor of 1812, in sight a little sooner than expected. About Jan. 15, it was nearest the *Sun*, 70 millions of miles distant, and about an equal distance from the *Earth* at the same time. A few days earlier it passed nearest the *Earth* at a distance of 53 millions of miles approximately. The first days of February it will pass into the southern constellation, *Sculptor*, and in March through *Phœnix* and *Horologium*. It will then be as faint as at the time of discovery, and soon after beyond the reach of the most powerful telescope.

The following ephemeris may be of service to those in southern latitudes desiring to follow it who have an ambition to try their eyes and telescopes on a celestial object, known to be gradually vanishing from sight:

BRUSSELS' EPHEMERIS.

1884.	R. A. h m	Decl. ° ′	Brightness.
Feb. 2	0 34	−28 3	2.3
11	1 2	−37 2	1.5
21	1 23	−43 7	1.0
Mar. 2	1 43	−48 5	0.6
12	2 2	−53 0	0.4
22	2 26	−56 2	0.2

The American computations put the time of passing perihelion about ten days later than that from which the above ephemeris is derived.

In the January number of the MESSENGER it was reported that Professor DAVIDSON had observed the comet with the naked eye, Dec. 1, which was thought to be the earliest record of its being seen without the aid of the telescope. I have a note for Nov. 28, which says: "To-night at 7^h the comet is just visible to the naked eye." In the 5-inch telescope, the same evening, I have:—"It is quite bright in the telescope, the tail is very difficult to see, not really certain that it was quite seen. The tail certainly has faded since last night." E. E. B.

The following elements and ephemeris of planet (235) have been computed by Professor E. FRISBY from observations made at the U. S. Naval Observatory, Washington, by commander W. T. SAMPSON, on the evenings of December 1, 6 and 21, 1883.

[Communicated by Rear Admiral Shufeldt, superintendent.]

	Wash. M. T.	App. α	App. δ
	h m s	h m s	° ′ ″
Dec. 1	13 13 19.5	3 16 31.80	+ 15 51 0.8
" 6	11 59 7.0	3 12 39.75	+ 15 50 6.1
" 21	12 12 46.0	3 3 48.88	+ 15 57 11.9

From which are derived the following elements:

Epoch. 1883 Dec. 21.5 Gr. M. T.

$$\left.\begin{array}{rcl} M &=& 275°\ 3'\ 21.2'' \\ \Omega &=& 67\ 13\ 21.2 \\ \pi-\Omega &=& 86\ 50\ 22.8 \\ i &=& 8\ 34\ 28.1 \\ \varphi &=& 4\ 10\ 44.2 \\ \log.\ a &=& 0.471817 \\ \mu &=& 695''.471 \end{array}\right\}\ \text{Mean Equinox 1883.0}$$

Comparison with the middle place gives,

$$\delta\lambda \cos\beta = 0''.0$$
$$\delta\beta = 0.0$$

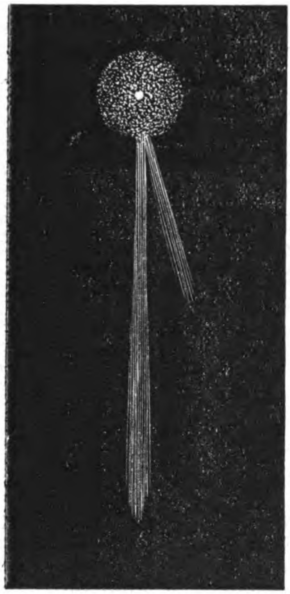
$$\left.\begin{array}{l} X=[9.995856]\ r \sin(v + 243°\ 49'\ 53.8'') \\ Y=[9.951720]\ r \sin(v + 157\ 48\ 10.8) \\ Z=[9.669480]\ r \sin(v + 138\ 36\ 6.8) \end{array}\right\}\ 1884.0$$

The following positions are computed for Greenwich midnight.

1884 Gr. $12^h.0$	App α			App δ		Log Δ
	h	m	s	°	′	
Jan. 3	3	0	23	+16	17.4	0.3585
7	3	0	12	16	26.7	0.3671
11	3	0	24	16	37.3	0.3758
15	3	0	59	16	49.1	0.3846
19	3	1	57	17	2.2	0.3934
23	3	3	17	17	16.5	0.4024
27	3	4	59	17	31.8	0.4113
31	3	7	2	+17	48.1	0.4201

Professor G. M. PHILLIPS, principal of State Normal school, West Chester, Pa., calls our attention to an erroneous statement respecting the line of change of time between the Intercolonial and the Eastern time districts. In the December number of the MESSENGER, it was stated that the line of change passed through the state of Maine. Professor PHILLIPS says the entire state of Maine belongs to the district of Eastern time. He speaks from an authoritative map and is donbtless right; we have no such map now before us.

Professor SWIFT, Warner observatory, Rochester, N. Y., on the evening of Dec. 29, caught the comet in one of its recent curious freaks. We have seen no notice of such an observation at an earlier date. We give his own description:



TELESCOPIC (INVERTED) VIEW.

"At 7 o'clock this enening I had a fine view for a few minutes (cut short by the clouds) of the Pons-Brooks' comet. I send you a drawing of it as seen through the 16-inch refractor of this observatory.

The coma is very large, as is also the nucleus, while the tail in comparison with the size of the head is very narrow. I could trace it to a distance of 6° or 8° and it is perfectly straight.

The principal object of this communication and ot the sketch is to call attention to the secondary tail which was for the first time observed. It is exceedingly difficult to see. It appeared 3° in length and like the priucipal tail narrow and straight. I shall watch with interest the further development of the new tail if indeed it is new."

BROOKS' (1812) COMET.

E. E. BARNARD, Vanderbilt university, Nashville, Tenn., favors us with full notes of observations of the comet, from which the following items of interest are taken:

First seen with the naked eye, Nov. 28. The tail was less bright in the 5-inch telescope than the night before.

Nov. 29. Condensation of coma noticed.

Nov. 30. A point like nucleus seen, tail brighter than ever before and one degree long.

Dec. 2. Comet very much brighter; tail 2¼° long, very straight, not perceptibly brighter along the axis. A large spot is seen in the head which contains a tiny nucleus.

Dec. 25. To the naked eye at 6 h, the brightness of the comet is fully equal Zeta *Cygni*. The tail in the 5-inch telescope is distinct, long and slim, and brighter along the axis. The nucleus is bright and slightly yellowish. The head is nearly round and has a beautiful pearly color.

Dec. 26. By naked eye comparison at about the same altitude, the

the comet is nearly as bright as the nebula of *Orion*, a little larger, but not so definite. The tail can be traced for 10° approximately.

Dec. 28. A faint tail could be traced 8° with the unaided eye. The nucleus is possibly a little smaller and sharper.

Jan. 9, 1884. By naked eye comparison, the brightness of the comet is between that of Epsilon and Zeta *Pegasi*. At 7^h it and the nebula of *Orion* were almost indentical in appearance.

OBSERVATIONS OF PLANET (235).

Observations made at the Naval Observatory, Washington, by W. T. SAMPSON, with the 9.6-inch Equatorial.

1883	M. T. Wash.	Planet —— * $\Delta\alpha$	Planet —— * $\Delta\delta$	No. of Com.	Planet α app.	log. $(p \times \Delta)$	Planet δ app.	log $(v \times \Delta)$	
					h m s		° ′ ″		
Dec. 1	13 13 19.53	−1 23.71	−1 54 4	20-4	3 16 31 80	9.48696	15 51 0.8	0.58793	1
" 3	11 18 40.82	−2 57.16	−2 31.0	15-3	3 14 58.36	9.04981	15 50 24.2	0.54266	1
" 5	10 47 54 80	−4 28.79	−2 52.4	25-5	3 13 26.73	8.83426	15 50 2.9	0.53831	1
" 6	11 58 6.99	+4 0.82	+0 36.6	10-2	3 12 39.75	9.33626	15 50 6.2	0.56103	2
" 9	15 17 19.69	+1 45.81	−2 9.0	15-3	3 10 24.14	9.67322	15 50 16 5	0.69931	3
" 18	8 9 50 85	−3 23.51	+1 59.2	25-5	3 5 14.84	9.15397_n	15 54 24.6	0.54438	3
" 21	11 12 46.03	−2 7.88	−7 29.7	20-4	3 3 48.88	9.41122	15 57 11.9	0.57015	4
" 28	10 23 1.02	−4 29.84	+1 19.8	15-3	3 1 26 89	9.34634	16 6 1.1	0.55811	4
" 29	8 01 31.58	−4 42.96	+2 58.2	15-3	3 1 13.77	8.75242_n	16 7 39.5	0.53228	4
Jan. 2	7 49 30.55	−2 53.70	−5 12.8	20-4	3 0 55.60	8.68337_n	16 17 4.6	0.52395	5

Star.	α 1883.0	δ 1883.0	Authority.
1	3 17 50.48	15 52 42.8	Bonn, 478.
2	3 8 33.92	15 49 16.1	Weisse, III 152.
3	3 8 33.83	15 52 12.2	Weisse, III 151.
4	3 5 57.79	16 4 28.2	Weisse, III 81.
	1884 0	1884.0	
5	3 3 47.75	16 22 17.9	Weisse, III 20.

The table of dates showing the minima of that wonderful variable star *Algol* kindly furnished by C. W. Irish will interest some of our readers who have been seeking such information.

Nearly all subscriptions to Vol. III. are now due and our patrons are requested to be prompt in remitting.

It is to be hoped that many old subscribers will also send one new name, at least, if the MESSENGER is deemed worthy of such support.

Subscriptions were received during the month of January from the following named persons:

John C. Ludwig, Cape Girardeau, Mo., John R. Hooper, Baltimore, Md., Geo. R. Vickers Jr. Baltimore, Md., Miss Anna Winlock, Harvard Coll. observatory, Cambridge, Mass., Dr. M. S. Dowling, Leslie, Mich., W. H. Numsen, Baltimore, Md., Professor H. B. Perkins, University, Appleton, Wis., John H. Eadie, Bayonne, N. J., Geo. W. Hough, Ypsilanti, Mich., John O. Williams, Springfield, Ill., Professor C. S. Howe, Buchtel College, Akron, O., Professor John Haywood Otterbein university, Westerville, O., Isaac P. Guildenschuk, Rochester, N. Y., Reading Room, Excelsior, Minn., Professor S. P. Langley, Allegheny observatory, Pa., Willis S. Barnes, Solon, Ind., Rev. G. Chapman Jones, Buffalo, N. Y., Charles H. Scales, Toronto, Ontario, Ca., Geo. Gildersleve, Baltimore, Md., J. H. Brithart, Indiana, Pa. S. W. Burnham, Chicago, Ill., J. D. Elliott, St Louis, Mo., University Library, East Minneapolis, Minn., J. D. Devor, Elkhart, Ind.

THE PLANETS.

[In Central Time.]

The red skies of morning and evening still continue. Physicists attribute these strangely beautiful phenomena to one of three causes: (1) volcanic dust, (2) meteors, (3) nebulous matter like that of the Zodiacal Light. The spectroscope shows that the colors seen are not due to watery vapor in the atmosphere. They evidently come from matter in a gaseous form, or in finelv divided state, and great extremes of temperature do not seem to modify their intensity in the least. They were first noticed Aug. 28 and have since been seen very frequently in all parts of the world.

The Zodiacal Light during the last week of January was very bright extending almost to the meridian. February will be favorable for observations of it.

The mean local time of the observatory is *slower* than 90th meridian time 12^m 35.89^s.

Feb. 1. The *Sun* is *slower* than the clock on local mean time, 13^m 47.1^s. Feb. 11, the difference is greatest being 14^m 27.75^s.

Feb. 29. The equation is 13^m 36.76^s.

The phases of the moon occur as follows: Feb. 3, 11^h 57.2^m p. m.; full moon, Feb. 10, 10 47.9^m p. m; last quarter, Feb. 18, 9^h 12.6^m p. m; new moon, Feb. 26, 0^h 35.1^m p.m. The moon will be in perigee, Feb. 4, 3^m p. m.; also, Feb. 29, 12^s. In apogee Feb. 18, 2.3^m a. m.

Mercury was in inferior conjunction January 20, it will be in greatest elongation, west, Feb. 13, $10^h 8^m$; 26° 12′. It will be then 20° in south declination and hence not very favorable for naked eye view. Feb. 5, its diameter is 8″; Feb. 25, 5.8″.

Feb. 5th, it rises, $5^h 38^m$ morning; 15th, $5^h 38^m$; 25th, $5^h 43^m$.

Venus is an evening star, in south declination and moving northward. During February its diameter ranges from 13.2″ of arc to 15.2″; its illuminated disc from .84 to .78 and its brilliancy from 67.5 to 76 5.

Its time of setting is respectively, Feb. 5th, $7^h 50^m$; 15th, $8^h 16^m$; 25th, $8^h 40^m$.

Mars is in favorable position for early evening observation. Its ruddy color in the eastern sky will seize the attention of those unused to star-gazing.

Feb. 1. *Mars* was in opposition, and hence nearest the *Earth* for this year, The planet is however now near the aphelion. When in perihelion and also in opposition, it is then nearest to the *Earth*. This was the case in 1877, when Professor HALL of the Naval observatory, discovered its tiny satellites, the planet then being only 35 millions of miles away, Such favoring circumstances will not again occur until 1892.

About Feb. 1, is the most favorable time of the year to observe the satellites; but it is very doubtful if they will be seen at all, this year, for the planet must be 60 millions of miles distance at opposition. Its time for rising for Feb. 5, 15, 25, are respectively, $4^h 4^m$; $3^h 5^m$; $2^h 13^m$; in the evening. Its average angular diameter is 13″ of arc. The apparent illuminated disc is nearly unity for this month. The numbers which represent the apparent disc, for any time, are the versed sines of the illuminated portion divided by the apparent diameter.

Minor Planets. The last discovered (No 235) was by J. Palisa, Vienna, Austria, Nov. 28, 1883. It is of the twelfth magnitude. Particular study of the Asteroid belt reveals the interesting fact that the small planets are not evenly distributed over the space between *Mars* and *Jupiter*; but that their orbits lie in groups with chasms between. The divisions of *Saturn's* rings and the grouping of the asteroids are probably due to like causes,

Jupiter and *Saturn* are in favorable positions for observation.

BOOK-NOTICES.

Elementary Geometry, new edition, including plane, solid and spherical Geometry, with practical exercises. By Edward Olney, Professor of Mathematics in the University of Michigan, Messrs. Sheldon & Co., publishers, New York and Chicago, 1883, pp. 333.

The authors school edition of elementary geometry, published in 1872, we have used in the class-room more or less for nine years. In most respects his plan and method have proved excellent. The introductory part, containing about sixty pages of definitions, illustrations, examples and exercises about, and upon, the main topics of geometry has always been thought by us most needful to prepare the students for the work.

In the new edition this part has been omitted, and what was necessary to make the work complete has been scattered through the book under appropriate subjects. In our judgment, this is a loss in the arrangement of the book rather than a gain. The average student will certainly be put at a disadvantage by it.

In other things the new edition is much better than the old, especially in these particulars: Philosophical arrangement; simplified and yet comprehensive; parallels better treated; original investigation provided for; good checks against mere memory work; improved method of treating incommeusurables, and generally those special adaptations to the class-room that plainly show the judgment and experience of the teacher as well as the skill of the mathematician.

A treatise on plane and spherical Trigonometry, by William Chauvenet formerly Professor of Mathematics and Astronomy in Washington, University, St. Louis, ninth edition, Messrs. J. B. Lippencott & Co. publishers, pp. 256.

It is most gratifying to notice that the study of the higher mathematics, in recent years, is receiving special attention in the great educational institutions of this country. This might be expected in the older colleges and universities, but it is surprising to know what is being done in those recently founded on a liberal plan and with munificent endowments. Harvard, Michigan, Yale and the Naval Academy have been exemplary for years, but Johns Hopkins is evidently now taking the lead in modern research in pure mathematics There is reason for this advancemant in the study of mathematics. Almost every branch of science is already so far in its development as to need and almost necessarily depend on the mathematics for further progress. The higher mathematics is the one efficient instrument by which proper generalization can be secured.

As a complete introduction to the study of trigonometry, Chauvenet's work is undoubtedly the best. The student who masters it has a ready knowledge of the science that is most pleasurable and efficient in all common applications. Our experience in its use in post-graduate classes has been gratifying. Students are able to undertake original work and they like to do it. They soon gain such a familiarity with the principles of generalization and transformation that work which is either long or complicated is no longer drudgery. This book may well find a place in the library of every teacher of mathematics.

The Sidereal Messenger.

Conducted by WM. W. PAYNE, Director of Carleton College Observatory. Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. NO. 2. MARCH, 1884. WHOLE NO. 22.

The Determination of the Division Errors of a Meridian Circle, by DR. KEYSER, *Director of the Leyden Observatory. Translated and abridged from the Leyden Observations, Vol. II, by* EDWARD S. HOLDEN.

The ordinary method of determining the Division Errors of a Circle depends on the assumption that the small differences between arcs which should be equal, can be measured with precision by means of micrometer microscopes, and upon the axiom that the whole is equal to the sum of all its parts.

If we have an arc whose terminal lines are a and z and which is divided into k like parts by intermediate lines b, c, d, etc., to determine the errors of these intermediate lines we use two microscopes at a distance apart of nearly ab, bc, cd etc.

Turning the circle, we place the first microscope on a, and we read the second microscope on b by means of its micrometer-head. Then by turning the circle, the first microscope is pointed on b, and the second is read on c. This process is continued until all the small arcs *ab*, *bc*, *cd* etc., have been compared with the first.

The differences

$$bc - ab = \mathrm{m},$$
$$cd - ab = \mathrm{n},$$
$$de - ab = \mathrm{o},$$
etc.,

are then formed; and m + n + o+ etc = P. Suppose the errors of a and z to be f (a) and f (z) then we have,

Error of $a = f\,(\mathrm{a})$

$$b = f\,(\mathrm{a}) + \frac{f\,(\mathrm{z}) - f(\mathrm{a})}{\mathrm{k}} + \frac{\mathrm{P}}{\mathrm{k}}$$

$$c = f\,(\mathrm{a}) + \frac{2\,[f(\mathrm{z}) - f(\mathrm{a})]}{\mathrm{k}} + \frac{2\,\mathrm{P}}{\mathrm{k}} - \mathrm{m}$$

$$d = f(\mathrm{a}) + \frac{3\,[f(\mathrm{z}) - f\,(\mathrm{a})]}{\mathrm{k}} + \frac{3\,\mathrm{P}}{\mathrm{k}} - \mathrm{m} - \mathrm{n}$$

etc., etc., etc.

The *eccentricity* must also be eliminated, and this is done in the simplest manner by reading two microscopes, 180° from each other and taking the mean of their readings.

Thus we add to the first and second microscopes, two others diametrally opposite, and by reading all four microscopes for each setting we compare those arcs which are limited by the lines, 180° + *a*, 180°+*b*, 180°+*c*, etc. as well as those first named. If the means of the readings of opposite microscopes are formed, the computation gives the half-sum of the errors of two opposite lines, that is to say the error of that diameter which passes through these lines; and this quantity is all that it is necessary to know.

In the determination of the division errors of the Leyden circle, no cases have arisen which are not comprised in the division of an arc of the circle, or the angle between two diameters into *two* or *three* equal parts. The process is extremely simple, but as it is easy to err in prefixing the + or − sign to the quantities determined, I will write out the programme which I prepared, in full.

If we always give to an error a sign such that if we apply the error with the sign to the erroneous reading we shall obtain the correct reading, it is to be remarked that the *error of an arc* has a different sign from the *error of its terminal line,* whose erroneous position is the cause of the error of the arc.

If for example the lines 0° and 90° are exactly right, and the arc 0°–45° too large, the *error of this arc is negative.* The *line* 45° must then lie further from 0° than the true position of 45°, and when 45° is read on the microscope, the screw must be turned farther [since the microscope revolutions increase from 45° towards 0°] and therefore the *error of the line is positive.*

In ordinary observations, we have to determine that point of the divided limb which lies between the two threads of the microscope, when its scale and head stand at 0_{rev} and zero. By means of the screw we measure the distance between this zero and the next *less* division, and the required quantity is the sum of this next less division and the microscope reading on it.

The numeration of the seconds on the microscope-micrometer-head increases as the numeration of the circle decreases. If we have read two microscopes, the difference of these readings is the distance of the zeros of these two microscopes relatively to the lines employed.

In the investigation of division errors however, we have to determine the distance between two lines referred to the distance between the zeros of two microscopes. If the difference between the readings of two microscopes is too *large,* the arc in question is too *small.* This assumes that the microscopes are arranged as for ordinary observations.

The investigation of division errors depends entirely upon the determination of the small differences between arcs which should be alike. Within certain limits, the distance of the two microscopes is arbitrary provided it remains constant.

We may if we like, reverse the micrometer-box of one of the microscopes or set the circle by a contrary way, and the whole problem comes back to this: to decide which one of two arcs compared with each other, is the larger. All danger of mistake is avoided, if we remember that, in the ordinary arrangement of microscopes a larger difference between the readings of the micrometer-heads corresponds to a smaller arc of the division of the circle.

I assume that the arc *a c* on the limb of the circle should be divided into two equal parts by the line *b*, and that the lines *a b c* follow each other in the same order as the increasing numbers on the circle. That is *c* corresponds to a larger number than *b*, and *b* than *a*.

Let two microscopes I and II be so placed that II always corresponds to the greatest degree in the numeration of the circle, and that their distance is *ab* or *bc* approximately. Now bring *ab* under the microscopes and read the micrometer-heads of both I and II. Then bring *bc* under, and again read both I and II.

When *ab* is under I and II let

m be the reading of the head of I on *a*,
n " " " " " " " II " *b*.

When *bc* is under I and II let

o be the reading of the head of I on *b*,
p " " " " " " " II " *c*.

Call the errors of *a* and *c*, *f*(a) and *f*(c).

Then

$$\text{Error of } b = \frac{(\mathrm{p}-\mathrm{o})-(\mathrm{n}-\mathrm{m})}{2} + \frac{f(\mathrm{a})+f(\mathrm{c})}{2}$$

If we have an arc *ad* which should be divided into three equal parts by *b* and *c*, I and II are to be set at the distance *ab*, *bc*, *cd* and these arcs are to be compared.

a, *b*, *c*, *d* follow in order with increasing numeration of the divided circle.

When *ab* is under I and II;

m is the reading of I on *a*,
n " " " " II " *b*.

When *bc* is under I and II;

o is the reading of I on *b*,
p " " " " II " *c*.

When *cd* is under I and II;

q is the reading of I on *c*,
r " " " " II " *d*.

Call $f(a)$ and $f(d)$ the errors of a and d.

Then,

$$\text{Error of } b = +\tfrac{1}{3}[(r-q)-(p-o)]+\tfrac{2}{3}[(p-o)-(n-m)] +f(a)+\tfrac{1}{3}[f(d)-f(a)].$$

$$\text{Error of } c = +\tfrac{2}{3}[(r-q)-(p-o)]+\tfrac{1}{3}[(p-o)-(n-m)] +f(a)+\tfrac{2}{3}[f(d)-f(a)].$$

If, as is commonly the case, the errors of diameters [and not of arcs] are to be determined, microscopes III (opposite to I) and IV (opposite to II) are to be fixed, and the mean of the readings of the heads of I and III takes the place of *m, o, q*, while the mean of the readings of II and IV takes the place of *n, p, r*, in the preceding formulæ.

The application of this theory is limited by the practical fact that the microscopes can not be placed at *every* distance apart. In the Leyden circle the microscopes can not be brought nearer to each other than about 40°, and no matter how the microscopes are arranged, two of them must always remain a certain number of degrees apart.

If however, the whole circumference has been once divided into a certain number of equal parts, and the errors of certain divisions determined, arcs become known, which can be taken as greater than 360°, and whose aliquot parts are greater than 40°. By the subdivision of these arcs the errors of other lines, as yet unknown, can be determined.

By this process it is not difficult to determine the errors of every 5°, even in the case where the microscopes can be brought no nearer than 40°.

When we come to this point all arcs which are multiples of 5° become known, and by taking these large enough, we can again determine the errors of the 1° divisions.

If we have to determine the errors of the lines which lie close to each other [5′ to 5′, 2′ to 2′ etc.] the influence of the accidental errors of observation increases rapidly as we divide an arc into a large number of equal parts. HANSEN (in *Ast. Nach.* No. 388) has given a formula for the determination of the relative accuracy with which the different lines are determined. The proof of this is not difficult and it results from what follows:—

Let

m be the number of small equal arcs into which a larger arc is to be divided,

w be the probable error of each one of these smaller arcs,

w (r) be the probable error in the determination of the error of the rth line, then

$$w(r) = w\sqrt{\left\{\frac{r(m-r)}{m}\right\}}$$

The maximum value of w (r) corresponds to m = 2 r.

A single microscope commands a certain portion of the divided limb, and within its field the distances of the visible lines may be measured and compared.

If we assume that the division errors for every 5° are determined, and that the 5′ lines are to be fixed, it would be necessary to divide the 5° spaces into 60 equal parts, and the weights of the resulting division errors of the 2½° marks would be one-fifteenth of the weight of the measure of a single space.

If the circle is divided to 2′, the 5° spaces must be divided into 150 equal parts and the weight of the 2½° marks would be 37.5 times less than the weight of the measures of a single space.

* * * * * *

There are only four instruments known to me which have the errors of each 1° determined by direct measures. These are the Pulkova vertical-circles and the meridian-circles of Greenwich, Paris and Washington.

* * * * * *

I have found a very simple arrangement [for the determination of the errors of every line] which was first described in the Leyden Observations, Vol I, page LXXXIII.

Although it is not possible to properly place two microscopes within a very short distance of each other, there is nothing to prevent placing them so that their distance shall be 180° ± this small distance.

By turning the circle the lines *a*, *b*, *c*, to be investigated are brought in succession under microscope I, and microscope II is read in succession on the lines under it. The circle is then turned about 180° and the lines which lay 180° from *a, b, c* in the first process, are now brought under I, and microscope II is read on the marks under it.

A very simple combination of the differences of the readings of Mic. II, gives the half sum of the errors of the lines which lie 180° from each other and thus the error of the diameter with which we alone have to do.

This method has many advantages, chief among which is that two auxiliary microscopes can be placed so as not to interfere with the four used for regular observations. * * * In order to avoid the awkward expression, *Correction on account of an error of division,* I shall, in what follows, denote by the *division-error* of a line, that quantity which must be applied to the reading on that line, with its proper sign in order to obtain the correct reading. [In other words division-*error* here means division-*correction.*]

The *division-errors* of the lines *a, b, c.* etc., I denote by f(a), f(b), f(c), etc.

That terminal line of an arc which corresponds to the *smaller* reading of the circle numeration, I call the *under,* that which corresponds to the greater reading of the circle I call the *upper* terminal line, so that the direction from the *under* to the *upper* terminal line is the direction of increasing graduation.

If the *under* line is correct, but the arc too large the *upper* line falls on a part of the limb where the microscope must read more than the line gives. The division-error of the line, is in this case positive, whereas the error of the arc is negative. In general, if a line lies at a point of the limb where the arc is greater than the name of this line, then we must read at the line *too little* and its error is positive.

Let *a* be the *under, b* the *upper* end-lines of an arc *ab,* and let the (positive) errors of *a* and *b* be f(a) and f (b). Let A and B be the points of the limb where *a* and *b* should fall, then *a* lies in relation to A, and *b* to B in the direction of increasing graduations. *a* lies between A and B, B lies between *a* and *b,* and the arc A B is the value which *a b* should have. Thus

$$ab = AB - Aa + Bb$$
$$ab = AB - f(a) + f(b).$$

If you look at either of the Leyden circles from the side on which it is divided, the graduations increase in the order left hand, top, right hand. On the left hand, at the end of a horizontal diameter I put a microscope without a micrometer, which I call microscope I. Opposite it, is a micrometer-microscope, II. The divided head of II is directed upwards. If this head is turned in the direction of increasing readings the threads move in the direction of increasing circle graduations.

Increasing numbers on the divided head thus give greater arcs on the limb of the circle. This is the opposite of the ordinary arrangement.

Let a be the under, z the upper terminal-line of an arc az which is divided by the lines b, c, d, etc. into parts which should be equal. a b c – – – follow in the order of increasing graduation. Let a′ b′ c′ – – – z′ be the divisions lying opposite (diametral) to a b c – – – z.

Assume that the errors of the diameters aa' and zz' are known: that is $\frac{1}{2}[f(a)+f(a')]$ and $\frac{1}{2}[f(z')+f(z')]$ are known.

The errors of the diameters bb′, cc′ etc. are to be determined: that is $\frac{1}{2}[f(b)f(b')]$; $+\frac{1}{2}[f(c)+f(c')]$ are to be determined.

Microscopes I and II were first so placed that their distance, counted from I in the direction of increasing circle graduations was very nearly $180°+ab$.

By turning the circle a, b, c, – – – are brought successively under I. b′, c′, d′ come under II, which is pointed on each one and read for each. The difference between two immediately following readings of the head gives one of the differences

$$ab - b'c'.$$
$$bc - c'd',$$
$$cd - d'e',$$
etc. etc.

As the reading of the head of II. increases with increased readings of the circle, $b'c'$ will be smaller than the arc ab, when the reading of the head for the pointing on *b* and *c'* is smaller than for the pointing on *a* and *b'*.

In this case the difference:

$$ab - b'c'$$

is positive; and so for bc — c' d' etc.

If we write all degrees and minutes on which the lines a, b, c, etc., fall, in order in one column, and if in a parallel column we write the readings of the head of II which correspond to them, we have only to subtract each number of this second column from the one standing immediately over it, in order to obtain the quantities.

$$ab - b'c'$$
$$bc - c'd'$$
$$cd - d'e'$$
etc.

with their correct signs.

After a b c d - - have been set, in their order under I, and the corresponding readings on b' c' d' made by II, the circle is to be turned 180°.

a' b' c' - - - are then to be placed, in order, under I, and II is to be read on the lines *b*, *c*, etc.

If a' b' =bc, then the reading of II for *b* and *c* would be the same.

If the reading for *c* is less than the reading for *b* then *bc* is less than a' b' and

a' b' — bc is positive and not
b c — a' b'

If as before the circle divisions corresponding to a' b' c' - - - are placed under each other and in a 2d column the corresponding readings of II on b c etc., and then each number in this 2d column subtracted from the one immediately over it, then we shall have the quantities.

$$a'b' - bc,$$
$$b'c' - cd,$$
$$c'd' - de,$$
etc.

with their proper signs.

For brevity let us put

$p = ab - b'c'$, $q = a'b' - bc$,
$r = bc - c'd'$, $s = b'c' - cd$,
$t = cd - d'e'$, $u = c'd' - de$,
$v = de - e'f'$. $w = d'e' - ef$.
etc. etc.

$$k = \tfrac{1}{2}[f(a) + f(a')]; l = \tfrac{1}{2}[f(z) + f(z')].$$

So that *k* and *l* are the errors of the diameters of the terminal lines of the arc which is to be divided.

k always refers to the *under*, *l* to the *upper* terminal line.

Also, let $f'(b)$, $f'(c)$ etc., be the errors of the diameters corresponding to b, c, etc., so that

$$f(b)=\tfrac{1}{2}[f(b)+f(b')]; f(c)=\tfrac{1}{2}[f(c)+f(c')]$$

and let *m* be the magnitude which each of the arcs ab etc. must have

* * * * * * * * * *

Division of an arc into two equal portions.

An arc *ac* has the errors of the end lines $f(a)$ and $f(c)$ given. The error of the middle line *b* is required.

$$p=ab-b'c',$$
$$ab=m-f(a)+f(b)$$
$$b'c'=m-f(b')+f(c')$$
$$p=f(b)+f(b')-f(a)-f(c')$$
$$=2f(b)-f(a)-f(c')$$

$$q=a'b'-bc,$$
$$a'b'=m-f(a')+f(b')$$
$$bc=m-f(b)+f(c)$$
$$q=f(b)+f(b')-f(a')-f(c)$$
$$=2f(b)-f(a')-f(c)$$

$$p+q=4f'(b)-2f(a)-2f(c)$$
$$=4f'(b)-2f(k+l)$$

$$f(b)=\frac{p+q}{4}+\frac{k+l}{2}$$

Division of an arc into three equal parts.

An arc *ad* has the errors of its end-lines $f'(a)$ and $f(d)$

known. The errors of the middle lines b, and c, are required.

* * * * * * *

$$f[b]=\frac{p+q}{3}+\frac{r+s}{6}+\frac{k+l}{3}+\frac{k}{z}$$

$$f[c]=\frac{p+q}{6}+\frac{r+s}{3}+\frac{k+l}{3}+\frac{l}{3}$$

Division of an arc into five equal parts.

An arc *af* has the errors of its terminal lines $f[a]$ and $f[f]$ known. Required the errors of the intermediate lines b, c, d, e.

Put $\alpha=\frac{4[p+q]}{10}+\frac{3[r+s]}{10}+\frac{2[t+u]}{10}+\frac{v+w}{10}$

$$\beta=\alpha-\frac{p+q}{2},$$

$$\gamma=\beta-\frac{r+s}{2},$$

$$\delta=\gamma-\frac{t+u}{2}.$$

Then,

$$f[b]=k+\tfrac{1}{5}[l-k]+\alpha$$
$$f[c]=k+\tfrac{2}{5}[l-k]+\alpha+\beta$$
$$f[d]=k+\tfrac{3}{5}[l-k]+\alpha+\beta+\gamma$$
$$f[c]=k+\tfrac{4}{5}[l-k]+\alpha+\beta+\gamma+\delta$$

The terms of the above formulæ which do not contain k and l give the errors of the intermediate lines, in relation to the end lines. I call them *relative-errors*, and they would be absolute if the end-lines were correct. The terms containing *k* and *l*, give that part of the error of the intermediate lines which depends on the errors of the end-lines. The sum of these two parts I call the *absolute error* and this it is which must be applied to the reading on any line to free that reading from division error.

These two parts of the absolute error are presented [in tables which are omitted here] separately, so that a new determination of the parts containing k and *l* may be at once introduced into the determination of new absolute errors.

For a circle divided to 5′, for which the errors of each 5° are already known, two observers working together for one hour daily require about three months to determine the errors of each line. This is $\frac{4248}{4320}$ of the whole number of the lines.

[A circle divided to 2′, whose 5° spaces were known would have 10,728 lines to be determined, and some 2.5 times three months would be required for the observations; say seven and a half months, an hour each day for two observers.]

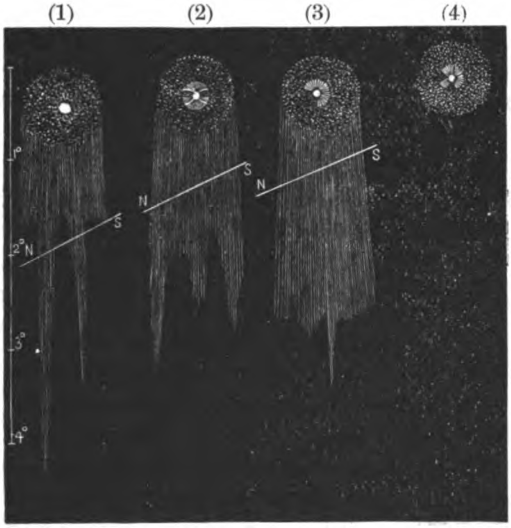
CHANGES IN THE BROOKS' COMET.

W. T. SAMPSON, NAVAL OBSERVATORY, WASHINGTON, D. C.

I send you a sketch of BROOKS' comet in which an attempt is made to represent a remarkable change which took place in the comet about January 13. On that evening the comet presented, in the 9.6-inch equatorial, the appearance shown in fig. (2). The well-defined and almost circular envelope which is represented was entirely wanting when the comet was seen on previous occasions. The nucleus was much more condensed and star-like than at any time before. The envelope was of nearly uniform brightness, radial in structure, with a perfectly defined outline which was easily measured. It seemed to be produced by two fan or sector shaped emanations from the nucleus which curving backward toward each other, met at the outer edges, leaving a darker elliptical space on each side of the nucleus. The space on the north side being the darker, and the preceding fan-shaped portion having an extension on the north side. A line drawn through the middle of the dark spaces would be perpendicular to the axis of the tail. The diameter of this envelope was 1′ 20″, while the diameter of the outer nebulous envelope, as far as it could be readily traced, was about 6′ 9″. The spectroscope showed a bright continuous spectrum which was surprisingly strong in the red which completely masked many lines. As the comet had not been seen here for several days, this condition of things may have been of considerable duration. Clouds prevented another view until January 17, when the head presented the appearance represented in fig. (3). The inner envelope had lost its sharp outline, and the following portion had disappeared, leaving a corresponding dark space; while the preceding portion had increased its angular dimensions and revolved through an angle of about 60°. This is the appearance it presented, though the change may have occurred in a very different manner. The 26-inch equatorial did not

Head of Comet.

Dec. 28. (1) Jan. 13. (2) Jan. 17. (3) Jan. 23. (4)



BROOKS' COMET.

bring out any additional details. The distance from the following side of the nucleus to the outer edge of the inner envelope was about 32″; whereas it had been 40″ on the 13th, taking half the diameter of the envelope on the 13th to represent the corresponding measurement on the 17th. This peculiar bright envelope seemed entirely to disappear for a number of days, leaving the nucleus surrounded by the ordinary coma having no structural appearance. Again, on January 23rd it was developed into the form shown in fig. (4); the terminating line passing tangent to the nucleus being curved backwards as on previous occasions, leaving a large sector much less strongly illuminated on the north side. On the south following side there was a dark rift or sector as shown in the figure. On this occasion the diameter of the bright envelope was only 32″.7, being much smaller than on the previous occasions.

A very marked increase in the length of the tail of the comet occurred between Dec. 27th and Dec. 28th. Fig. (1) gives an idea of its appearance on the last mentioned day. For about one-third of its length, the tail was broad and fairly uniform in brightness; from the middle of this broad portion issued two long bright streamers, one being longer and brighter than the other. The total length was about four degrees.

The Lunar Eclipse of Josephus Flavius, a Problem for College Students. Professor JOHN G. HAGEN, S. J., *College of the Sacred Heart, Prairie Du Chien, Wisconsin.*

I. It is well known that the Jewish historian, Josephus Flavius, in his *Antiquitates Judaicæ* (XVII c. 6. n. 4), mentions a lunar eclipse, that was visible in Jerusalem the night after the cruel execution of forty students and their teachers, Judas Sariphai and Mathias Margalothi, by King Herod. As this tyrant died only a few months later, this eclipse has become an object of interest both to historians and astronomers.

In a recent publication,* Florian Riess, S. J. has shown that the eclipse must have taken place within the years 750 and 753 a. u. c., and that, as Herod died shortly before Easter, only the following probable eclipses are to be computed:

750	a. u. c.	March 12-13,
751	"	Jan. 31 and Marh 1-2,
752	"	Jan. 20,
753	"	Jan. 9-10.

*Das Geburtsjahr Christi, Stimmen aus Maria Laach, 1880.

The first of these was indeed visible in Jerusalem, having its middle after 2 o'clock in the morning, and being nearly six digits in magnitude. It was first computed by Keppler†, and considered by him as the one recorded by Josephus.

In the second case, the full *Moon* was not near enough the nodes to be eclipsed by the *Earth's* shadow; and in the third, the eclipse was not visible in Jerusalem; for it was entirely over, when the *Moon*, about 6 o'clock in the morning, rose above the eastern horizon.

In the last case, Jan. 9-10, 753 a. u. c., the eclipse was total and almost central, and visible in Jerusalem during its whole course.

Florian Riess, S. J. alleges that two grave reasons against Keppler, in favor of this latter eclipse as the historical one. In the first place, he says, Keppler's eclipse was far less calculated to leave on the minds of the people such an impress of Heaven's anger against Herod's cruelty, as to be remembered at the historian's time, ninety years after. Secondly, Josephus Flavius mentions a great many facts, as Herod's sickness, his journey to Kallirhoe, his death and funeral, etc., as happening between the eclipse and the Paschal feast, which can not possibly be piled up between March 13 and Easter; no such difficulty, however, can be urged against the last eclipse.

On the strength of these premises, therefore, the above-mentioned author computed the elements of this eclipse from the tables of Delhambre, Olufsen and Hansen, as follows:

Jerusalem mean time of opposition (in longitude) 753 a.u c. Jan. 9, $13^h\ 16^m\ 29^s$.

Sun's longitude	287°	35′	52.″6	Hourly motion		2′	32″	.9
Moon's longitude	107	35	52. 6	Hourly motion		36	51	.4
Moon's latitude			—73. 8	Hourly motion		− 3	13	.1
Sun's equa. hor. parallax	$\pi=$		8. 7	True semi-dia.	$R=$	16	15	.0
Moon's equa. hor. parallax	$p=1$	0	17. 0	True semi-dia.	$r=$	16	27	.2

II. The writer wishes to avail himself of this opportunity

†Inventitur autem eclipsis lunæ partialis digitorum pene sex, mane, diei 13, martii anno 42 (= 750 a. u. c), tribus horis ante solis ortum.

to show how this, and similar problems, may be given to students even in the lowest algebra classes as soon as they have become acquainted with equations of the second degree, and with the theorem of Pythagoras, viz: That in a right-angled triangle the square of the hypothenuse equals the sum of the squares of the other two sides. The solution of the problem comprises three parts, viz: The times of the contacts, the magnitude of the eclipse, and the angles of egress and ingress.

1. *Times of contact:*

If ρ denotes the radius of the earth's shadow, *i. e.* the radius of the circle in which the cone of shadow is intersected by a plane perpendicular to its axis and passing through the center of our satellite, a simple geometrical consideration furnishes the following value for ρ.

$$\rho=\pi+p\pm R\begin{cases}+\text{ for penumbra}\\-\text{ for umbra,}\end{cases}$$

which is to be increased by 2 per cent. on account of the terrestrial atmosphere. By the theorem of Pythagoras the equation for outer and inner contacts will be

$$(\rho\pm)r^2=a^2+b^2$$

where a and b denote the distances of the two centers in longitude and latitude. The number of hours elapsing between opposition and contact, may be denoted by x, and this, multiplied by the hourly motion, will give the increment (positive or negative) of a and b from the time of opposition to the moment of contact. Thus, in the case of the present problem the equation of outer and inner contacts is:

For the *Umbra:*

$$(2703.7\pm987.2)^2=(73.8+198.1x)^2+(2058.5x)^2$$

$$x=-.0034\pm\sqrt{\begin{matrix}3.184109+.0034^2 & \text{outer contacts}\\0.687643+.0034^2 & \text{inner contacts;}\end{matrix}}$$

and for the *Penumbra:*

$$(4692.8\pm987.2)^2=(73.8+198.1x)^2+(2058.5x)^2$$

$$x=-.0034\pm\sqrt{\begin{matrix}7.542337+.0034^2 & \text{outer contacts}\\3.209307+.0034^2 & \text{inner contacts.}\end{matrix}}$$

The number before the root denotes the *middle* of the eclipse, viz. 0.0034 hours or 0.2 minutes before opposition whilst the root itself expresses *half the duration* between first and second contact. Thus we obtain the following phases in mean time of Jerusalem:

First contact with penumbra, 753, Jan. 9^d	10^h	$31.^m5$
Second contact with penumbra,	11	28.8
Moon enters shadow,	11	29.2
Total eclipse begins,	12	26.5
Middle of the eclipse,	13	16.3
Total eclipse ends,	14	6.1
Moon leaves shadow,	15	3.4
Third contact with penumbra,	15	3.8
Fourth contact with penumbra,	16	1.1

2. *Magnitude.*

The *magnitude* of an eclipse, or the part of the diameter obscured, equals the sum of the radii of the two disks in question, minus their least central distance. If the magnitude is to be expressed in decimals of the diameter, the angular magnitude is to be divided by this diameter; and if in digits, this last result is multiplied by twelve. In the present case we have, by the theorem of Pythagoras, for the least central distance d of the disks (shadow and moon) the formula:

$$d^2 = (\rho+r)^2-3.184121\,(198.1^2 + 2058.5^2).$$

These figures have been explained and already computed in the equation of contacts, so that by a simple substitution we find $d = 73.''67$. The eclipse was therefore almost *central.* Then the magnitude is:

$$\frac{\rho=r-d}{2r}=1.832, \text{ (moon's diameter}=1).$$

3. *Angles of Ingress and Egress.*

Even this part of the problem may be solved by such students as are not yet acquainted with trigonometry, provided the professor shows them a table of natural sines or cosines, and explains the definitions of these functions. The sines (cosines) of these angles of contact are the quotients of the central distances in longitude (latitude) by the sum of the radii. If the angles of ingress and egress, with reference to the umbra, are α and β respectively, we have in our present case

$$\sin \alpha = \frac{2058.5 \times 1.7878}{\rho + r}; \alpha = 86^\circ \text{ toward the east,}$$

$$\sin \beta = \frac{2058.5 \times 1.7810}{\rho + r}; \beta = 83^\circ \text{ toward the west,}$$

counted from the north point of the moon's limb, as referred to the ecliptic.

III. In conclusion, the following additional remarks might contribute towards encouraging teachers in proposing problems of this kind to their classes.

First, if the elements of the eclipse are referred to the equator, the relative distance and hourly motion in Right Ascension of the two disks must be multiplied by the cosine of their mean declination. If the students are not able to do this, it may be done by the teacher in preparing the problem.

Secondly, in the case of a *solar* eclipse or the *transit* of a planet, if the teacher does not like to take upon himself the trouble of correcting, for the parallax of his place, the geocentric elements, which he will find in the Ephemeris, he may let the students compute the circumstances of the eclipse or transit as seen from the center of the *Earth*; and then by means of a terrestrial globe with horizon frame, find the countries in which the two outer contacts and the middle of the phenomenon are visible. The *Sun* would then be imagined right above the globe; but the globe must be rectified according to the declination of the *Sun* and the times of the phases: if, moreover, a horizontal disk of pasteboard, hanging down from the ceiling by a string, be swept over the globe just so far north or south as agrees with the declination of the moon or planet, the motion of the cone of penumbra may be brought before the eye of the student in the clearest manner. The diameter of this disk, expressed in diameters of the globe, is given in the American Ephemeris under the letter *l*.

That problems of this kind are taken up with great interest by students of algebra is sufficiently proved by the authority of the late Professor HEIS, who ranked first among his colleagues in Germany, and whose name is well-known also to the astronomers of this country. Amongst his numerous algebraic problems,* we find the two eclipses recorded in the history of the Peloponnesian war by Thucydides, and also the one mentioned by Cicero, De Republica I, 16.

In suggesting such astronomical problems to professors of algebra the writer feels confident, from his own experience in the class-room, of their practical utility; for he has had his pupils compute all the lunar and solar eclipses, together with the transits of *Mercury* and *Venus* as they have successively occurred; he even publishes the solution of this problem from their very copy-books. The interest displayed by his scholars he deems an evidence of success.

STAR-STUDIES WITH THE OPERA-GLASS.

BY THE EDITOR.

From the letters received in regard to home studies of the stars with the opera-glass, since the issue of the last MESSENGER, there seems to be more general interest in this elementary work than was anticipated. In view of what appears, steps have already been taken to secure the necessary aids suggested in the outline of the plan of work in our last article, such as star-maps, blanks for records and tracing or sketching, opera-glasses, etc. It will require considerable time to gather the desired information and to get ready for active and continuous work. Meanwhile for many who have an opera-glass, it will certainly be a profitable exercise to make as complete a study of the instrument in hand as possible. Elemental works on physics will give the student a general idea of the form and arrangement of the lenses, how they bend the rays of light

* Heis' Collection has lately been translated into English, and, it is hoped, will appear before the public in the course of this year.

from a straight path and form images near the observers eye in a way more convenient for study. For a fuller knowledge of the physical properties of lenses in most common use, the more complete works by Ganot or Daschenel (though they are called elementary) will be found definite, helpful and satisfactory. If any such work is read with an instrument in hand, and an attempt is made to apply the principles faithfully and rigorously, most students will find the field of study just as large and interesting as they care to make it.

It must be sufficient now to say that the opera-glass, single or binocular, is a Galilean telescope, or a pair of such instruments. Its object-glass is a double convex lens and its eye-piece is double concave in form.

In the best instruments both object-glass and eye-glass are acromatic being conbinations of three pieces of glass in each. The middle piece in each case is flint glass, and the other two are crown glass.

Different kinds of glass are used in the same lens, so as to transmit light through it and focus the same without showing the colors due to refraction and dispersion of light rays. The flint glass has greater dispersion power than the crown glass because it contains about 33 per cent. of the oxyde of lead, not a trace of which is found in the other. On account of this, and the difference in shape of the two pieces, refraction is secured and dispersion is neutralized, and objects are magnified without colors in the light by which they are viewed. Many other interesting facts will appear in connection with the study of the physical properties of ordinary optical instruments.

One of the first things that observers do in preparing for astronomical observation with a new instrument is to determine its magnifying power and its field of view, as it is called, which meanes the angular space on the sky that the glasses will bring before the eye at once, on account of their size and the curvature of their surfaces.

This knowledge is essential to good observation because without it much of the work attempted will be uncertain, for it can neither be checked, nor compared satisfactorily with similar work done by others.

The following are some of the more simple methods in common use for approximate results:

To find the magnifying power of the opera or field glass lay off distinct parallel lines on a smooth surface, as that of a planed board, say six inches apart.

Set the board thirty feet or more away, perpendicular to the line of sight, and view the spaces using the glass with one eye and the other without it, being careful to note how many divisions or spaces the unaided eye will make equal in width to a single division or space shown by the glass. If the glass magnifies three times, one space in the glass will just equal three seen by the unaided eye.

A number of devices will readily suggest themselves for determinating close approximations if the power is also fractional.

The opera-glass now at hand tried in this way shows a power of 2.6 nearly.

If we have any means of knowing the focal lengths of the object-glass and the eye-piece of any instrument, its magnifying power is then found by dividing the focal length of the obiect-glass by the focal length of the ocular.

The extent of field of view is easily found by noting the time that it takes any star near the equator to pass by the field. This time converted into degrees will give the magnitude of the field. Two stars whose distance apart is known may also serve the same purpose.

Another simple method consists in viewing an object thirty or forty feet distant and measuring on the same, the diameter of the field of view. Divide half of this diameter by the distance from the eye, and the quotient will be the natural tangent of half the field of view. A table of natural tangents will give the angular value sought.

Only the simplest and easiest methods of work are here given so that any person wanting to test an instrument for himself may be encouraged to do so because the task is not a difficult one.

The attempts, however, should be repeated times enough to show the substantial agreement of several results. Tried by the last method, the opera-glass at hand shows a field of 12° 24′.

Any persons interested in easy observations of the stars with the opera-glass as herein described and also in an article in the preceding number of this publication are requested to correspond for further information if desired.

PONS-BROOKS' COMET.

E. E. BARNARD, NASHVILLE TENN.

On the nights of Jan. 20 and 21, I had some very interesting observations of the comet. Jan. 20, with the eye alone, the tail was faintly visible for a distance of 18°, streaming back parallel to the southern outlines of the Zodiacal Light; though the tail was not noticeable for more than $1\frac{1}{2}$° to 2° from the head, there seemed to be a bright brush to that distance that could be followed distinctly. The telescopic view was very striking; the nucleus, round and star-like and very bright. A friend present remarked at once on the stellar appearance of the nucleus. A very faint envelope extended completely around the head which was bright and very even in its light—not softening toward the edges—like a uniform disc. There was considerable coma about the nucleus which seemed to extend beyond the head of the comet in front. The body for a distance of about one degree to the rear of the nucleus was pretty bright and of uniform light, and apparantly the terminus, but issuing out from this was the fainter part of the tail, along which numerous faint dark lines were occasionally visible; and though looked for no decided separation was seen. One degree back of the nucleus the confusion of the cometary light suggested some sort of disturbance.

Jan 21, the naked eye view was as the night previous, but the telescope revealed remarkable changes. The nucleus which was so distinctly stellar on the 20th had melted away into a mass of dense haze, the star-like form having entirely vanished. The head was very bright and even in light. Though closely looked for, I could not make out the faint envelope surrounding the head at the former observation. At the point one degree behind the nucleus, there seemed to be greater confusion of the light. The body of the comet appeared rapidly to swell and contract with quick pulsations in the light. I cannot force myself to believe this a deception, for close to the comet was a small star which seemingly for a moment would be involved in the nebulous matter and the next instant entirely free of it. The seeing was good, so it could scarcely be attributed to poor definition. The most remarkable change had occurred in the tail which had split into three distinct branches, at a distance a little over one degree back from the nucleus, the spaces were perfectly free of cometary matter. The southern branch was the brightest, the northern very faint. The split that caused the northern separation began at a greater distance from the head than the other.

On this date the same *flattening* of the head was noticeable aad the coma extended in front of the head for some little space, almost obliterating the outline of the comet.

DISCOVERY OF A NEW COMET—Professor KRUEGER reports that a message has been received from Melbourne announcing the discovery of a small comet on 1884, Jan. 12, in R. A. $22^h\ 40^m$, and S. Dec. 40° 8′, moving quickly towards the southeast. "Unless there has been some error in the transmission from Australia, the comet at present does not seem likely to become visible here."

NAMES OF MINOR PLANETS.—Herr Palisa announces that three of the minor planets discovered by him have been named as follows:—No. 220, Stephania; No. 221, Eos; No. 222, Lucia.

The Mean Solar Parallax from the Belgian observations of the transit of *Venus* (1882) at Texas is $8''.907 \pm 0''.084$.—*Observatory.*

EDITORIAL NOTES.

Professor E.S.HOLDEN's translation,the leader in this issue, is a most valuable paper on an important theme for the professional astronomer. Though occupying more pages than have been given to any one theme previously, those observers, or students of theory, for whom it is written, will find it by no means too long for interest or profitable study.

A.N.No.2,568 Professor J.HAGEN, College of the Sacred Heart,Prairie Du Chien, Wis., discusses" The deflection of the level due to solar and lunar attractions." If we remember rightly no less than six different solutions have been given to the "Lunar Deflection of the Vertical," and strange to say the one given by DR. PETERS, the only exact one, has been disregarded by those who have written since his time. We will soon publish the historical part of the article.

Professor S. C. CHANDLER of Harvard College observatory, kindly calls attention to the fact, that the outburst in the light of the Brooks' comet, Sept. 22, 1883, must have occurred in the space of four or five hours, as is strongly probable from observations in the *Astronomische Nachrichten,* No. 2453, and in *Nature* of about the same date. It is therefore very important that all observations of the comet on that day, in this country, by any persons who were following it should be known, that a complete history of its wonderful changes may be written if possible. To this end the MESSENGER especially requests that all observers examine their note-books and communicate to it everything of interest seen on that day.

Prof. DAVIDSON has communicated to the California Academy of Sciences some notes upon the appearance of *Saturn, Jupiter* and *Mars.* With regard to *Saturn* he states that the preceding part of the ring clearly shows the unequal division of the outer ring; the Encke dark division being nearer the outer circumference, whereas on the following part of the ring the reverse appears clearly to be the case. Because of this he attributes to the shadow of the outer edge the ring B projecting beyond the Cassini dark division and making it apparently broader and the inner part of the A ring narrower. This might lead to measurements for determining the height of this rim above the plane of A. He has noted a movement of the fine belt line accross *Saturn* to the southward; and thinks he has detected a fine dark line in the darker shading beyond the bright equatorial belt. Other points of interest are referred to in the case of *Saturn*; and a series of drawings of *Jupiter* has been kept up as well as of *Mars.* He reports a series of positions for the Pons, 1812 comet,extend ing from December 12 to January 25.

NOTE ON THE 228TH ASTEROID.

Agatha, the 228th minor planet, was discovered by Palisa, at Vienna, on the 19th of August, 1882. In Dr. Tietjen's *Circular Zum Berliner Astronomischen Jahrbuch* for January 15, 1884, Dr. Kreutz gives the following elements:

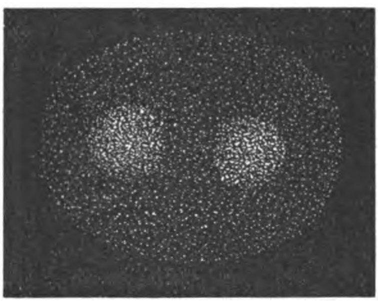
Longitude of perihelion	328° 58′ 21″
Longitude of ascending node	313 19 45
Inclination	2 33 18
Eccentricity	0.2397
Mean distance	2.1968
Period	1189ᵈ.3

The mean distance, it will be seen, is less than that of any other asteroid with the exception of *Medusa*. The perihelion distance is 1.669—almost exactly equal to the aphelion distance of *Mars*. The longitudes of the perihelia now differ by only four degrees. This, however, will not always continue; and hence in the distant future *Mars* and *Agatha* may approach each other so closely as to render the perturbation of the latter by the former a question of great interest. The two planets, it will be observed, have nearly the same inclination, or, in other words, more nearly in the same plane.

D. K.

A NEW AND REMARKABLE NEBULA.

Some ten years ago, while searching for comets, I ran across an exceedingly large and fairly bright nebula near twelve *Monocerotis* which I of course supposed was a familiar object to every astronomer. Since then I have observed it on a great many occasions, being



A NEW NEBULA.

sometimes in doubt if it were not after all simply a glow from the well-known cluster II. 2, VII, or 1424 of general catalogue. Not until three years ago, did I ascertain that the object was not recorded in any published catalogue of nebulae. On a very fine night soon after my 16-inch refractor was mounted, and, before it was brought into adjustment, I turned the telescope on the nebula, and, to my surprise found it a very remarkable object, so much so as to appear worthy of an illustration. The sketch is drawn from memory, but I consider it a good representation. I have not been able to get an observation of it since. The telescope not being in adjustment I could only estimate its position but it will not vary much from R. A. 6^h 22^m Decl. $5°10^m$. It slightly recedes and is a little north of the above cluster. With my 4½-inch it appears to have no definite outline like the *Merope* nebula, but with the 16-inch it appeared quite sharply defined and in shape a perfect ellipse, having at each focus either a round and much brighter nebula, or, it has two centers of condensation, probably the latter. It appears to be a nebula of the dumb-bell type, and is very large, one of the largest visible from this latitude, and, well worthy of a critical examination by astronomers. It is now favorably situated for observation, and I hope some astronomer will have a clear sky and be able to get its exact position. It is unaccountable to me that so conspicuous a nebula should have so long been overlooked. About eighteen months ago Mr. BARNARD, now connected with the Vanderbilt observatory, Nashville, Tenn., in his sweeps for comets, picked it up and called my attention to it, thinking it might possibly be a comet. LEWIS SWIFT.

PRIZES FOR 1884.

H. H. Warner has issued the following which will be of interest to astronomers all over the country:—

It is a gratifying fact that more astronomical discoveries, and those of more importance, have been made by Americans during the past few years, than by all the rest of the world combined. That this has been due largely, to the impetus given by competition for the honors and prizes awarded to discoverers cannot be denied, and in order that this interest may be continued and sustained, I offer the following prizes for 1884:

Two hundred dollars for each and every discovery of a new comet made during the year, subject to the following conditions:

1. It must be discovered in the United States or Canada, either by the naked eye or telescope, and it must be unexpected.

2. The discoverer must telegraph immediately to Dr. LEWIS SWIFT, director of the Warner observatory, Rochester, N. Y., giving the exact time of discovery, the position and direction of motion, with sufficient exactness, if possible, to enable at least one other observer to find it.

3. This intelligence must not be communicated to any other party or parties, either by letter, telegraph or otherwise, until such time as a telegraphic acknowledgment has been received by the discoverer from Dr. SWIFT. Great care should be observed regarding this condition, as it is essential to the proper transmission of the discovery,

together with the name of the discoverer, to the various parts of the world, which will be immediately done by Dr. SWIFT.

Three disinterested astronomers will be selected to decide all disputed questions. H. H. WARNER.

ROCHESTER, N. Y., Feb. 8th., 1884.

We can not resist the temptation to copy some paragraphs from a recent private letter from Professor C. PIAZZI SMYTH, Royal observatory, Edinburgh, Scotland, in relation to current work and the ROWLAND gratings. He says: "I obtained, last summer, by kindness of Professor ROWLAND one of his unequalled works in the shape of a ruled surface 3.5×5.0 inches on a flat plate of metal 6.4×5.4×0.75 inches. Number of lines=14.438 to the inch." "I am having a large apparatus, with achromatic objectives four inches in diameter, and 72 inches solar focus, made by Messrs. T. COOKE & SONS of York for the holding and using of the above grating worthily, and I expect it will answer excellently and something more, for *some* subjects. Not however quite so for the one subject I am working at now which is vacuum tubes of my own contrivance, and wherewith some of the gases, I have found, with a large prismatic apparatus that there are not fewer than 7000 or 8000 lines in the spectrum. But to get a dispersion to separate them 14,438 lines to the inch are not enough; for even if they be used with the fourth or fifth order of spectrum, in the place of the first or second, the bright lines of successive orders get mixed up and inevitably confused."

Professor SMYTH will doubtless soon try some of the more finely ruled gratings from Professor ROWLAND's machine. Those containing 28.876 lines to the inch are said work well in the extremeties of the spectrum, while those with 43,314 lines to the inch on plane surface give very brilliant results. With all these gratings the achromatic objectives must be used if high magnifying power is desired.

Mr. J. R. HOOPER of Baltimore followed the Pons-Brooks' comet closely during the latter part of the month of January noting some interesting physical changes. Jan. 23, 6^h 30^m 75th Meridian time, he saw the nucleus double. Jan. 21 there was no sign of such a phenomenon, nor did he see it double after the observation on the 23d. He several times saw parts of circles of light around the nucleus indicating activity. These observations correspond to those made at Washington near the same time and elsewhere reported in this issue. Mr. HOOPER's note of the observation made at the above date is as follows:

"Nucleus of Pons' comet seen to be elongated at an angle of about 20° with the tail. On closer examination seen to be double. The points of light distinctly separated, the one toward the tail smaller and brighter—appearance like a double-star seen slightly out of focus and through some haze. Watched at intervals for 30^m and until too low for good definition."

In the October number of the MESSENGER, I gave the approximate places of several new nebulae. The following is a more accurate place of one of them:

R. A. 3^h 8^m 33^s.
Decl. —26° 12½′

It is a faint nebula, not large, pretty even in its light; a faint star close *p*—slightly *s*—probably involved. . Star is *s* and *f* the nebula by about 30′.

E. E. BARNARD.

I have found an unrecorded nebula in

R. A. 8^h 14^m 4^s
Decl. —36° 45′ 50″

It is a very faint nebula of moderate size; quite uniform in light, a small star involved (north of middle) probably a nebulous star. A brighter star lies north and just free from the nebula.

E. E. BARNARD.

PROPER MOTION OF LACAILLE. 3643

This star which has been observed by STONE (4801), YARNALL (3814) and ARGELANDER (9264) has proper motions of about $-0^s.026$ and + 0″.37 in R. A. and Dec. respectively.

EDWARD S .HOLDEN.

REPSOLD'S POSITION-MICROMETER.

It may interest some of your readers to know that the price of a REPSOLD micrometer like that described in the Encyclopædia Britannica, Vol. XVI—article micrometer—for a 15-inch telescope, is $1250.

EDWARD S. HOLDEN.

To be sure that the MESSENGER should not in the future be sent to subscribers not desiring its continuance, notice was recently sent to every one whose subscription to Vol. 3 was due suggesting that the publisher be informed of the wish of every such person. Many pleasant and encouraging replies have already been received. It is probably too much to expect that *none* would forgot to attend promptly to a matter even so important as this.

During the month of February subscriptions were recieved as follows:

C. A. Hubbard, Lake City, Minn.; Albion College Library, Albion, Mich.; Ladies' Hall reading room, Carleton College, Northfield, Minn.; A. E. Engstrom, County Supt. of schools, Cannon Falls, Minn.; Professor C. A. Young, Halsted observatory, Princeton, N. J.; Professor

Daniel Kirkwood, State university, Bloomington, Ind.; Judge N. H Hemiup, Minneapolis, Minn.; Professor W. Upton, Brown university Providence, R. I.; Rev. H. Robinson, Leadville, Colorado; Professor J. Hagen, S. J. Sacred Heart College, Prairie Du Chien, Wis.; Professor D. Green, Scientific school, Troy, N. Y.; Miss Grant, 249 Dearborn avenue, Chicago; Samuel A. Boyle, attorney at law, Philadelphia, Pa.; Professor N. O. Wardlaw, Christiansburg, Va.; J. M. Thompson, Salem, O.; C. L. Clippinger, M. E. College, Fort Wayne, Ind.; Dr. W. L. Nicholson, Fort Dodge, Ia.; Professor H. S. S. Smith, Princeton, N. J.; Reading room, Wellesley College, Wellesley, Mass.; Geo. B. Merriman, Rutger's College, New Brunswick, N. J.; Professor R. W. McFarland, State university, Columbus, O.; Professor C. A. Young, Halsted observatory, Princeton, N. J.; S. S. Cheevers, Rector Episcopal church, Shamokin, Pa.; Professor W. J. Warren, Minneapolis, Minn.; Professor D. B. Purinton, West Virginia university, Morgantown, West Va.; Charles P. Howard, Hartford, Conn.; Harvard College Library, Vol. I and II (bound,) Cambridge, Mass.; Geo. C. Hill, Rosemond, Ill., M. H. Cryder, Morris, Ill.; Dr. J. H. Cryder, Morris, Ill.; Dr. J. H. Wythe, Oakland, Cal.; Geo. W. Armes, San Francisco, Cal.; Charles Burckhalter, Oakland, Cal.; James Lick Trust, San Francisco, Cal.; Thomas Thomas, Trenton, N. J.; C. W. Irish, civil engineer, C. & N. W. railway company, Iowa City, Ia.; Professor C. Bates Johnson, Providence, R. I.; F. E. Seagrave, Seagrave observatory, Providence, R. I.; Library of Amherst college, Amherst, Mass.; W. H. Stevens, Carson, Nevada; Professor J. S. McGhee, State Normal school, Cape Girardeau, Mo.

BOOK NOTICES.

The Principles of Logic, by Professor Schuyler, of Baldwin university is a good example of that useful sort of text-book which offers a minimum of text and a maximum of class-room work. As an outline it is well conceived and well drawn. To the teacher who is thoroughly conversant with the subject it affords a general plan of instruction with abundant opportunity to draw upon his own resources and follow his own method. A noticeable feature of the book is the large use made of formulas and of symbolic notation. Most logicians would probably attach less importance than the author does to the fourth figure in syllogisms, and more to the judgments U and Y; but the plan of the work allows the teacher to adjust the proportions of topics at his discretion.

L'Astronomie, Revue mensuelle d'Astronomie populaire, de Meteorologie et de Physique du globe, par M. CAMILLE FLAMMARION.—Sommaire du N de Fevrier 1884: *Sirius et son systeme*, par M. C. Flammarion (10 figures).—Le cataclysme de Java, l'eruption de Krakatoa et les illuminations crepusculaires (2 figures).—Nouvelles de la Science: La comete de Pons (2 figures).—Observations astronomiques et Etudes selenographiques, par M. Gerigny (3 figures).—(Librairie Gauthier-Villars, quai des Augustins, 55, Paris.)

OBSERVATIONS OF PONS' COMET, MADE AT THE U. S. NAVAL OBSERVATORY AT WASHINGTON, D. C. BY

W. T. SAMPSON AND EDGAR FRISBY.

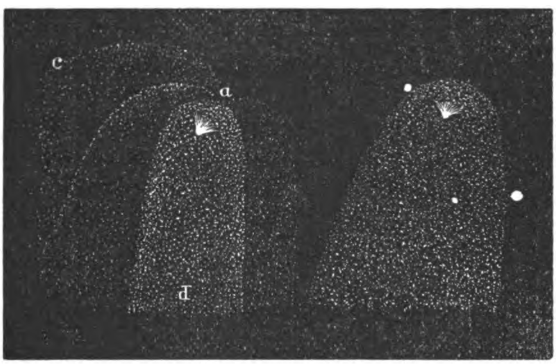
[Communicated by Rear-Admiral Shufeldt, Superintendent.]

1884.	Wash. M. T.	Comet—Star $\Delta\alpha$	Comet—Star $\Delta\delta$	No. of Comp.	Comet α app.	log (p×Δ)	Comet δ app.	log (p×Δ)	Obs'r	Comp. Star
	h m s	m s	′ ″		h m s		° ′ ″			
Jan. 2	5 46 50.0	+2 31.64	+5 45.0	20.4	21 53 30.44	9.503	+20 47 14.0	0.519	S	1
2	6 0 5.3	−1 24.42	−0 56.4	20.4	21 53 34.48	9.531	+20 46 20.0	0.531	S	2
3	5 39 53.3	−4 11.65	+4 37.6	20.4	22 0 35.66	9.475	+19 7 49.4	0.536	S	3
3	7 14 8.9	−0 53.65	+6 25.3	20.4	22 1 2.87	9.630	+19 1 4.6	0.618	S	4
5	5 39 40.5	+1 24.73	−1 49.6	20.4	22 14 39.15	9.450	+15 38 57.5	0.582	S	5
6	7 8 55.7	−1 18.78	−0 24.8	20.4	22 21 59.81	9.602	+13 44 2.2	0.653	S	6
7	7 19 46.1	−2 28.32	−5 47.1	20.4	22 28 52.50	9.608	+11 52 57.3	0.671	S	7
9	7 29 7.9	−0 30.58	+0 44.9	25.5	22 42 14.26	9.607	+ 8 7 15.7	0.698	F	8
13	6 20 4.6	−2 38.24	−3 12.8	30.4	23 7 3.89	9.480	+ 0 37 30.3	0.738	S	9
17	7 27 27.8	+3 30.07	−1 0.1	15.3	23 30 8.96	9.585	− 6 47 39.9	0.774	F	10
20	6 2 16.2	+1 11.30	−4 42.7	25.5	23 45 20.31	9.419	−11 49 34.8	0.818	S	11
21	6 0 43.1	−0 58.02	+9 32.1	20.4	23 50 10.27	9.415	−13 27 3.4	0.827	S	12
21	7 10 53.7	+0 35.75	+16 24.8	25.5	23 50 24.10	9.565	−13 31 23.1	0.806	F	13
22	7 21 27.7	+0 41.40	+1 36.8	20.4	23 55 7.18	9.582	−15 6 33.0	0.807	S	14
25	7 4 26.7	−0 30.76	+3 38.6	30.6	0 8 13.98	9.565	−19 30 58.6	0.828	S	15
26	6 3 47.0	+1 20.58	+1 15.4	20.4	0 12 9.76	9.435	−20.50 6.2	0.858	S	16
Feb. 1	6 55 21.0	+1 42.42	+6 7.0	20.4	0 34 4.88	9.580	−28 9 37.7	0.851	F	17

ADOPTED MEAN POSITIONS OF COMPARISON STARS.

Star.	α 1884.0	δ 1884.0	Authority.
	h m s	° ′ ″	
1	21 50 59.10	+20 41 17.6	Weisse (2) 21, 1209
2	21 54 59.18	+20 47 5.0	" (2) 21, 1318
3	22 4 47.54	+19 3 1.1	" (2) 22, 67 and 68
4	22 1 56.77	+18 54 28.6	⅓(*Ll.* + *Rum* + *Lam.*)
5	22 13 14.64	+15 40 37.7	Weisse, 22, 233
6	22 23 18.77	+13 44 18.4	" 22, 460
7	22 31 20.97	+11 58 36.5	" 22, 626
8	22 42 44.97	+ 8 6 24.4	" 22, 866
9	23 9 42.18	+ 0 40 39.8	" 23, 145
10	23 26 38.99	− 6 46 40.0	" 23, 502
11	23 44 9.12	−11 44 49.9	" 23, 868
12	23 51 8.40	−13 36 32.5	" 23, 1014
13	23 49 48.47	−13 47 44.9	⅓(*Weisse* + *Lamont* + *Stone.*)
14	23 54 25.91	−15 8 6.2	Arg. Oeltz. s. 23179
15	0 8 44.89	−19 34 31.8	Stone 70
*16	0 10 49.34	−20 51 15.9	Ll. 234
17	0 32 22.73	−28 15 36.0	Arg. Oetz. s. 315

January 17, I could see the faint outlines *ad* and *ac* quite distinctly. And frequently before I have suspected them by moving the telescope back and forth; but last night, (21st), I could see nothing of them, probably because the central part was so bright. The head was



PONS-BROOKS' COMET, JAN. 17-21.

a beautiful sight last night. The nucleus was flesh colored, the fan bluish pink and the whole head bluish white. The blue tint is, I suppose, the color of the sky showing through the comet.

I traced the tail with an opera-glass to nearly 20°.

*Baily's reduction of this star is 1′ wrong. Compare also Gould's Uranometria Argentina.

The head was equal to *τ Ceti* in brightness.

The star on the right side of the comet's head Jan. 21st, is Lalande 46929, 9th magnitude, Weisse 23rd, 1014, 9th magnitude.

The other two were much fainter and could scarcely be seen through the matter of the comet.

H. C. WILSON.

OBSERVATIONS OF COMET I, 1883, (BROOKS-SWIFT).

[Made at the Cincinnati Observatory.]

1883		Mt. Lookout M T.	$\Delta\alpha$	$\Delta\delta$	Comp	α app.	l.f.p.α	δ app.	l.f.p.δ	Star
		h m s	m s	′ ″		h m s		° ′ ″		
Feb.	28	8 21 39	−0 9.98	+0 31.8	8.6	23 46 10.44	9.709	+31 41 26.7	0.767	1
	28	8 21 39	−0 24.88		8.0					2
	28	8 21 39	−1 5.26	−4 6.9	8.4	23 46 10.34	9.709	31 41 26.6	0.767	3
Mch.	2	8 3 58	+0 35.26	−3 48.3	18.6	0 5 21.86	9.725	31 58 2.5	0.729	4
	7	7 55 21	−0 4.19	−5 21 3	10.4	0 52 39.49	9.731	31 44 3.7	0.681	5
	7	7 55 21	−0 29.92	−7 46.7	10.2	0 52 39.79	9.731	31 44 1.7	0.681	6
	8	7 51 7	+2 2.12	−0 49.5	10.8	1 1 47.59	9.730	31 32 35.6	0.667	7
April	3	8 54 3	−0 25.40	+3 59.8	10.6	3 47 31.00	9.687	19 49 18.0	0.712	8
	3	8 54 3	−0 42.22	+4 9.3	10.5	3 47 31.01	9.687	19 49 18.7	0.712	9

Star.	α 1883.0	Red.	δ 1883.0	Red.	Authority.
	h m s	s	° ′ ″	″	
1	23 46 20.33	+0.13	+31 40 49.4	+5.5	Leyden IV Z 112 No. 118 and Z 115 No. 130.
2	23 46 35.21	+0.13	+31 41	+5.5	Anonymous. Est. 10 mag.
3	23 47 15.47	+0.13	31 45 28.0	+5.5	Leyden IV Z 118 No. 159 and Z 123 No. 198
4	0 4 46.33	+0.20	32 1 45.2	+5.6	½(Weisse 0^h 56−57+Ley'n IV Z 112 " 137)
5	0 52 43.32	+0.36	31 49 26.8	+5.0	½(Weisse 0^h 1315 + Leyden IV Z 132 " 68)
6	0 53 8.34	+0.37	31 51 43.4	+5.0	½(Weisse 0^h 1326+ " IV Z 136 " 105)
7	0 59 45.08	+0.39	31 33 20.2	+4.8	⅓(Lalande 1888−1900+Weisse 0^h 1464 +Leyden IV Z 132 No. 176).
8	3 47 55.63	+0.77	19 45 21.4	−3.2	½(Weisse 3^h 1013 + Yarnall 1708).
9	3 48 12.46	+0.77	19 45 12.6	−3.2	½(Weisse 3^h 1019 + Yarnall 1712).

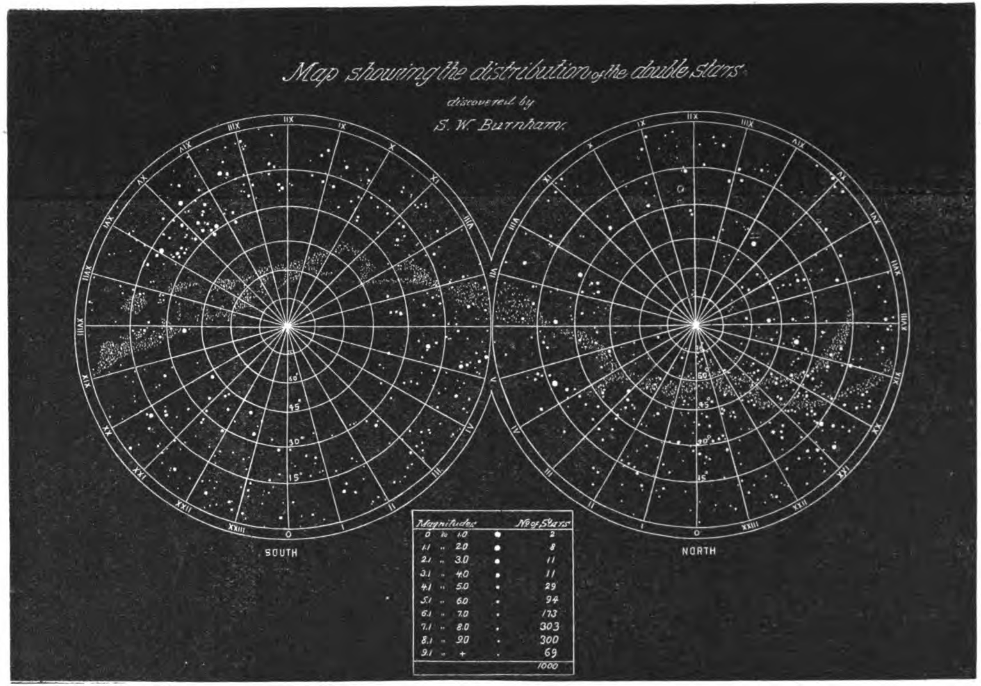
These observations were made by myself with the 11-inch equatorial and filar micrometer. The corrections for differential refraction have been applied. The following notes were recorded.

February 28. "Comet picked up by sweeping 4-inch telescope. Bright round head, but very faint tail. Strong condensation at the center of the head. Very easy to observe."

March 2. "Head bright; strongly condensed toward the center. Tail scarcely visible, but can be traced to one diameter of field, power 90."

March 7. "Head round, condensed in center. Brightness of the center equal 7 mag. star. Tail very faint."

H. C. W.


Map showing the distribution of the double stars
discovered by
S. W. Burnham.
SOUTH
NORTH
Magnitudes
No. of Stars
0 to 1.0 2
1.1 " 2.0 8
2.1 " 3.0 11
3.1 " 4.0 11
4.1 " 5.0 29
5.1 " 6.0 94
6.1 " 7.0 173
7.1 " 8.0 303
8.1 " 9.0 300
9.1 " + 69
1000

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory.
Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. NO. 3. APRIL, 1884. WHOLE NO. 23.

MR. S. W. BURNHAM, *Micrometrical Measures of* 748 *Double-Stars made with the* 18½-*inch Refractor of Dearborn Observatory.**

The diagram given on the opposite page was prepared in the first instance for my own information, concerning the distribution in space of the new double-stars contained in this and the preceding catalogues. It then seemed that a reproduction of it might properly find a place at the close of the series. These double-stars are as uniformly scattered over the surface of the sky as could be expected when due allowance is made for the unequal distribution of stars generally, and the difference in observing weather at different seasons of the year. The Milky Way, of course, furnishes a greater number of new double-stars than the same area elsewhere; and that part of the heavens on the Meridian in the fall and summer months was more carefully examined, and with correspondingly better results.

No systematic search has been made for the discovery of new pairs. At this time, when comparatively so little has been done in the detection of really difficult objects, it is hardly worth while taking the necessary time to follow any special plan in looking for new pairs. No appreciable amount of time can be lost by the repeated examination of

Extract from the appendix of Mr. Burnham's fourteenth catalogue of double-stars, recently published by the Royal Astronomical Society of England.

stars when the telescope is directed at random. A hundred years hence it may be desirable to make a careful systematic study of all the stars, not known to be double, down to the eleventh or twelfth magnitude, with the great refractors of that time, and especially if some location shall be found where a steady air and good definition can be had most of the time, at certain seasons of the year at least. Under such circumstances a thorough examination by an experienced observer of stars not catalogued as double would lead to valuable results, and would practically exhaust the field of discovery so far as the moderate or smaller apertures used in observatories now established are concerned. The Southern Hemisphere, however, is an almost untried field, particularly that portion within 40° of the South Pole. Very few close pairs have been discovered, and in the region mentioned there is probably not one double-star known that would be called difficult with the telescope of this observatory. Assuming a uniform distribution of double-stars in the Northern and Southern Hemispheres, several hundred fairly close pairs could be picked up with a small aperture of first-class definition without going below the eighth magnitude. A large number of close and unequal pairs will be found in the naked-eye stars.

The whole number of stars represented in the accompanying map is 1,000, of the following orders of brightness:—

Magnitudes.	No. of Stars.	Magnitudes.	No. of Stars.
0 to 1.0	2	5.1 to 6.0	94
1.1 " 2.0	8	6.1 " 7.0	173
2.1 " 3.0	11	7.1 " 8.0	303
3.1 " 4.0	11	8.1 " 9.0	300
4.1 " 5.0	29	9.1 " +	69
Total	...	..	1000

LIMITING DISTANCE OF NEW PAIRS.

My catalogues, particularly the earlier ones, contain a few stars which, from the distance of the components, it would have been better to reject. It may sometimes be desirable to record faint companions to bright stars and previously known pairs when they are beyond the ordinary limits of distance, but it is rare that the maximum distance of the Pulkowa Catalogue, 16″, should be exceeded, and in stars from 8 or 8.5 magnitude down, the companion should generally be within 5″ at the most. Pairs of this distance will rarely prove of much interest. All the rapid and interesting binaries are much closer.

Omitting some of the wider pairs, and also the close pairs which have not been measured, there are left 743 double-stars out of 1,000 which are represented by the following mean distances:—

Magnitude.	No. of Stars.	Mean Distances.
		″
3.1 to 4.0	6	1.88
4.1 " 5.0	16	1.89
5.1 " 6.0	61	1.80
6.1 " 7.0	119	1.92
7.1 " 8.0	240	1.36
8.1 " 9.0	247	1.57
9.1 " +	54	1.63
Mean distance of 743 stars =		1.58

In the early history of double-star astronomy, when for this work instruments were inferior as well as smaller, there might have been some excuse for including in a catalogue wide pairs, and those where both components were faint; but at this time there is no justification for ever calling two tenth-magnitude stars which happen to be 5″ or 10″ apart a double-star in the proper sense of the term. At any time since the publication of the work of Struve the time spent in observing such objects would be little less than lost, and this will necessarily be the case for all time to come. Of course it is very easy to make with a telescope very moderate in size and indifferent in definition, an imposing catalogue of so-called discoveries, so far as numbers go, if these faint and wide couples are included; but the value of such a list now and in the future will depend solely upon the number of first-class pairs it contains. The Pulkowa Catalogue, as given in Vol. IX of the publications of that observatory, will serve as a model for this class of work so far as the element of distance is concerned. A close pair—that is, where the distance does does not exceed 1″—should be recorded, however faint the components may be, and of course the magnitude of the companion to any star should have no weight in retaining or measuring it as a double-star.

An examination of the various double-star catalogues of original entry with reference to the proportion of close pairs is instructive as illustrating the relative number of systems of this kind in each, as well as showing the greater perfection of modern telescopes for this kind of work. Those of the STRUVES are so well known that further comment is unnecessary.

The seven catalogues of Sir JOHN HERSCHEL contain nine stars where the estimated distance is 1″ or less. Of this number I have examined and measured seven, the distances being 2″.5; 1″.81 ("violent suspicion," H.); 1″.02 ("almost certain," H.); 2″.27; 3″.26; 1″.2 ("not verified," H.); and 1″.80. The remaining two could not be found, one being noted as doubtful by HERSCHEL. So that at most we have only two pairs of Class I. HERSCHEL gives 68 stars of Class II, estimated at 1½″ to 2″, all of which, with perhaps three or four exceptions, are below the ordinary limits of magnitude, most of them being from 10 to 12 magnitude. In all, about 24 of these stars have recently been observed, mostly at Cincinnati and Chicago, of which 16 exceed 2″ in distance, and four were not found as described, four pairs only coming within the limits of Class II. It is practically certain that of the remaining 44 stars there would not be more than a dozen that would come within the required distance. I have assumed the number, however, to be 20.

The following table gives all the principal original double-star catalogues published, and the number of pairs in each of Class I (distance from 0″ to 1″) and Class II (distance from 1″ to 2″). In the last column is given the ratio of stars of these classes to each thousand double-stars catalogued by the discoverer:—

	Class I.	Class II.	Total.	Ratio.
BURNHAM, Catalogue of 1,000 stars ..	266	254	520	520:1000
O. STRUVE, " " 547 " ..	154	63	217	400:1000
STRUVE " " 2,640 " ..	91	314	405	150:1000
HERSCHEL I " " 812 " ..	12	24	36	45:1000
HERSCHEL II " " 3,429 " ..	2	20	22	7:1000
ALVAN G. CLARK	14	1	15	
All other observers	40	75	129	
			1344	

From this investigation we find the pairs having a distance not exceeding 2″ are less than 1,400; and it is safe to say that the total number of stars now known which can be properly called double is but little if any greater than 3,000, and that at least three-fourths of the remainder are not worth observing for any reason.

THE SATELLITES OF MARS.

BY THE EDITOR.

Aside from the books written by Professors NEWCOMB and HOLDEN, and the paper by Professor HALL, very little has been published concerning the satellites of *Mars*. Though several years have passed since the discovery of these small bodies, scarcely anything new can now be added that will interest the student of astronomy, or the general reader who has access to these valuable books and paper above mentioned. Although this be true, it seems desirable, from the queries of recent correspondents, to make a re-statement of what is known of the satellites of *Mars* for the convenience of readers who may not have the information at hand.

This notable discovery was made August 11–17, 1877, by Professor ASAPH HALL of the Naval Observatory, Washington, D. C. It was not accidental, for Professor HALL began the study of the subject in the spring of that year, examining all authorities within reach, and when the time of opposition came a systematic search with the great equatorial was undertaken, and prosecuted through discouraging circumstances until the two moons were found, and until it was settled that there were two and not three, as at one time supposed, on account of the rapid motion of the inner one.

It is impossible to convey, in words, the impression that this discovery made on the minds of leading astronomers everywhere. It was justly esteemed a triumph of patience and skill of high order, to which will be given appropriate place in the history of modern astronomy.

Of the many names suggested for the satellites of *Mars*, Professor HALL chose those suggested by Mr. MADAN of Eaton, England, viz.:

For the outer satellite, Deimos.

For the inner satellite, Phobos.

The classical scholar will remember that these are the names which Homer applies to the horses which drew the chariot of *Mars*, and that the passage, as translated by Bryant, reads:

> "He spoke and summoned Fear and Flight to yoke
> His steeds, and put his glorious armor on."

The time chosen for the search was very favorable on account of the relative positions of *Mars* and the *Earth*. This happens when *Mars* is as near the *Sun* as possible, and the *Earth* as far away as possible, and *Mars* opposite from the *Sun*, and can occur only once in fifteen years.

In 1877 these conditions were nearly fulfilled, and the planet *Mars* was, at nearest approach, about 36 millions of miles from the *Earth*. The *Sun* was in apogee July 3, and *Mars* was in perigee August 21, and opposition occurred

September 5. If these phases of the planets had taken place nearer the same date the distance between them would have been less, and by so much, observation more favorable.

These satellites are the smallest celestial bodies known. In the largest telescopes they appear as points of light, and hence can not be measured at all in the ordinary way. The inner satellite is a little brighter than the other, and, therefore, possibly a little larger. Their diameters are probably less than ten miles, and are assumed to be about six and seven miles respectively.

The outer satellite, Deimos, revolves around the planet in $30^h\ 16^m$, and the inner one, Phobos, in $7^h\ 38^m$. The latter is 5,800 miles from the center of *Mars*, and less than 4,000 miles from its surface. It would, therefore, be quite possible with one of our telescopes on *Mars* to know if the inner satellite is inhabited, for the motion of living beings could be easily recognized.

With these facts before the mind, it is impossible to realize the problem of difficult seeing that was mastered by the aid of the telescope, in observing these minute bodies at the distance of 36 millions. The outer satellite was seen at a distance of about 6 or 7 million times its own diameter; as Professor HOLDEN has aptly said, it is like suspending a ball two inches in diameter and viewing it with a telescope at a distance equal to that between Boston and New York. "Such a feat of telescopic seeing is well fitted to give an idea of the power of modern optical instruments."

The rotation-time of the planet *Mars* is $24^h\ 37^m$. As before said, the time of revolution of Phobos is $7^h\ 38^m$, so that the satellite evidently would revolve more than three times about the primary while it was making but a single rotation on its axis. To an observer on *Mars* this curious relation of the two motions would cause most interesting physical phenomena, some of which may be briefly noted here. It will be remembered that the motion of the planets around the *Sun*, and all the satellites, with two exceptions, around their primaries, are in the same direction, and that is from west to east. This is also true of the rotation of the planets on their axes so far as known. Now, if this be so, the apparent diurnal motion of a satellite in the heavens will be approximately the difference of the two motions. If the planet rotates on its axis more rapidly than the satellite revolves about the common center of gravity, then the satellite will appear to rise in the east and set in the west. This is constantly observed in the case of the *Moon;* also in Deimos, whose revolution-period is $30^h\,16^m$. But this satellite's motion is a little slower than that of the planet, and so there would be a slow westward apparent diurnal motion that would be very strange to people like ourselves. On the other hand, because of the rapid motion of Phobos, it would appear to rise in the west and set in the east, and because the relative motions of planet and satellite are greatly different, the apparent diurnal motion of this satellite would be as surprisingly rapid to an observer on *Mars* as that of Deimos was slow. The phenomenon of two satellites rising at the same time—for example, one in the east and the other in the west—and the latter sweeping through the sky eastward, at the rate of about 45° per hour, and, in less than four hours, meeting the other a few degrees above the eastern horizon on its slow westward march, would be a view at first sight almost as impressive as MITCHEL'S first sunset in Adam's time. Add to this the supposition that the planet *Mars* is inhabited by beings not greatly unlike ourselves, with telescopes or some other means of aiding the natural powers of sight equal or superior to those we enjoy, and the field of speculation is limitless and interesting to those possessing a lively imagination.

The Misses. Lassell, last year, kindly placed a 7-foot Newtoman telescope at the disposal of Professor WILLIAM HUGGINS of England, to aid in photographing the solar corona. Between April 2 and September 4, fifty photographs were taken all of which show a coronal appearance. The coronal appearance in some of these pictures has been proved genuine as far as 8′ from the *Sun*, (216,000 miles).

ON THE DEFLECTION OF THE LEVEL DUE TO SOLAR AND LUNAR ATTRACTION*.

BY F. G. HAGEN S. J. COLLEGE OF THE SACRED HEART, PRAIRIE DU CHIEN, WIS.

The deflections of the Vertical have been experimentally studied by de Rossi, Plantamour and Zollner, but during the last decennium this question became of greater interest by the publications of Mr. d'Abbadie: "Etudes sur la Verticale," 1872, and "Recherches sur la Verticale," 1881, etc., which are not yet complete and are to embody his observations made in Brazil, Ethiopia and in the south of France since almost half a century; and also by the two reports of the committee appointed by the Brittish Association for the measurement of the lunar disturbance of gravity, which were published in 1881 and 1882. Whilst these publications show forth results that cannot be fully explained as yet, it is strange to say that even the theoretical part of the question seems to be unsettled with many authors. We will give some of their results in historical order, but, to avoid confusion, reduce them to a common notation as follows: Let m be the mass of the disturbing body, r and r' its distances from the center of the *Earth* and from the level, z and z' its zenith distances as seen from the center of the *Earth* and from the level, M and ρ the mass and radius of the *Earth* respectively, and h the horizontal parallax of the *Moon* in seconds of arc.

1824. N. H. Abel, in the "Magazin for naturvidenskaberne" 8, Christiania, 1. serie, t. III, p. 219.

$$\text{Lunar Deflection} = \left\{ \frac{m}{r^2} \sin z : \frac{M}{\rho^2} \right\} 206264.''67$$

Substituting $m = M : 68.5$ and $\rho : r = 0.01655101$ he obtains $0''.825 \sin z$.

1844. C. A. F. Peters, "Von den Kleinen Ablenkungen der Lothlinie etc." in Bulletin de l'Academie Imp. de St. Petersbourg, t. III, No. 62, p. 212.

*A. N. No. 2568.

$$\text{Deflection} = \left\{ \frac{m}{r'^2} \sin z' - \frac{m}{r^2} \sin z \right\} : \frac{M}{\rho^2}$$

$$= \frac{3}{2} \frac{m}{M} h^3 \sin 2z \,(\sin 1'')^2$$

Substituting $M : m = 81.24$, $h = p \cdot 57'$ he obtains for the *Moon* $= 0''.0174\, p^3 \sin 2z$; and in the case of the *Sun* $m : M = 359551$, $h = 8''.58$.

$$\text{Deflection} = 0''.0080 \sin 2z.$$

1847. C. Ramus, "Om uligheder i pendulsvingningerne formedelst et himmellegems tiltraekning" in the "Oversigt over det Danske videnskabernes Selskabs forhanlinger, Kjobenhavn, p. 9. He gives exactly Peters' formula, and by substituting $m : M = 1 : 75$, $\rho : r = 1 : 60$, he finds the lunar deflection $= 0''.019 \sin 2z$.

1864. E. Sang, "On the deflection of the Plummet due to solar and lunar Attractions," Edinburgh Tra. XXIII, 89. He gives the formula:

$$\text{Deflection} = \frac{1}{r^2} \times \frac{\rho}{r} \sin 2z$$

Then he continues: "For the *Earth's* mean distance (from the *Sun*) r^2 may be taken to represent $128''$, and therefore (since $\rho : r = 1 : 23800$) the deflection of the plummet due to the *Sun's* attraction may be stated as $\frac{1''}{186} \sin 2z$. The *Moon*, though much nearer to us than the *Sun*, is yet so small in comparison, that the effect of a pressure equal to her attraction would only derange the plummet through one second (*i. e.* : r^{-2} represents $1''$). In this case, however, the ratio of r to ρ is only 60: 1, and therefore the deflection due to the *Moon's* influence is $\frac{1''}{60} \sin 2z$ or three times that due to the *Sun*."

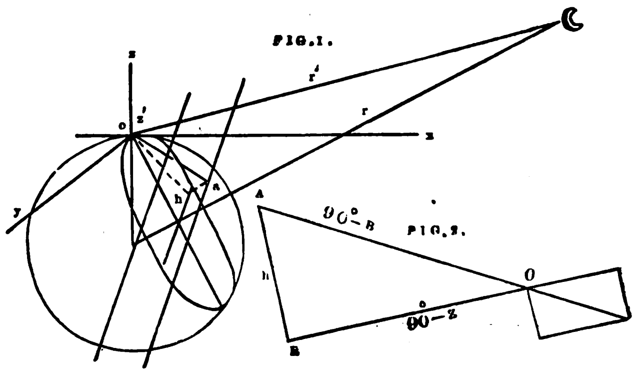
1876. R. v. Sterneck, "Ueber den Einfluss des Mondes etc." in the Sitzungsberichte der k. Akademie der Wissenschaften. Wien, LXXIII, 4, p. 553. He finds a lunar deflection as large as 0″.48, the direction of which is altogether independent of the *Moon's* position; his formula will be explained below.

1881. Report of the Committee appointed by the British Association. In a note to page 21 it is said, that for Cambridge the maximum meridional horizontal component of gravitation, as due to the lunar attraction, is 4.12×10^{-8} of pure gravity, and that this force will produce a deflection of the plumb-line of 0″.0085 and further that the maximum deflection of the plumb-line occurs when the *Moon's* hour-angle is $\pm45°$ and $\pm135°$ at the place of observation.

Now in order to show how far these authors do or do not agree, and upon what hypotheses they have based their calculations, we propose to solve the problem in the following way. We disregard with them the flatness and daily rotation of the *Earth*, the latter causing a constant deflection of the level, the variations of which are the very point in question; but with R. v. Sterneck we shall first suppose our *Earth* to present continually the same face to the disturbing body, thus attributing to the former a (monthly or yearly) rotation around an axis perpendicular to the orbit of the latter and passing through their common center of gravity. The mechanical effect of this supposed rotation, or of its centrifugal force, will then be equivalent to the attraction of the *Earth's* center by the *Moon* or *Sun*, but with a negative sign; and to an imaginary rotation of the *Earth* around a central axis which is parallel to the one mentioned before. By subtracting the effect of the latter from the total variation thus found, we shall have the true variation of the level.

Our system of co-ordinates is represented in Fig. 1. Let the axes of x and z be in the vertical plane that may be passed through the place of observation and the center of the disturbing body, z being directed toward the zenith and x

parallel to the horizon towards the azimuth of the luminary; the positive direction of y we shall decide below. There will be no danger of confounding the axis of z with the zenith-distance z.



The forces acting upon any particle on the *Earth's* surface, according to our hypothesis, are: (1) the gravity g towards the center of the *Earth*; (2) the gravity γ towards the disturbing body with the two components $\gamma \sin z'$ parallel to x, and $\gamma \cos z'$ parallel to the axis of z; (3) the centrifugal force caused by the (supposed) rotation of the *Earth* and the disturbing body around their common center of gravity. Let e denote the distance of the latter from the center of the *Earth*, θ the angular velocity of this rotation, R the distance of the place of observation o from the line r joining the centers of the two celestial bodies, and λ the angle between R and the axis of rotation. Through the place of observation we pass a plane perpendicular to r, which will intersect the *Earth* in a circle; through its center and parallel to the axis of rotation we draw a diameter which will be inclined towards R by the angle λ. Now we will consider the axis of y negative on that side towards which the angle λ extends, as viewed from the place of observation. If we then draw perpendiculars from o to the axis of rotation and its parallel, the distance oa of the place of observation from the axis will have the perpendicular components

$\rho \cos z - e$ and $R \sin \gamma = \rho \sin z \sin \lambda$.

The first, being parallel to r and hence to the plane (x, z), is again resolved into $(\rho \cos z - e) \sin z$ parallel to x, and $(\rho \cos z - e) \cos z$ perpendicular to the horizon.

The other component is first resolved into $\rho \sin z \sin \lambda^2$, parallel to R, and $\rho \sin z \sin \lambda \cos \lambda$, and parallel to y; whilst the former is again resolved into $- \rho \sin z \sin \lambda^2 \cos z$ parallel to x, and $+ \rho \sin z \sin \lambda^2 \sin z$, perpendicular to the horizon. Since the centrifugal force in any distance d from the axis of rotation is expressed, by $\theta^2 d$, we find the following forces acting upon the unit of mass on the *Earth's* surface.

$$X = \gamma \sin z' + \theta^2 \rho \left\{ \cos z \cos \lambda^2 - \frac{e}{\rho} \right\} \sin z$$

$$Y = \qquad + \theta^2 \rho \sin z \sin \lambda \cos \lambda$$

$$Z = - g + \gamma \cos z' + \theta^2 \rho \left\{ 1 - \sin z^2 \cos \lambda^2 - \frac{e}{\rho} \cos z \right\}$$

The equation of the level is then, in each point of the *Earth's* surface,

$$Xx + Yy + Zz = \text{const.};$$

and its deflections

$$\frac{dz}{dx} = - X : Z,$$

in the azimuth of the disturbing body, and

$$\frac{dz}{dy} = - Y : Z,$$

90 degrees distant.

(*To be continued.*)

POLARIZATION OF THE LIGHT OF THE ASTEROIDS.

BY M. W. HARRINGTON.

This account should perhaps be entitled absence of polarization in the light of the asteroids for the results obtained were negative. It had occurred to the writer that there might possibly be enough polarization in the light of these bodies to enable one to distinguish them from stars when a sufficiently delicate apparatus was employed. They never occupy such a position that the solar light reflected from them and reaching the *Earth* leaves them at the angle most favorable for polarization; but as there is some polarization at all angles it remained to be seen whether there would not be enough in the case of the asteroids to be detected.

To test the matter I had a plate of Iceland spar made with sufficient thickness to separate the two images by about 12′. With it in the principal focus of the telescope, stellar bodies showed two distinct images entirely clear from each other and the two disks of *Mars* overlapped only slightly. This plate was placed on my wedge-photometer in such a way that in the telescope it was directed toward the objective while the wedge was on the eye-side. When placed in the telescope and focused, the two images of the body would gradually pass into the darker parts of the wedge and the test lay in ascertaining if the two images were extinguished simultaneously or one after the other. If the latter were the case the light was somewhat polarized, if the former, there was no distinguishable polarization. The images were usually in a line parallel to the diurnal motion though other directions were frequently tested.

The apparatus showed distinct polarization for the *Moon* at its quarters, and gave results in substantial accord with those obtained by other observers with different apparatus. I was satisfied, therefore, that any lack of results for the asteroids would not be due to the instrument. It was then tried repeatedly on the asteroids, but entirely without signs of polarization. There were tested in all some fifteen asteroids, which ranged in brightness all the way from *Vesta* to the twelfth magnitude, and in position all the way from opposition to as near the *Sum* as they could be picked up. I accompanied the tests with the wedge with eye-estimates of the brightness of the images, but I could in no case satisfy myself that there was a difference between them. It may be remarked that as the images were close to gether they were in a favorable position for eye-estimates. As a result the writer believes that in no position where they can be observed is the light of the asteroids sufficiently polarized to make a difference of a tenth of a magnitude in the brightness of the images.

The apparatus was also recently tried on some of the planets. *Mars, Jupiter* and two of his satellites, *Saturn* and *Titan* were tried but with negative results. The planets were not far from opposition and I did not expect results from them, but I hoped for something definite in the case of the satellites. The hope, however, proved futile.

ANN ARBOR, Feb. 28th, 1884.

OBSERVATIONS ON THE PONS-BROOKS' COMET.

W. H. NUMSEN, BALTIMORE.

The following is an abstract of the result of my observations upon this comet. Whether the notes are of value, I know not, but possibly they may be of interest to some of your readers.

Only a few short and irregular observations were made in Sept., and no notes were kept, as the comet appeared for the most part as a faint and indefinite patch of light. On the 22nd, 23d and 24th, it was not observed, but on the 25th, it was, and I was surprised at its marked increase in brilliancy since previously seen; but visitors being present unfortunately no notes were made. It was next observed on Oct. 2, and from that date until Jan. 20, (when the comet was last seen by me) notes were regularly kept upon every occasion.

During Oct. the weather was generally very unfavorable, and only the 2nd, 8th, 9th, 11th, 27th and 30th were entered in my observing-book. In Nov. only one observation was secured, on the 30th. On Dec. 3d I set to work in earnest, and from that time until Jan. 29th the comet was observed upon every clear night with perhaps four or five exceptions.

The following are the dates:—Dec. 3, 6, 10, 11, 15, 16, 17, 18, 21, 25, 27, 28, 29; Jan. 2, 3, 5, 6, 9, 13, 17, 20, 21, 23, 25, 26 and 29. On the 30th and 31st it was cloudy, and after that I paid no more attention to the comet as it was too low down and set too early for me.

The dates below are selected from my observing-book, and the notes condensed from same. All the observations were made with my 4-inch Equatorial by T. Cook & Sons of York, E., and with a comet eye-piece p. 25, unless otherwise mentioned. Finder 1¼-inch. Field of view of finder 3°, of comet eye-piece 1½°, 75th meridian time is used.

Oct. 2nd.—7:45 to 8:30 very clear, slight wind. Found with p. 25 by means of Schulhof's ephemeris. Appears as an irregular patch of faint light, without trace of nucleus or tail. Think I get a glimpse of it through finder. While making notes, it had moved out of field, (clock-work being detached), tried and succeeded in picking it up with finder.

Oct. 9th.—8 to 8:30. Very clear and beautiful. Moon just passed 1st quarter. Set by ephemeris, and comet was in field, near middle. No doubt about seeing it, while it is not easy, it is not difficult. No tail, however, and no nucleus evident. Unclamped R. A., closed eyes, and put out of field for an unknown distance, swept back and with p. 25, picked up as soon as it entered the field again. Invisible in finder.

Oct. 30th.—8:15 to 9:05. Beautifully clear, stars glistening. Brisk wind. Found at once. Undoubted condensation here now. No tail yet apparent, but nebulous matter seems larger. Pretty easy in finder.

Nov. 30th.—7:25 to 8. Pretty clear; some haze along horizon. Set telescope and found with finder; no mistake. Strong condensation now towards center, and much brighter. Fancy at times traces of a tail in *n. f.* direction, but am not positive about it.

Dec. 6th.—6:10 to 6:35. Very clear and bright. Moon near 1st qr. Swept with finder without resorting to circles, and easily caught. With p. 25 suspect streak of tail about

25′ long, *n. f.* more *n.* Not seen steadily. Getting misty. Wind from east.

Dec. 15th.—7:15 to 7:30. Clear; wind lulling. Moon just up. After sighting over telescope, could see a starry point, but nothing nebulous. Not certain whether it is the comet or not. With p. 25 not positive of tail, though possibly an elongation toward *n. f.* Nucleus, however, seems more positive.

Dec. 16th.—7:45 to 8. Pretty clear now; cloudy all day. Can see the stellar point again, but no nebulosity. If no 5th magnitude star in that position, then it is the comet. Through finder traces of a tail at once seen, and with p. 25 tail is evident; no doubt about it; plain as anything. Fully 30′ long and perhaps slightly over; fades away gradually. About 10′ from head pretty bright, balance fainter and fainter. Moon behind clouds.

Dec. 17.—6 to 6:30. Pretty clear; some haze along west. Certainly seen with naked eye now. Set finder for naked eye object and it was the comet. As easy as either of the two stars b^2 and b^3 *Cygni* upon Heis' Atlas. Tail very easy through finder, and with p. 25 certainly 35′. A regular star-like nucleus now.

From this date naked eye estimates of its brightness were made at each observation, but I shall give only the telescopic observations, except an occasional naked eye remark.

Dec. 21st.—5:35 to 6:30. Fairly clear, few clouds along west. At 5:45 easily picked up with finder, and at 6^h easily visible to naked eye. With p. 25 can't certainly trace tail more than 1°, about 40′ to 50′ pretty bright, and then fades away insensibly.

Dec. 27th.—6:25 to 6:55. Cleared up now and windy. Not the ghost of a tail to naked eye. With p. 25 can't for the life of me see any great increase in length of tail, and about 1½° is the extreme length to me. A distinct star-like nucleus now evident at once. No nebulosity except the coma. Wind increasing; afraid of roof.

Dec. 28th.—6:25 to 7:10. Very clear. Some puffs of wind at times, but generally quiet. Looks hazy to naked eye. One or twice I thought I could detect trace of tail to naked eye, but not steadily. Through finder think I can trace tail clear across field 3°, and with p. 25 it is plain to 1½° and then gradually fades away to 3° or so. Nucleus at first did not strike me as stellar, though afterwards thought it was so.

Dec. 29th.—6:45 to 8. Clear and quiet; 5th magnitude stars easily seen. Not positive about tail to naked eye; it may be there, but I don't see it. Its cometary nature is more pronounced, however. With p. 25 nucleus strongly condensed, though not positive about it being distinctly stellar. While thinking over it, ran telescope along tail to see how it was coming on. But my stars! how it has grown since last night. Easily and certainly traced to 3½°, and probably nearly 4° long. Looks thin and narrow. Appears to spread sbout 1° from nucleus, and then starts straight and narrow again. A straight, bright streak extends from head nearly to end of tail.

Jan. 2d.—6:40 to 8. Clear; strong wind at times. Moon about 3 days old. With p. 25 don't appear as bright as last time. Tail spreads more, though not as long. Can't trace it more than 1½°. Straight, bright streak seen last time is not visible to-night.

Jan. 3d.—6:45 to 7:30. Very clear, moonlight; some little wind. Decided nebulosity to naked eye now, and upon first looking up think can detect tail, but very short if I do. Through finder nucleus very plain, tail about 1°. With p. 25 tail about 1½° or so; pretty straight, and appears to taper to a point about 1° or so from head.

Jan. 13th.—7:15 to 7:45. Very clear now; cloudy all day. Moon up, but behind clouds. Almost equal to a *Pegasi;* sometimes, with averted vision, suspected as fully equal to it. Looks like a star, with only a small trace of nebulosity. Disappointed about tail, but nucleus is much brighter than expected, and much brighter than when last seen (9th)

With p. 25 a strange change in nucleus or coma since last seen. Never saw it look this way before. A *sharp* and *distinct* stellar point, surrounded by a bright, almost circular nebulosity, and then outside of this the regular faint coma.

(*To be continued.*)

CORRESPONDENCE.

To the Editor of the SIDEREAL MESSENGER:

MY DEAR SIR:—You are doubtless familiar with the verses written by Sir JOHN HERSCHEL to be sung on the occasion of sealing up the 40-foot reflector at Slough, as they have been frequently printed. You may not have seen, however, the Latin translation of them which I enclose. It has been copied for me by my friend Dr. R. GARNETT, superintendent of the reading room of the British Museum, from "Trash from Parnassus," a little pamphlet privately printed in Cambridge, England, in 1842. The translation is signed "F," and Dr. GARNETT supposes this to stand for THOMAS FORSTER, the writer on calendars.

I enclose Sir JOHN HERSCHEL'S original verses (which never seemed to me to be quite worthy of the occasion), and the Latin translation (in which they seem to gain dignity), and I shall be glad if they seem to you worth reproduction. I am, my dear sir,

Very truly yours,

EDWARD S. HOLDEN.

Washburn Observatory, Madison, March 16, 1884.

THE HERSCHELLIAN TELESCOPE SONG.

Requiem of the Forty feet Reflector at Slough, to be sung on the New Year's Eve, 1839–40, by Papa, Mamma, Madame, and all the little Bodies in the tube thereof assembled.

In the old Telescope's tube we sit,
And the shades of the past around us flit;
His requiem sing we with shout and with din,
While the old year goes out and the new one comes in.

(Chorus of youths and virgins.)

Merrily, merrily, let us all sing,
And make the old Telescope rattle and ring.

Full fifty years did he laugh at the storm,
And the blast could not shake his majestic form;
Now prone he lies where he once stood high,
And searched the deep heavens with his broad, bright eye.

Merrily, merrily, etc.

There are wonders no living wight hath seen,
Which within this hollow have pictured been,
Which mortal record can ne'er recall,
And are known to Him only who made them all.

Merrily, merrily, etc.

Here watched our father the wintry night,
And his gaze hath been fed with pre-Adamite light;
While planets above him in circular dance,
Sent down on his toils a propitious glance.

Merrily, merrily, etc.

He has stretched him quietly down at length,
To bask in the starlight his giant strength;
And Time shall here a tough morsel find,
For his steel-devouring teeth to grind.

Merrily, merrily, etc.

He will grind it at last, as grind it he must,
And its brass and its iron shall be clay and dust;
But scathless ages shall roll away
And nurture its frame in its form's decay.

Merrily, merrily, etc.

A new year dawns, and the old year's past,
God send us a happy one, like the last;
A little more sun, and a little less rain,
To save us from cough and rheumatic pain.*

Merrily, merrily, etc.

God grant that its end this group may find
In love and in harmony fondly joined;
And that some of us, fifty years hence, once more
May make the old Telescope's echoes roar.†

(Chorus, fortissimo.)

Merrily, merrily, let us all sing,
And make the old Telescope rattle and ring.

H.

—*1839 was a very wet year.—N. G.

—†*Tuba mirum spargens sonum.*--N. G.

TUBUS HERSCHELLII.

Hic pater et mater filii filiæque sedemus
Ecce telescopii, nocte micante, tubo!
Hic læta insolitos faciamus voce sonores,
Dum novus annus adest, et vetus inde fugit!

Chorus.

Lætus io jam quisque canet, mimicoque canore
Echo per veterum concinet acta tubum!

Horrida qninque annos ridebat flamina cæli;
Tempestas formam rumpere nulla potest,
Ast ubi stelliferum porrexit in ardua truncum
Procumbit gelido machina grandis humo.

Lætus io, etc.

Multa telescopio fulserunt sidera noctu,
Astraque mortali non numeranda manu,
Inque cavo longo quot sunt miracula visa!
Quæ solum omnipotens conspicit ipse Deus.

Lætus io, etc.

Hic mihi per noctem pater observare solebat
Ante hominem facti lumina multa poli,
Dum illi, perpetuis cœlo revolubile gyris,
Mulcebat vultum quisque planeta suum.

Lætus io, etc.

Omnia tempus edax mordaci dente vorabit;
En sub Fortunæ calcibus omne perit!
Et quamvis facile inveniet non dentibus ipsis,
Sera giganteum pulveret Hora tubum.

Lætus io, etc.

In vano hoc faciet; nam facta notata per illum,
Dum vivit Cybele, vera videnda manent:
Iam novus annus adest vetus aura atque annus abibit.
Di mittant pluviæ, sole tepente, minus.

Lætus io, etc.

Tempore venturo Fors protegat omnia vobis,
Eque tubo intactas fundat uterque preces,
Ut placeat Divis multos revoluta per annos
Turba telescopico quæ canet orta choro.

Lætus io, etc.

F.

TUNBRIDGE WELLS, Feb. 25, 1842.

EDITORIAL NOTES.

DOUBLE-STAR OBSERVATIONS.

The double-star observations of S. W. BURNHAM of Chicago, made in 1879 and 1880, with the 18½-inch refractor of the Dearborn observatory, have been recently published in the Memoirs of the Royal Astronomical Society of England. The reprint of this important American work is before us. It consists (1) of 151 new double-stars with measures, (2) of the micrometrical measures of 770 double-stars. In the introduction will be found a full-page map showing the distribution of the stars, a description of Mr. BURNHAM's mode of observing, a full account of the micrometer used with new method of bright-wire illumination, and remarks concerning the excellent observing-seat devised by Professor G. W. HOUGH. The map and what it shows are presented elsewhere in an extract from the appendix of the catalogue. When it is remembered that the fourteen catalogues of double-stars published by Mr. BURNHAM since 1873 now contain 1013 numbers, chiefly, if not all, new double-stars, something of the magnitude of the work will be understood, and if it be added that his measures are esteemed authority the world over, the publication of them abroad will not be surprising, except that the Royal Astronomical Society should have anticipated American enterprise in this thing.

Nature (Feb. 28) refers to Mr. BURNHAM's work in the following complimentary way: "Every one who is interested in this branch of astronomical science will read with much regret one remark in Mr. BURNAM's introduction. He writes: "The present catalogue will conclude my astronomical work—at least so far as any regular or systematic observations are concerned." He expresses himself modestly respecting his own labors: "In a field so infinitely large, one can accomplish but little at the most, and how much or how little, the astronomers of a few centuries hence can, perhaps, best decide. * * * At this time I may venture to claim that my work in this field has been prosecuted with some enthusiasm, and for its own sake only, and that my interest has not been divided among several specialties."

But a higher estimate of Mr. BURNHAM's work in this particular line of observational astronomy, to which he has devoted himself, may be justly taken. To read the discovery of upwards of a thousand double-stars within a limited period by one observer, we might almost suppose we were living in the days of Sir WILLIAM HERSCHEL, when the heavens were comparatively an open field, and had not undergone the wide and close exploration which they had done when Mr. BURNHAM commenced his work. He has had, it is true, the advantage of instruments of the finest class, and we may believe, an unusually acute vision; but he must have exercised an extraordinary and most meritorious amount of patience, perseverance and care in the discovery and accurate measurement of such a list of double-stars, and it will be gratifying to the astronomical world that such well-directed exertions have met with so exceptional a success."

In Brooklyn, N. Y., and vicinity, there is an amateur astronomical society. Mr. S. V. WHITE, the broker, of 210 Columbia Heights, Brooklyn, is president, and WILLIAM T. GREGG, of same place, is treasurer. One Washington astronomer seriously doubts whether an amateur society can possibly carry so large a name as the "American Astronomical Society," and says it has no right to if it can.

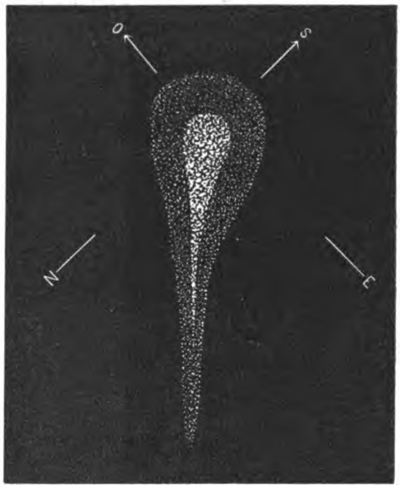
ALGOL'S MINIMA.

	1883 Nov. 28	Dec. 21	1884 Feb. 2	Feb. 22	March 3	March 16
	h m	h m	h m	h m	h m	h m
SAWYER 75°	7 0*	5 30	5 42	7 23	9 4	5 53
HOOPER 75°			6 30*	8 11	9 52	6 41
PARIS 75°			7 16	8 57	10 39	7 28
IRISH 75°		7 30*	7 44	9 25	11 7	7 55
" 90°		6 30*	6 44	8 25	10 7	6 55

The table above shows some variation in the times of Algol's minima, as taken from several sources. Those marked with a star are times as observed, the others are computed from them. The third line in the table is taken from a Paris periodical which regularly gives the time in advance. All the table is reduced to 75° time except the bottom line which is 90° time and taken from the table of Mr. IRISH in the February MESSENGER. The figures show a difference between Messrs. SAWYER and IRISH, of two hours instead of one as stated by the latter, (Nov. 28 and Dec. 21). On Feb. 2, having the Paris time I went into the observatory at $6^h\ 30^m$ and found the star then about. 3½ mag., and at $7^h\ 10^m$ was above 3d mag., while at 9^h it had reached maximum evidently ahead of the predicted time, both Paris and Irish. Every other date has been cloudy until March 16, when a fairly close observation gives $7^h\ 30^m$ as time of greatest obscuration, very nearly exactly the Paris time, and a little ahead of Mr. Irish. These discrepancies can hardly be a variation of the stars period, but, rather, indicating the difficulty of getting a satisfactory observation except at long intervals. J. R. H.

Bound volumes I, II, of the MESSENGER in neat, plain library style, will be sent to any address, post-paid for $2.75 per volume.

E. L. TROUVELOT observed the Pons-Brook's comet, Dec. 17, 1883, at 6^h 3^m, Marseilles (France) mean time, with a telescope of 156 m m. in aperture and power 85. The following is a copy of his drawing, as in *La Nature:*



THE COMET AT MARSEILLES.

Our readers will be interested to compare this drawing with the one published in the January MESSENGER, which was furnished by Mr. J. R. HOOPER of Baltimore.

Nature (Feb. 14) has the following interesting facts respecting the Pons-Brooks' comet: "This comet approaches the orbit of *Venus* within 0.076 (*Earth's* distance from the *Sun* being 1); that of *Jupiter* within 1.98; and that of *Uranus* within 1.17. The ascending node falls at a distance of 15.46. During the revolution of 1812–1884, the calculations of M. M. SCHULHOF and BOSSERT show that the approximate effect of the planetary attraction upon the periodic time, at the instant of perihelion passage in the former year, has been as follows·

Comet accelerated by action of *Jupiter,*	446.49	days.
" " " " " *Saturn,*	13.96	"
Comet retarded by action of *Uranus,*	13.48	"
" " " " " *Neptune,*	1.48	"

Hence the period of revolution in 1812 has been shortened by perturbation to the extent of 445.49 days. The orbital velocity of the comet at perihelion is 29.2 miles in a second, at aphelion it is 3550 feet in the same time.

THE OCCULTATION OF BETA CAPRICORNI.

Much the same phenomena, connected with the occultation of the little star preceding *Beta Capricorni*, as were observed by Mr. BARNARD (MESSENGER, December, 1883, page 290), and by Mr. SAWYER (MESSSENGER, January, 1884, page 312), were observed by myself here on the same occasion. I transcribe the following record from my observing-book:—

1883. Nov. 6.3.

Moon 1.^{d}0 before first quarter.

Dimensions 7 mag. star same decl. as *Beta Capricorni* and 4′ pr. in R. A.

8 16 2.5 Bl. [Chronometer Bliss 2083] Wt. .4

Star = B. A. C. 6992.
= Yarnall 8811.
= Newcomb (Standard Stars) 900.

"The star disappeared very sharply at the above time,but aboEt 1^{s}.5 later a winged blur of light appeared at the same spot of the *Moon's* limb, aud was visible for two or three-tenths of a second, and of about one-half the brightness of the star itself. I have never before observed anything like this. The disappearance took place at about 90° from the north point. Power 90±."

I have nothing to add to the above record, of my own observation, except, perhaps, that the first disappearance of the star was total; and I was about removing my eye from the telescope to verify the beat of the chronometer, when there appeared what I have described as a winged blur of light * * * of about one-half the brightness of the star itself. I add this only because all the circumstances of the observations are still so perfectly recalled in my mind.

It may be worth the while to add, also, that the theory of duplicity of the star will not suffice to account for all these phenomena. They may, however, be in part explained, if the star shall be found to be a double—a matter which can now be very soon determined.

DAVID P. TODD.

Lawrence Observatory, Amherst, Mass.

The large nebula figured by Dr. SWIFT in the SIDEREAL MESSENGER No. 22, p. 57, is indeed a remarkable object; but probably the most wonderful thing about it is that observers should have failed to see it long ago, since it is very noticeable. Amateurs may look this up, as it will be seen with ordinary telescopes. Bring the cluster (mentioned by Dr. S. and a naked eye object) into the field, and just north preceding this scattering cluster will be the nebula, which is larger than the ordinary field. E. E. B.

NEW INVESTIGATIONS ON THE CONSTANTS OF PRECESSION.

In one of the last meetings of the "Niedersheinische Gesellschaft fur Natur & Heilkunde," Dr. SCHOENFELD presented a lately published article by Mr. F. BOLTE, entitled: "Investigations on the Constants of Precession, based upon the Star catalogues of Lalande & Schjellerup." The writer here makes the first attempt to take into consideration the regular proper motion of the fixed stars in the determination of these important constants; while up to this time those parallactic changes of star positions, at most, have been considered which are due to the motion of the solar system. Such legitimate proper motions may be of different kinds, but the most obvious assumption is that they occur in planes which are but slightly inclined to the plane of the Milky Way. This is the idea that the writer has adopted, and he has applied it to the 3300 stars common to the above mentioned catalogues, supplementing a treatise of DOEYER's, which the latter discusses the R. A's. of these stars, by considering their Declinations at the same time. The result for the precession is a very good substantiation of STRUVE's constant, now so commonly applied in our almanacs; for the assumed common motion of the stars, however, it is an entirely negative one, for its value, determined as 0″.4 per century, is much less than its probable error.

The speaker touched upon various possible explanations of this interesting result, particularly this: That the attraction of the Milky Way upon the individual stars may be counteracted by the attraction of the nebulæ which are most thickly clustered about the poles of the Milky Way.—From *Sirius*, February, 1884.

Professor H. C. WILSON, astronomer, in charge of the Cincinnati observatory, has issued the seventh publication of the observatory, which contains the observations of the comets of 1880, 1881 and 1882, made under the direction of Professor ORMOND STONE, until June, 1882. Since that time the work has been carried forward by himself.

Besides the ordinary observations for positions, interesting physical studies of the comets for the three years named are also presented. The method used in reducing and discussing observations of the trains of comets is that of Professor BREDICHIN, director of the observatory of Moscow. For reduction to the plane of the orbit formulæ found in A. A. Nos. 300 and 1172 were used. This publication also contains ten full-page drawings, showing interesting physical changes in nuclei and tails of *b* 1881, *a* and *c* of 1882. The notes that precede these drawings are instructive, for they indicate how the new physical theories of Professor BREDICHIN stand the test in relation to these comets.

AMATEUR STAR-STUDIES.

To the Editor of the SIDEREAL MESSENGER:

Your articles on "Astronomy in High Schools" must be welcome to a wide circle of readers. Prof. HAGEN has also done amateurs a kindly service by showing them how the calculation of eclipses may be made by students of algebra. May I call attention to another fascinating field of study that is open to them without knowledge of the higher mathematics?

Working out the orbits of double-stars by a graphical method, from the tables of observations, is quite within the reach of most persons who interest themselves at all in astronomical studies. A very slight equipment is required, of which the essentials are: "A Hand-book of Double-Stars," or some other work setting forth a graphical method, and containing records of observations; a broad table; an ellipsograph; a set of drawing instruments (protractor, dividers, ruling-pen, etc.); some large sheets of paper, and a sheet of millimetre paper. The "Hand-book" will be ordered from London (if necessary) by any publishing house. The table should be smooth, and should stand three and a half or four feet high. It should be tested with a level, in the place where it is to be used, and made perfectly horizontal. A good ellipsograph is indispensable. Nothing can be done trying to draw an ellipse with string and pins. A wooden trammel may be constructed after the fashion of the instrument used by cabinet-makers (reduced in size, of course) at trifling expense, or a metal one may be ordered of any dealer in astronomical apparatus. The great objection to both is, that they do not rest firmly upon the paper, or are held in place by brads, which deface the paper by punching holes in it. To obviate this trouble I have had a trammel made by plowing the furrows for the sliding-buttons on the face of a wheel of brass six inches in diameter and one inch and a half thick, filled on the under side with lead for the sake of added weight. This instrument stays in its place without pins. A smaller one of the same construction, about four inches in diameter, will be found convenient at times. Or, what would be better, if one did not stand for cost, the instrument might be made of concentric rings neatly fitting together, and so reducible to any desired size. The rod carrying the drawing-pen should be of steel, about eighteen inches in length. The pen should have a plumb-line attached, that its perpendicularity may be always secured. A sheet of millimetre paper costs 25 cents, and may be ordered of any dealer in engineers' supplies.

Thus equipped, the amateur will have means pleasantly to occupy all his leisure days and nights, when sun and stars do not shine, though he live in the cloudiest corner of the world.

N. M. MANN.

By oversight we have omitted to mention before the late gift of Mr. LEWIS M. RUTHERFORD of New York City to the trustees of Columbia college. The gift consisted of the valuable astronomical instruments of his private observatory on Second avenue, and were as follows: A thirteen-inch equatorial telescope with mounting and clockwork complete; a photographic lens with accessories for celestial photography; two micrometers for measuring double-stars; four micrometers for measuring star-plates, now in use by Dr. B. A. Gould at Washington; a transit instrument by Stackpole & Brother; a sidereal clock and additional appliances for the observatory.

Professor REES, director of the observatory of Columbia college, says the outfit would cost at least $12,000. Mr. RUTHERFORD generously bears the expense of moving and of re-mounting the instruments.

The following table appears in a recent number of *The Artisan* (Nashville, Tenn.), which gives the date of discovery of comets and the names of the persons who have received the Warner prize for the same:

Date.	Discoverer.
1881, May 1,	Lewis Swift.
1881, July 13,	J. M. Schaeberle.
1881, Sept. 17,	E. E. Barnard.
1882, Nov. 16,	Lewis Swift.
1883, Sept. 1,	Wm. R. Brooks.

A special award of $250 was given for the last discovery. The others received $200 each.

Nov. 24, 1883.—Large, bright meteors were frequent on the night of Nov. 23, before midnight. A grand meteor, ¼ full moon, appeared in the west at 6^h 42^m, motion west, quite slow; intensely white; burst into fragments about 19^h 30^m, $+ 14°$. Place of disappearance about 18^h 50^m, $+ 5°$. A friend saw a meteor at about 5^h 30^m, in the east, at an altitude of 30°, traveling to the southwest. It disappeared during its flight, and reappeared to burst with dazzling brilliancy, leaving a train visible for some time. Small meteors were frequent, west of the zenith, with motion westward. A fine one, equaling *Jupiter*, in the east, burst at about 9^h 30^m, shooting vertically downward from an altitude of 25°.

The "Gegenschein" was visible a little south of east of the *Pleiades*, and involving that group, while a zodiacal band stretched from the southwest horizon to the "Gergenschein." This wonderful object, I find, always visible since the first of October, when the moon is absent. It moves eastward as fast as the *Sun*, keeping nearly in opposition.

E. E. B.

OMICRON CETI.

On the evening of February 29th, I found *Mira* quite bright at 7^h 45^m (Nashville mean time). It was brighter than *Alpha Piscium* (B. A. C. 625), or *Delta Ceti* (B. A. C. 811). I judged its brightness to be equal to that of *Eta Eridani* (B. A. C. 910). This would make it about the third magnitude. It was remarkably ruddy—so much so that it at once attracted attention as soon as it entered the field of the instrument, and thereby caused its identification. I was not thinking of *Mira* at the time, and was for several minutes in doubt as to what star it could be, because it was strange to me. There is a small companion south which appeared of an ashy hue, or, possibly, pale blue. WEBB (Celestial Objects) says that in 1878 he found no trace of red in *Mira*. *Alpha* was redder. HERSCHEL describes it as very full ruby. E. E. BARNARD.

During the month of March subscriptions were received from the following named persons:—

Hon. Gordon E. Cole, Faribault, Minn.; J. W. Rall, St. Louis, Mo.; Academy of Sciences, by Wm. Robasz, Rochester, N. Y.; M. A. G. Meads, Buffalo, N. Y.; E. Howard & Co., Boston, Mass.; Thomas P. Peckham, Ledyard, N. Y.; Professor A. L. Brewer, Classical and Military School, San Meteo, Cal.; Mrs. Sarah C. Strong, Beloit, Wis.; Justice Stahn, Baltimore, Md.; Henry H. Parkhurst, New York City; N. Y.; Professor William A. Rogers, Harvard College Observatory, Cambridge, Mass.; Library of the U. S. Naval Observatory, Washington, D. C.; E. Crocker, Berea, Ohio; Frank Smith, Ypsilanti, Mich., Professor Geo. Davidson, U. S. Coast Survey, San Francisco, Cal.; James Bird, Atlanta, Louisiana; James S. Lawson, U. S. Coast and Geodetic Survey, San Francisco, Cal.; Professor E. L. Schaefer, Bethlehem, Pa.; J. J. Gilbert, U. S. Coast and Geodetic Survey, Seabeck Olympia, Washington Territory; F. G. Blenn, (Vols. I, II, III) East Oakland, Cal.; W. A. Savage, Columbus, Ohio; G. D. Hulett, Sodus, N. Y.; I. A. Sanford, Neenah, Wis ; Professor D. F. Higgins, Arcadia College, Wolfville, Canada; Professor James M. De Garmo, Institute, Rhinebech, N. Y.; C. W. Tallman, Batavia, N. Y.

The European astronomers and some in America are trying to find a definition for mean solar time on which all can agree.

Mr. C. BURCKHALTER, Oakland, California, has the hearty thanks of the MESSENGER for personal interest in obtaining new subscribers. His recent sketches of *Jupiter* agree well with those of other observers. The photographs of his 10½-inch BRASHEAR reflector, certainly indicate good facilities for observation. He is greatly pleased with the instrument.

The important discussion "On the deflection of the Level, due to solar and lunar attraction," by Professor J. HAGEN, Sacred Heart College, Prarie du Chien, Wis., appears in this issue. The simple and direct manner in which it is treated makes the mathematical part of it as interesting as the historical.

Current memoranda of the planets and book-notices are deferred for want of space.

From a late issue of *Science* we learn of Astronomical work now going on at Natal. an English colony in South Africa, under the direction of Mr. EDMUND NEISON, government astronomer of that place. The following subjects are being pursued:

1. "The dimension of the exact amount of parllactic inequality of the motion of the *Moon* by means of observations of the positions of of a crater near the center of the lunar surface.

2. The determination of the exact diamater of the *Moon* by observations of pairs of points near the limb.

3. The effect of irradiation and its variations on the apparent semi-diameter of the *Moon.*

4. The systematic variation of the apparent place produced by the irregularities on its limb.

5. The real libration of the *Moon* by a method independent of the errors caused by abnormal variations in the apparent semi-diameter of the *Moon.*"

Mr. NEISON's work entitled "The *Moon* and condition and configuration of its surface," published in 1876, by Longmans, Green & Co,. London, is good authority.

A NEW AND FAINT NEBULOSITY.

I have found in

$$\left.\begin{array}{llll} \text{A. R.} & 5^h & 56^m & 30^s \\ \text{Decl.} & +10^\circ & 26\frac{1}{4}' & \end{array}\right\} 1884.0.$$

a very faint nebulosity. It lies a little over ¾° north of *Mu Orionis*, and requires a low power to be seen at all. With my 5-inch refractor and a power of about 30 diameters, it is quite distinct; but higher powers diffuse it greatly. There is a faint star in its center, and several others on its borders, about 2′ diameter. I have repeatedly seen this nebula since January, 1883. E. E. BARNARD.

The Glasgow catalogue of stars, which for some time has been in preparation by Professor GRANT, has been recently published.

MR. TYDEMAN, 835 Linden street, Camden, N. J., has a 3-inch Achromatic; also a 7-inch and a 13½-inch Reflecting Telescope, for sale.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory.
Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

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THE GREAT COMET OF SEPTEMBER, 1882.

PROFESSOR H. A. HOWE, DENVER UNIVERSITY.

This great comet has fled from the gaze of man, and thirty generations of astronomers will pass away, before it will submit itself to human scrutiny. Then, perchance, it will again burst unexpectedly into view, to be firmly bound by the chains of mathematical analysis, which, though more tenuous than gossamer, are stronger than steel. As a man's biography comes suitably after his death, but before the remembrance of him has faded from men's minds, so, since this comet is now buried in the darkness of space, a short history of it, with a fresh prediction of the time of its resurrection, may not be inappropriate.

The first accurate observation of which we have record was made by Mr. FINLAY at the Cape of Good Hope, on Sept. 7, ten days before perihelion passage. Just before it reached its perihelion the same observer watched its disappearance among the undulations of the *Sun's* limb, as it began its transit, describing an apparent path not dissimilar to that of *Venus* on Dec. 8, 1874, though opposite in direction. Its velocity was nearly 300 miles per second, and it dashed through the outer envelope of the *Sun* at a distance of 280,000 miles from his surface, being thus exposed to a heat so intense, that one is reminded of the old speculation that comets are the enforced abodes of lost spirits, which are thus exposed to uncomfortable extremes of temperature. Its nucleus then appeared as a fiery globular mass, whose diameter was about 2,000 miles. Prof. PETERS observed five or six envelopes rising sunward to a height of 12,000 miles above the straw-colored nucleus, while opposite the *Sun* extended a brush 38,000 miles long. In a few days the nucleus appeared elongated, and soon seemed to split into a number of parts, or, more exactly, a number of centers of condensation were formed, ranged in a right line, connected by, and enveloped in, the coma. As the weeks went by these centers changed their appearance and relative positions, and gradually became fainter till June, 1883 when the comet was observed for the last time, at Cordoba.

Its spectrum, which was so brilliant that it was studied in the day-time, was chiefly characterized by the presence of the bright lines of sodium; a narrow, continuous spectrum given by the nucleus was clearly seen. Hence we conclude that its density was considerable, and that a collision between such a body and the earth, would be fraught with disastrous results to us.

It now remains to collect all the observations and compute the orbit as accurately as possible. Here a formidable difficulty arises. Since the comet approached very near the *Sun*, the intense heat caused a violent action in the nucleus; as the fluid matter rose toward the *Sun*, and was again repelled, it seems that certain quite dense portions of the nucleus were carried off. After perihelion, a cooling process set in, and the denser portions drew the surrounding fluid matter to themselves; thus the various condensations were formed. Now, different observers observed different portions of the head; some took the positions of the fainter points of light, because they were more star-like, and thus their positions could be more accurately determined; others very naturally observed the brighter portions. When the object became faint the centre of the elongated, nebulous mass was taken. Observations of the relative positions of the centres of condensation were made by few, the best series being at Athens, Cape of Good Hope and Mt. Lookout.

First, then, by a careful discussion, all the observed right ascensions and declinations should be reduced (as far as possible) to some point which is thought to be the centre of gravity. If this point can be found, and the observations referred to it, its motion ought to satisfy elliptical elements very well, since the disturbing forces are apparently slight.

Five forces acted upon the nucleus, viz.: the *Sun's* attraction, the attraction of the planets, the mysterious force which drove away the comet's tail, the resistance of the corona, and the forces within the nucleus, caused by the intense heat. Dr. MORRISON has remarked that the perturbations produced by the planets were absolutely inappreciable; so narrow was the ellipse that the repulsive force from the *Sun* would tend to diminish the velocity before perihelion, and increase it afterwards; but this force is small. The observations have not shown any effect of the resistance of the corona; the disruptive forces within the nucleus have no power to change the position of the centre of gravity in space, for the centre of gravity in a moving system is unaffected by the mutual actions of internal forces. Nor would the diminution of the mass of the body, as a portion of it was driven away along the tail, affect its path. Hence the determination of the position of the centre of gravity with reference to the points of condensation is a task to which the computer should address himself.

Since all the drawings and discussions of the nucleus have not yet been printed, the writer has made an approximation to the true orbit, by the aid of the observations made at Cordoba. The same point in the nucleus was observed until Feb. 12, 1883; after that date the point was invisible, and the centre of the elongated nebulous mass was taken. The observations were compared with an ephemeris computed from Prof. FRISBY's elements. The normal places were as follows:—

Greenwich M. T. Equinox of 1883.0

	Nov. 16.0, 1882.			Jan. 3.0, 1883.			Mar. 25.0, 1883.		
α	141°	55′	46.″43	106°	53′	58.″08	88°	22′	36.″47
δ	−24	50	4. 77	−29	7	17. 79	−10	46	17. 33
λ	154	8	47. 75	113	53	55. 04	88	4	17. 62
β	−37	26	50. 85	−51	10	56. 64	−34	12	54. 16
L	234	4	19. 30	282	49	42. 60	4	30	19. 90
log R	9.9949425			9.9926772			9.9990495		

Using the notation in the new edition of Oppolzer, Vol. I, the following values of constants were obtained:—

	Prime.			Third.		
P	217°	52′	41.″17	325°	36′	59.″16
ψ	82	1	1. 32	84	40	59. 11
log N	9.1375780			8.9659629		
log D	9.9907133			9.9971768		

W	290°	27′	35.″07	log f′	9.5578575
W′	207	6	34. 86	" A′	8.7397621
H	6	23	25. 88	" B′	9.3577802
H′	7	43	24. 78	" C′	9.4872718*n*
F′	38	3	56. 66	" K	0.1494578
G′	297	4	50. 33	" tan J	1.3113119

From Prof. FRISBY's orbit the following six quantities were obtained:

2 f′′′	1°	24′	24.″64	log r′′′	0.5559818
2 f″	2	30	39. 22	" r″	0.3938543
2 f′	1	6	14. 58	" r′	0.2229559

By the aid of these the following were computed:—

I	1.5785324	log VII	0.3537552
log II	1.0683348*n*	log VIII	0.5789603*n*
log III	0.1505931*n*	log IX	1.0167042
IV	0.2465647		
log V	0.5210239*n*	log Γ	9.7916529*n*
log VI	1.1807771*n*	log Δ	0.0054556*n*

In the approximations for distance, the following values of the principal quantities were found:—

	1st Approximation.	4th Approximation.
log x	7.8349975	7.8352897
log y	9.5630839	9.5632102
log ρ′	0.1733953	0.1733778
log ρ′′′	0.5501693	0.5501474
log r	0.2227984	0.2227857
log r′′′	0.5559388	0.5559181

With these improved values, a new computation of the quantities Γ, Λ etc. (which depended upon Prof. FRISBY'S orbit, and were used in the approximations for distance), was made. Then new approximations for distance were made. The heliocentric longitude and latitude were then found. The final results were:—

	Prime.	Second.	Third.
log r	0.2227856	0.3937567	0.5559179
log ρ	0.1733776		0.5501472
2 f	1° 5′ 38.″239	2° 29′ 17.″746	1° 23′ 39.″509
l	110 13 32. 22		107 25 22. 45
b	—32 51 51. 13		—33 42 8. 42
u	241 35 46. 56		244 5 4. 33

The system of elements thus became:—

T	Sept. 17.2637,	Gr. M. T., 1882.		
π	55°	2′	16.″59	1883.0
☊	345	43	55. 01	1883.0
i	141	54	31. 54	1883.0
φ	89	13	55. 8	
	log e		9.9999610	
	log q		7.8821773	
	log a		1.9289	
			Period	782.4 years.

The second normal place was satisfied within 0.″02 in both lognitude and latitude. The perihelion distance is 707,500 miles, the semi-major axis 7,878,000,000 miles, and the semi-minor axis 105,600,000 miles.

If this be the comet which appeared in 370 B. C., whose orbit was calculated by PINGRE from Greek observations, its mean period during three revolutions has been 751 years. The comet of 370 B. C. had a very small perihelion distance, and was otherwise similar to that of 1882. In the year 1131 A. D., a comet was seen, and in 1132, two of them came into view, according to the Chinese chronicler MATUOANLIN, but their orbits are unknown.

THE PLANET SATURN.

BY THE EDITOR.

The time for best observations on the planet *Saturn* has passed for this year; and as the noble object takes its leave of us, it may be profitable to state briefly the important and interesting results of recent physical study upon its wonderful system that have come to our notice. Telescopes in all parts of the world have been vieing with each other in careful scrutiny of details of that which may be seen under favorable circumstances, and the patient and scholarly search has not been in vain. It will be remembered that the mean distance of the planet is about 882 millions of miles from the *Sun*; its diameter nearly 70,500 miles, and its time of rotation on its axis is 10^h 14^m 24^s, less than half of one of our days. Nearly in the plane of its equator, the planet is surrounded by two rings at a considerable distance away, and outside of these revolve eight satellites, which is double the greatest number known to belong to any other planet. Observation is most favorable near the time of opposition, which last occurred Nov. 28, 1883. The next will take place Dec. 11, 1884, and generally these periods succeed one another at intervals of one year and from twelve to fourteen days.

In the telescope the physical appearance of *Saturn* resembles that of *Jupiter*. Upon its surface are seen spots, and light and dark belts lying parallel to the direction in which it revolves. By observing spots the time of the rotation of the ball is determined. The value given approximately above was determined by Professor HALL after a month's study of the transits of a bright spot across the central meridian, and is about two minutes less than that found by Sir WILLIAM HERSCHEL eighty-two years earlier. The motion of a point, then, on the equator of *Saturn* would be nearly six miles per second. The globe is not a sphere, but its figure is that of an oblate spheroid, and strange to say, its polar compression is greater than that of any other planet, not excepting *Jupiter*, which is larger, and also rotates in less time than *Saturn*. The polar diameter is less than the equatorial by about 7.800 miles. Its axis of rotation is inclined 64° 18′, the equator making an angle with the same plane of 25° 42′. *Saturn*, therefore, has greater extremes of temperature during its year than *Earth* or *Mars*.

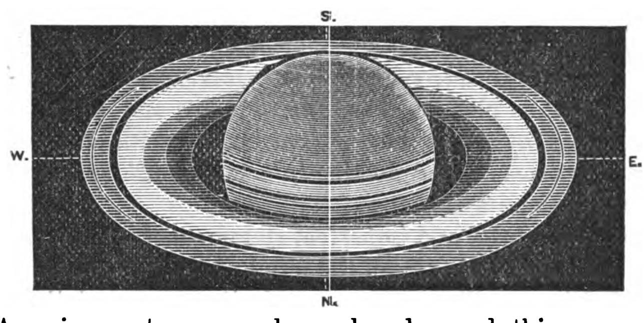
No one knows anything of the internal condition of *Saturn*, and that of the surface is little more than conjecture. What is seen is thought to be a dense layer of vapors and cloud-like forms, through which the eye cannot penetrate with the strongest optical aid; and yet it is quite evident that the parallel bands, as in the case of *Jupiter*, are due to the rapid rotation of the planet on its axis. The bands are fainter than those of *Jupiter*, and spots are of rare occurrence.

The chief characteristic that distinguishes the Saturnian system from every other celestial object, is the broad, flat ring that encircles the equator at a considerable distance from it. By increase of telescopic power, the single ring is easily divided, and the two stand out concentrically over the equator, the inner one being the brighter of the two, with a broad, dusky edge toward the planet. This rapid shading off of the inner edge of the bright ring has been spoken of, unfortunately, as a separate one, and called the Crape Ring; but is difficult to see why it should be thought of as a separate ring when there is nothing to indicate it.

It is now well established that these rings do not form a continuous mass, either of solid matter, as early supposed, or of fluid substance, as later believed; but that they are really streams of minute meteoric bodies, countless in number, yet all independent, and revolving in separate orbits about the planet. They are so many, and so far away from the *Earth*, that they appear as a continuous mass, "like particles of dust floating in a sunbeam," as elegantly penned by one writer.

This very brief and imperfect statement of what is known and on record will refresh the mind of the reader, and that which follows will appear as new in its proper relation.

Careful English observers have given attention to the belts and rings of *Saturn* during the last opposition. Mr. RANYARD, in November last, noticed a narrow, dark belt stretching across the disc of the planet, and slightly fading away towards either limb. It was as easily seen as Cassini's division on the ring. At the January meeting of the Royal Astronomical Society Mr. GREEN (February *Observatory*) made a sketch on the blackboard to indicate the relative positions of the different belts on *Saturn*. Mr. GREEN said that the ring hid the northern part of the planet, but the outline of the ball could be traced on either side for some distance through ring C—the dusky ring. To the south of the dusky ring was a bright belt, the central position of which was so brilliant as almost to suggest that Mr. BRETT'S hypothesis of specular reflection might be applicable to it. Further to the south there was a dark, broad belt, which he thought was the one Mr. PRATT had described as the Vandyke-brown belt, which he should be more inclined to speak of as a sepia belt. In contact with this was a narrow belt, which he believed was the one Mr. RANYARD had described. It had the looped edges referred to, and was not a clean, even belt. The color of the dark belts seemed to him of a rich, yellowish brown, something of the tint seen on a Cochin-China egg. Further to the south was another belt, and, finally, there was a faint, ill-defined cap round the southern pole." Mr. GREEN claimed that there had been great changes on the planet's surface during the last year.



American astronomers have also observed this new narrow belt. Professor E. S. HOLDEN'S note-book, Nov. 8, '83, contains the following, which has also appeared in *Observatory* for March, with a drawing, which is reproduced above.

"*The Ball.* The S. hemisphere is dark; the S. pole the darkest. A dark stripe along the S. edge of the bright equatorial belt. The belt has a dark and narrow stripe along its middle. Dec. 2 (accompanying drawing), the S. pole is mottled, especially so near the shadows. The bright equatorial belt is bounded on the S. by a narrow, dark belt some 2″ wide; it is the darkest thing on the ball. South of this is an equally narrow, bright streak; then S. of this is the nearly uniform S. hemisphere. N. of the equatorial bright belt is a narrow, dusky belt (1.″5?), then a narrow, bright belt (1.″5?), and then the dark band, which is the dusky ring itself (C). The principal division is seen all around; that in ring A. is seen at both ends. The shadow of the ball on the ring is as drawn. It is wider and of different shape on the preceding side, as drawn. I did not specially look for (or see) the shadow of the ball on the ring C."

Professor C. A. Young, with the 23-inch Clark equatorial of the Halsted observatory, in Nov. last saw the ball of *Saturn* through Cassini's division. Professor HALL of Washington was present at the time, and shared in the interest of this rare observation. Professor YOUNG says the "seeing was very fine at the time. *Mimas* was conspicuous not far from conjunction, and so was the olive-green polar cap, and the brownish and reddish belt south of the white equatorial belt." These observers saw Cassini's division perceptibly less dark where the ball of the planet was behind it. So far as we know, this is the first time that the planet has been noticed through the dark space between the rings. The observations of Professor GEORGE DAVIDSON, U. S. Coast Survey, San Francisco, in the astronomical notes of Bulletin 1 of the California Academy of Sciences, are exactly in the line of our thought. They are so well stated that we give them in full. Under the head of *Saturn*, he says:—

"*The position of the Encke division* plainly divides the outer ring A into two slightly unequal annuli by being nearer the outer than the inner circumference. This was certainly the case at the preceding part of the ring, but at the following part of the ring the division was apparently nearer the inner circumference. This anomaly was doubtless occasioned by the sun shining full on the preceding part of the ring, but at the following part the shadow of the raised rim of the outer circumference of the B ring was projected across and beyond the outer edge of the Encke division upon the inner bright border of the A ring. This reduced the apparent breadth of the inner annulus of the A ring at that point, and makes it appear narrower than the outer annulus. When the atmosphere was quiet this shadow made the breadth of the Encke division greater at the following than at the preceding part of the ring. It was, of course, a very small difference, yet it was unmistakable, under favorable conditions. *The dusky ring.* While there were but two or three occasions on which the inner circumference of the dusky ring was sharply defined, yet without this condition, there were no times when the extreme parts of the dusky ring were equally distinct. And upon most occasions the preceding part of the ring was the brighter. It became a question why this appearance was so generally presented; whether it was in the ring itself, and would thus give a clue to its period of rotation, or whether it was owing to the direction of the atmospheric waves of disturbance as we see them in geodetic observations, whether due to peculiarities of the telescope or the observer's eye. Sometimes these observers made the comparison before announcing the result; the atmospheric disturbance might account for part of it. Changes of eye-pieces did not correct the impression. Decided change of parts was exhibited during one period of two or three hours. But upon more than one occasion the following part has seemed the brighter without any doubt in the observer's mind. It seems that one reason for the preceding part being brighter than its normal tone, must be in the additional light reflected upon it from the illuminated body of the planet being brighter near the preceding limb, after opposition. I have not had an evening when the atmosphere continued sufficiently and uniformly quiet to observe during the whole night under equal conditions.

The dusky ring, where it crosses the body of the planet, does not present a uniform tone of color, but the inner circumference seems a little denser and darker than further out. This might arise from a narrow, dark belt on the body of the planet, just on the line of projection of the inner circumference on the body of the planet. There is, across the white equatorial band on the body of the planet, a very narrow, dark belt, which I first noticed close to the edge of the dusky ring. This belt moved very slowly towards the south during December and January.

I have recorded also, upon two occasions, a narrow, dark line across the body of the planet in the dark part south of the bright equatorial belt. It revealed itself only upon short occasions of extreme quietness of the atmosphere.

For all these studies I have used eye-pieces of various characters, with magnifying powers from 120 to 500 diameters, but only on one or two occasions utilizing the latter."

ON THE DEFLECTION OF THE LEVEL DUE TO SOLAR AND LUNAR ATTRACTION*.

BY J. HAGEN S. J. COLLEGE OF THE SACRED HEART, PRAIRIE DU CHIEN, WIS.

(*Continued from page 79.*)

The attraction γ of the disturbing body is:

$$\gamma = \gamma_0 : [1 - \frac{2\rho}{r}\cos z + (\frac{\rho}{r})^2]$$

where γ_0 is the attraction on the center of the earth. The square of $\rho:r$, being less than 0.0003, even in the case of the moon may be omitted, and by the same approximation we may put $\gamma_0 = \theta^2 e$, whence:

$$\gamma = \theta^2 e(1 + 2\frac{\rho}{r}\cos z).$$

*A. N. No. 2568.

Besides we have:

$$\cos(z'-z)=1, \quad \sin(z'-z)=\frac{\rho}{r}\sin z,$$

consequently:

$$\sin z'=\sin(z+z'-z)=\sin z+\frac{\rho}{r}\cos z \sin z'.$$

Finally in those terms which contain the factor $e{:}r$, we are allowed to write $\sin z$ and $\cos z$ instead of $\sin z'$ and $\cos z'$ and thus find shorter:

$$X=\frac{\theta^2\rho}{2}(3\frac{e}{r}+\cos\lambda^2)\sin 2z.$$

As regards Z, we have even for the moon

$$\theta^2\rho:g<0.000005,$$

consequently the square of this quantity may be omitted, and $Z=-g$. Thus we obtain for the total deflection of the level the formulas:

$$(1)\quad \begin{aligned} \frac{dz}{dx}&=\frac{\theta^2\rho}{2g}(3\frac{e}{r}+\cos\lambda^2)\ \sin 2z \\ \frac{dz}{dy}&=\frac{\theta^2\rho}{2g}\sin 2\lambda\ \sin z. \end{aligned}$$

From this we have to subtract the deflection caused by the supposed rotation of our earth around a central axis perpendicular to the orbit of the disturbing body. If the latitude of a place with regard to this orbit is denoted by β, the centrifugal force is $\theta^2\rho\cos\beta$, and its projection on the horizon (towards the orbit) $=\frac{1}{2}\theta^2\rho\sin 2\beta$, hence the deflection of the level

$$(2)\qquad =\frac{\theta^2\rho}{2g}\sin 2\beta.$$

This is to be resolved parallel to the axes of x and y. Let the points in which the produced lines R and ρ and the axis of the orbit intersect the celestial sphere, be denoted by R, O and A, then in the right-angled triangle of Fig. 2:

$AR=\lambda$, $RO=90^\circ-z$ and $AO=90^\circ-\beta$. From this we obtain the components:

$$(3)\qquad \frac{dz}{dx}=\frac{\theta^2\rho}{2g}\cos\lambda^2\sin 2z\,,\qquad \frac{dz}{dy}=\frac{\theta^2\rho}{2g}\sin 2\lambda\sin z\,.$$

By subtracting (3) from (1) we have the true deflection of the level:

$$\frac{dz}{dx}=\frac{3}{2}\frac{\theta^2\rho e}{g\ r}\sin 2z;$$

$$\frac{dz}{dy}=o;$$

or, since $\theta^2 e=\frac{m}{r^2}$, $g=\frac{M}{\rho^2}$,

$$(4)\qquad \frac{dz}{dx}=\frac{3}{2}\frac{m}{M}\left(\frac{\rho}{r}\right)^3\sin 2z\,,\qquad \frac{dz}{dy}=o.$$

We proceed to compare this solution with those mentioned in the beginning. It is at once seen to agree with PETERS' formula, the forces applied in both solutions being the attraction of the disturbing body both on the center and on the surface of the earth, and the gravity at the earth's surface. The same forces have been applied by RAMUS and SANG, whose formulas essentially coincide with PETERS'. All these solutions agree in that the deflection is directed towards the azimuth of the disturbing body and is greatest when the latter is nearest to the earth and at 45 degrees zenith-distance.

ABEL, on the contrary, disregarded the attraction of the earth by the disturbing body, thus supposing the deflection to be caused by the full attraction of *Moon* or *Sun* instead of taking the difference between the former and latter. His deflection is therefore too large and besides, reaches its maximum at the rising and the setting of the luminary.

Captain STERNECK'S formula is marked (8) on page 561 and 563 and is the following: Deflection $= \frac{a\rho}{2e} \sin 2\beta$. Since his $a = \theta^2 e:g$ in our notation, it is identical with our formula (2), the effect of a supposed monthly rotation of the earth around a central axis perpendicular to the *Moon's* orbit, which is also expressly mentioned on page 555 of his paper. The deflection of the vertical implied in PETERS' formula is not represented in his, because he disregards the variation of the *Moon's* attraction on different points of the *Earth*, as is stated on page 554.

In the short note of the Report of the British Association it is not said how the lunar deflection, which amounts to nearly one half of that given by PETRRS, has been calculated.

In conclusion, I may say that the preceding demonstration in not quite so short and direct as that given by PETERS in the *Bulletin de l' Academie Imperiale de St. Petersbourg*, but, it is hoped, will be found to show forth the errors, especially of those authors who have found lunar deflections to the enormous amount of 0.5 and 0.8 seconds of arc.

OBSERVATIONS ON THE PONS-BROOKS' COMET.

W. H. NUMSEN, BALTIMORE.

(*Continued from page 85.*)

The stellar point small, and brighter than the circular nebulosity, and perfectly distinct from it. The circular nebulosity somewhat fainter, but perfectly distinct from the coma, and the coma faint and indefinite, three grades, as it were. I estimate the *diameter* of the circular nebulosity as about 1′, by a rough comparison with the companion of δ Orionis. At 7:20 moon was out of clouds in east, and with p. 25 tail could be traced for $1\frac{1}{4}°$ pretty plain, and perhaps $1\frac{1}{2}°$, but after that uncertain. Seems perfectly straight.

Upon comparing my sketch and notes with the drawings in the March number of the MESSENGER, I find it agrees pretty well, except that my telescope, being only a 4-inch, did not show the dark spaces on either side of the nucleus. To me it appeared of nearly uniform brightness, its boundaries terminating sharp, without the slightest trace of fading into coma. The stellar nucleus was so distinct that, at first, I thought the comet was passing over some star.

Jan. 17th.—6:30 to 7:50. Pretty clear; no clouds, but seems slightly misty. Tail much easier to naked eye than expected. Pretty plain for 3° or 4° or so, and I think that, when seen sideways, several degrees longer; possibly 6° or 7° total. Through finder tail only evident for $1\frac{1}{2}°$, but getting misty. Tail, I think, is now slightly curved. If it is, convexity is on south side. (Up to this time the tail had always appeared to me perfectly straight.) With p. 25 bright, circular ring, seen last time, cannot be seen to-night. Nucleus a strong condensation, and think I can see at times a small stellar point, said point not in center, but somewhat more to *n. f.* side of condensation. For $1\frac{1}{4}°$ the tail is evident, bright, and broadens. After that it seems to get thinner, and a fainter, narrower portion starts on. Can't be certain of this fainter portion, for more than $2\frac{1}{2}°$, but getting more misty.

Jan. 20th.—6:30 to 7:20. No clouds, though slightly misty look. To naked eye tail not as bright nor as long as when last seen. Through finder, nucleus plain. Tail appears slightly curved towards right. Certain of it for 3° and over by field of view, and fades away. With p. 25, nucleus pretty stellar and evident. No doubt about tail being slightly curved, and spreads. Convexity on south side, and seems to be somewhat more convexity than concavity. Can't be certain of tail for more than 3° or so. Nucleus is distinct by itself, and pretty stellar. No nebulosity around it, except the pretty uniform brightness of head. Can't see or suspect any brighter point in nucleus.

Jan. 21st.—6:40 to 7:30. Very clear, but slight mist towards west. To naked eye tail appears, I think, slightly curved. Through finder, undoubtedly curved, and sweeps downward. Traced clear across field, 3° though not much further. With p. 25, curvature easily noticed. Surely 3°, and possibly $3\frac{1}{4}$° long, but after that uncertain. If anything, south side is better defined, and more clear cut; north side seems blurred. Nucleus strongly condensed, and pretty distinct, but does not appear decidedly stellar. Can't say that I can see any brighter condensation point in nucleus. Comet getting fainter.

Jan. 23d.—6:30 to 7:20. No clouds, but haze 10° or 15° above horizon. With naked eye, tail pretty easy. Dead sure of it for 2°, and pretty certain for 3°, and possibly a little more. Through finder nucleus pretty distinct and strong. Tail plain for $1\frac{1}{2}$°. With p. 25, tail easy for $1\frac{1}{2}$°, or perhaps 2°. Curvature very easy now. Convex edge always more distinct than concave one. Comet getting low and in the mist.

Jan. 25th.—6:20 to 7:15. Clear. Tail pretty plain to naked eye; certainly $2\frac{1}{2}$° to 3° long; points curved towards β Ceti, and spreads. With p. 25, nucleus appears like an infidenite condensation, somewhat brighter towards middle, but can't pick out any stellar point in it. Border fades into coma. Curvature of tail very pronounced; appears to bend like a bow.

Jan. 26th.—6:15 to 7:15. Very clear and beautiful. Still. Tail pretty plain to naked eye for 2° or so, and I suspect at times a faint continuation to about half-way to β Ceti. Curvature about the same as last night. With p. 25 nucleus appears pretty stellar, and with finder there is a star (est. $1\frac{1}{2}$° pos. 340°) of about equal magnitude to nucleus. Tail easy for $1\frac{1}{2}$° can be traced certainly for 2° and possibly more. Both sides somewhat indefinite.

Jan. 29th.—6:15 to 7:10, Very clear and distinct. Crescent moon. Appears to have "fizzled out;" looks nebulous, but am not certain about seeing tail. With p. 25 nucleus appears at times pretty stellar, though not sharply so. There is a star about 15′ *n. f.*, pos. 45°. Nucleus appears about as large as this star, though not as bright. Pretty sure of tail for 1°, and sometimes think can trace it clear across field 1¼°. Still curved, though I think not as much as before. Very indefinite on both sides and towards end.

With reference to the foregoing, I would say that I am conscious of the fact that I may have made errors in the observations, but if I have, I have tried to do so upon the side of seeing too little, rather than too much. The length of tail was estimated by judging from diameter of field. To avoid bias and previous knowledge, it was my custom to make observations, first, with naked eye, then with finder, and then with comet eye-piece, making notes of each, separately, at the time. This rule was generally followed, except when the state of the sky was so uncertain as to cause me to hurry up.

Baltimore, March 17, 1884.

INTRA-MERCURIAL PLANETS.*

The scientific journals bring us items from the reports of M. TROUVELOT, who accompanied Mr. JANNSEN to the Caroline Island in the South Pacific, to observe the total solar eclipse, of May 6, 1882.

The members of this Academy will recollect that JANNSEN and his associates upon their return *via* San Francisco, were invited to attend our meeting. Messrs. PALISA and TACHINI and ROCKWELL were absent. All these gentlemen had been observers of the eclipse, and some of them had specially directed their attention to the question of intra-mercurial planets. No one had seen any sign of these bodies, but M. TROUVELOT made known to the Academy that at the time of totality he had seen a star—a red star—

* A paper read by Professor George Davidson, U. S. Coast Survey, before the California Academy of Sciences, as it appeared in Bulletin No. 1.

of the fourth magnitude, about three degrees north and three degrees west of the *Sun*, and that the star had no definite disk or appreciable phase. He had no opportunity to consult star charts, and therefore he could not pronounce judgment upon its being a star or an intra-mercurial planet.

The next day I placed the *Sun* in its proper position on the star charts of ARGELANDER, and then found δ *Arietis*, of the fourth magnitude, situated two and three-fourths degrees north and two and three-fourths degrees west of the *Sun*. I had to be absent during the day, but M. TROUVELOT came and examined the charts aud my location of the *Sun*. This to my mind was the solution of M. TROUVELOT's red star. But δ *Arietis* is not a red star, and we can only suppose that there were such conditions present as gave to the star a reddish hue, or that M. TROUVELOT sees objects red where other observers do not.

I have been thus particular about details, because we now read published statements that are somewhat different. It is mentioned that he saw a decidedly red star "a little to the north and a little to the west of the *Sun*." He, moreover, is reported to have stated (*Nature*, page 546) that on September 5th and 7th, he examined the part of the sky where the *Sun* was then situate, with a telescope of the same aperture that he used in observing the eclipse, and with the eye-piece then employed, he recognized the two white stars which he had noted as 41 and ε *Arietis*, but the red star was not found, even though he swept to a much greater distance than any probable error of his observation would allow. On this circumstance he remarks:—

"As much as the absence of a red star as brilliant as that one I observed during the eclipse seemed naturallv to lead me to suppose that the star in question was not other than an intra-mercurial planet, nevertheless, as the most necessary elements—such as the position, and a disk, or a sensible phase—failed my observation, I believe it is my duty to hold my opinion in reserve, and for the present suspend my conclusions upon the possible nature of this star."

With regard to the reference to the stars 41 *Arietis* and ε *Artetis*, respectively of the 4th and 4½ magnitudes, it need only be remarked that they were not in or near the region of the reported red star. The former star was 10¼° north of the *Sun* and 2½° to the east; the latter star was 4⅓° north ½° east of the *Sun*. They may be thrown out of the case, except as indicating that he saw them, probably with the naked eye, as he could hardly be looking in that locality for an intra-mercurial planet. Two or three stars of this constellation, but of the 5th and 6th magnitudes, lie from 1½ to 3° to the north and west of δ *Arietis*, but they do not appear to have been seen.

We are therefore reduced to the consideration of δ *Arietis* as being the star which M. TROUVELOT saw. At our meeting he named the estimated distance of the observed star from the *Sun*, and this estimated distance almost exactly tallies with the position of δ *Arietis*; and his observing 3° west and 3° north is represented by 2¾° west and 2¾° north; the estimated magnitude agrees with the actual magnitude; and the absence of the disk and of phase, agree with the observer's statement that it was the star.

In my judgment, but one condition remains unsatisfied, namely, that it was a red star. And it seems to me not unlikely that there may have been atmospheric or possibly cosmic conditions in that vicinity which gave the star a reddish hue; or that he may have a tendency to see an object with a reddish tinge. The seeing 41 and ε *Arietis* as white stars might militate against this view. But in M. TROUVELOT's great atlas of astronomical drawings, and in his drawings of *Sun* spots, in the Cambridge Annals, we can not help noting that his red spot on *Jupiter* is very brilliantly red as compared with the appearance to most observers; and in some of the sun spots we find a reddish tint added to the blackness of the dark centres, the same reddish tint not being visible to other observers. It would be interesting for M. TROUVELOT to institute comparison with other observers in order to settle this color question.

THE NEW OBSERVATORY OF LA PLATA.

[Translated from the *Bulletin Astronomique* (French) by Miss NELLIE FIFIELD, Carleton College.—Ed.]

The last courier of Rio de la Plata brings the interesting news of the founding of a new observatory in South America, where there are, unfortunately, still so very few. The governor of the province of Buenos Ayres, M. DARDO ROCHA, who has already contributed so much to the recent progress accomplished in Argentine Confederation, has caused the decree of the foundation of a new city—La Plata—as the capital of the province. The city, already commenced at "la Ensenda de Baragan," on the bank of the river, will be provided with an observatory, the director of which is named M. BEUF, lieutenant of a very distinguished vessel of our navy, formerly director of the observatory of Toulon, and recently director of the Argentine naval school. The decree gives to M. BEUF an annual payment of 24,000f., and one sum of 100,000f. for the first construction, with the authorization of choosing his helps. He was permitted to use a certain number of excellent instruments constructed in France for the observation of the transit of *Venus*, at the expense of the government. The last courier brings, besides, the order of new instruments. The first very important work, as well in scientific point of view as in the needs of the administration of the country, to be undertaken, is the drawing of a map (or chart) of the province, of which we still have but very imperfect outlines. M. BEUF adopts, for this grand work, the only rapid, economical, and at the same time very exact process which the nature of this country permits. The immense extent and uniformity of the plains, or *pampas*, which compose the greater part of them in the present state, renders, in fact, impracticable the ordinary geodetical processes, because the very meager dimensions which would be possible to give to the triangles would have necessitated a considerable number of stations. It would result in a very great loss of time and a great accumulation of errors in walking through a country so flat, where the absence of stone will render impossible the construction of a number of surveying signals. M. BEUF is, then, decided to profit with the extreme precision which we obtain to-day by the aid of our excellent portable instruments, and of the telegraph, in order to proceed to astronomical determinntion of fifty equally divided points over all the province, to which we shall re-attach by topographical process, as exact as possible, all the details of the surrounding country. If we have sufficient help we shall be able to carry abreast the two different operations, beginning with the most populated portion, and in a few years of toil shall obtain an excellent and very useful map of this grand province, where the population, railways, and the improvements of the soil, make, since five or twenty years, so rapid progress. It would be very desirable that this same process should be applied by the national government to the whole territory of the Argentine Confederation, each province bearing the expenses of the work which belongs to it. It is the only possible method of having, in a short time, and with least expense possible, a good map of the Argentine Confederation, and to make effective the measure of a grand arc of the meridian, which would be so useful in this part of the southern hemisphere to the study of the form of the globe. We could not congratulate the governor of the province of Buenos Ayres too much for the fruitful initiative which he has just taken in these scientific enterprises.

A Note on the Number of Stars in the Pleiades, by Professor E. S. HOLDEN.

The method proposed by M. CERASKI in Ast. Nach: 2581 to determine how many stars veritably belong to the group of the Pleiades, may be found in the Proc. A. A. A. S. for 1880, p. 7.

It is a perfectly rational method for solving, from a great number of cases, the general question, "How many (nominal) magnitudes of stars are associated together at the same real distance from us?" But if it is applied to one cluster separately, the results may be found less certain than is desirable.

In the paper cited I have applied this method, so far as I had the data, to 167 clusters. It may be of interest to cite the result of this inquiry, which is that, so far as the data are sufficient, and on the assumption that the stars of each cluster are equally bright, per unit-area, the mean difference of (nominal) magnitudes is 3.8 *m* on Herschel's scale. So that the diameter of the largest star of each cluster is on the average 4.1 times the diameter of the smaller, if we admit the fundamental hypothesis.

The data on which these conclusions depend are given on pp. 10-15 of the memoir in question.

TRANSIT OF THE PONS' COMET OVER A BRIGTH STAR.

The passage or transit of a large comet over a large star is an event which very rarely occurs, and if, as in the present case, the comet be moving rapidly, the chances of any one observing it during the very brief interval of transit (in this case only two or three minutes) are extremely small. It is therefore a matter of some interest to preserve a carefully recorded instance of the kind, and by some few of your readers its importance will be recognized.

It has long been a mooted question by astronomers, whether a comet be of any more substantial materials than incandescent gas. Stars of the smallest magnitude are readily seen through their nebulosities, even when those nebulosities are hundreds of thousands of miles in diameter, but may there not be solid cores (to some comets at least) which would totally eclipse a star if they should be centrally superposed, even on a first magnitude star? This phenomenon has never yet been observed; but as it may arise from the minuteness of such solid or liquid cores, such negative testimony cannot decide the question.

Early in the evening of the 24th inst. I found Pons' comet close to s star in *Cygnus* of the seventh magnitude, and from its relative position could see, at a glance, that a transit was inevitable. As I had been for three months watching this very comet for such an opportunity, I hurried my preparations, putting on a power of 100 and getting an assistant to mark time. The following are the results: Longitude of telescope being 5^h 26^m 28^s west of Greenwich; the star being of the seventh magnitude is not noted in ARGELANDER'S "Uranometria Nova," and is far outside of BESSEL'S zones; its right ascension, however, is 20^h 50^m and declination north 33°, or nearly so. Star began to fade at 6^h 31^m 42^s local time; star began to brighten at 6^h 35^m 22^s; interval, 3^m 40^s; middle time of transit, 6^h 33^m 32^s; longitude west of Greenwich, 5^h 26^m 28^s; or (by a singular coincidence) at 12^h, Greenwich mean midnight.

I am very sensible that it would be unsafe to state, in positive terms, that the star and the centre of the nucleus coincided; but, ta all appearances, the central line of passage, was through the star; yet I found it impossible to see the stellar centre of the comet in contact with the star on either side, and there was an interval corresponding with the waning of the star's light, when the nucleus was invisible. The star is an orange-tinted star, about 30^m south following ε *Cygni*, and faded by estimation half a magnitude.

If Pons comet, then, have a solid or liquid core, it cannot well be over two hundred miles in diameter, while the inference is, that it is, like many other comets, a gaseous body throughout, although to-night (December 27th), it shows a well-defined planetary disc, which, I must think, would obliterate an ordinary star. The tail (about 2° long) however, is diaphanous to stars down to the 13th and 14th magnitudes, even up to the circular nebulosity which surrounds the head.

The comet is now plainly visible to the naked eye; but only conspicuous in a good telescope; yet it is brightening fast, and *may* establish its claims to be ranked among the great comets of the century.—*Beta, in Times-Union* (Ill).

EDITORIAL NOTES.

Interesting notes and drawings of the Pons-Brooks' comet, by W. C. WINLOCK, Naval Observatory, Washington, D. C. have been received. They will appear in our next issue.

A cut and full description of the new Boswell observatory of Doane college, Crete, Nebraska, came too late for this month. This important scientific work, which has grown so rapidly under the direction of Professor G. D. SWEZEY will receive early attention.

Some of our readers have been much interested in the computation of the orbits of comets. Professor HOWE, having this in mind, in preparing the leader of this number, has given enough to guide any one in its computation having only a limited acquaintance with the higher mathematics. He purposes to continue work on the orbit of this great comet to make it as accurate as possible, and hence, needs all the observations of it that he can get. Any astronomer who will give him such aid will materially assist in a worthy object.

The seventh magnitude star on nearly the same parallel with *Beta Capricorni*, and preceding it by fourteen seconds in time, has attracted considerable attention during the last few months. In November last Mr. BARNARD of Nashville, was preparing to observe the occultation of *Beta Capricorni*, and happened to see the eclipse of this little star just before it. First about nine-tenths of its light disappeared, and for the space of one second there remained in its place a minute point of light estimated a tenth magnitude. This also instantly disappeared. Mr. BARNARD at once accounted for the strange phenomenon on the supposition that the star was a very unequal double, but he was unable to separate it with his six-inch equatorial. Mr. SAWYER of Cambridgeport, Mass., with a 4.37 inches Clacey equatorial observed the same phenomenon, and at the time attributed it to some irregularity in the *Moon's* surface; but since, says Mr. BARNARD's explanation may prove to be the true one. Professor D. P. TODD, Amherst, Mass., also observed the same occultation, and says, that the little star disappeared very sharply at $8^h\ 16^m\ 2.^s5$; but about $1.^s5$ later a winged blur of light appeared at the same spot on the *Moon's* limb, and was visible for two or three tenths of a second, and of about half the brightness of the star itself. Professor TODD thinks that the theory of duplicity of the star will not account for all the phenomena observed, though, if found to be double, they may be in part so explained. Shortly after occultation, Mr. BURNHAM of Chicago, was unable to separate the star with the 18½-inch Dearborn refractor, and a like attempt by Professor SWIFT of Rochester, N. Y., with the Warner 16-inch was unsuccessful. At the time of the last two observations the star was unfavorably situated for delicate work. The star is coming to place very soon however, so that its duplicity may be determined.

AN AURORAL GLOW ON THE MOON.

Last fall I was led to inspect the *Moon* with more than usual care. On November 4, 1883, I saw on the dark part of the *Moon* a misty light different from that to be ascribed to the feeble illumination due to light reflected from the *Earth*. This appearance was seen repeatedly by myself and others in November and December. The weather in January and February was not favorable to observations. But on March 29th last and 30th, the phenomenon was distinctly seen by myself and others. One who had seen it last fall, on looking at it on the 29th, remarked at once that it appeared on a different part of the disc, and, on the 30th, he noticed that the light had narrowed down.

This accumulation of light shifts its place upon the disc; but generally is seen brightest along the dark limb of the *Moon*. The appearance is that of the light of the *Aurora Borealis* on the *Earth*, as it might show to one looking at it from the *Moon*. I suggest this explination, therefore: that it is a light of the same nature as the *Aurora Borealis*, and produced by the same cause. So far as my observations go, this appearance is to be seen before the first quarter, and after the 3d quarter. At the time of quadrature, I have seen a line of light along the dark limb. I have been unable to see anything of it while the *Moon* is gibbous.

My telescope is a three-feet achromatic, two and one-fourth inches aperture, with a magnifying power of about sixty diameters. The eye-piece is negative. It is likely such diffused light is seen better with a low power. JOHN HAYWOOD.

SMALL STAR PRECEDING BETA CAPRICORNI.

I am very glad to see (MESSENGER No. 23) that Professor TODD of Lawrence observatory, Amherst, Mass., also witnessed the phenomenon exhibited at the occultation of this small star on Nov. 6, 1883. If I had felt the slightest doubt concerning the character of this object, the remarks of Mr. SAWYER and Professor TODD would have confirmed my suspicions of duplicity. Before the remaining point of light had disappeared the explanation of the phenomena flashed upon me. I will again state that what I saw was simply an instantaneous diminution of the light of the star to a tiny point, and then the instant disappeaarnce of this; to me there was no total disappearance and reappearance of light.

It will be strange if no such phenomenon was observed at former occultations of the star. May I ask that the records of our observatories be looked over for similar notes on former occultations which must have been frequent since the star lies near the *Moon's* path? I had never seen the star eclipsed previous to Nov. 6, 1883.

E. E. BARNARD.

The royal road to success in the mastery of many things new and difficult in science is by calm and patient work, and by thorough and courteous discussion. Principles are always seen, most quickly and clearly, in such an atmosphere.

The discussion of the question of the true unit of time by English astronomers, for the last few months, seems latterly to have assumed the following form: Is mean solar time measured by the *Sun's* mean motion in longitude, or by its mean motion in hour-angle? If this statement fully and fairly represents Professor STONE's side of it, which it is not easy to understand from the meager reports of the discussion before us, the question does not seem to be a difficult one. In studying it, however, it should be borne in mind that astronomers generally obtain mean solar time from local sidereal time. In making the change from the latter to the former, the mean longitude of the *Sun* at the time of change must be known. An error in this element will produce a corresponding one in the resulting mean solar time; but this error, as commonly thought of, is a well known constant, in regard to which LEVERRIER and HANSEN closely agree. To determine the amount of it, the reader is referred to any standard work in theoretical astronomy which discusses the fictitious year, the *Sun's* mean motion, and the length of the year, the epoch of the *Sun's* mean longitude, and the beginning of the fictitious year.

In a paper by Professor NEWCOMB, recently read before the Royal Astronomical Society, on Mr. STONE's theory of the mean solar day, two points are especially noteworthy:—

1. Concerning the use of a *variable* unit of time in practical astronomy.

2. When this supposed change in the mean time unit began.

Following this paper, Professor STONE is reported to say (*Astronomical Register*, No. 256) that he had before stated that the change of time was due to the alterations of the equation of condition connecting the sidereal times and the mean solar times. Just what change he means to make in the equation of condition does not appear in the brief account.

On the second point he says: "It is evident that the change of time begins at the iustant when the changes in connection between the sidereal times and mean times were made."

Professor STONE's way of testing the accuracy of his theory was by "a comparison between the observations made at the meridian of Greenwich with HANSEN's lunar tables, without any allowance for the errors of tabular mean time since 1864, and with the tabular places corrected for such errors in accordance with his theory." He says the comparison which extends over a complete revolution of the *Moon's* nodes afforded the most positive evidence of the correctness of his views.

One thing is certainly true; that Professor STONE is right or wrong in accounting as he does for the increase of errors in HANSEN's tables, and American astronomers will be interested in that question.

We have before called attention to the fact that the ROWLAND gratings are hereafter to be manufactured by Mr. JNO. A. BRASHEAR, Pittsburgh, Pa., and of the undoubted superior quality of the work done by the ROWLAND dividing engine. It now seems equally certain that the mechanical part of this delicate ruling process is to be skillfully managed; for the ability and experience of Mr. BRASHEAR is already favorably and generally known.

These gratings claim attention for three points of excellence:

1. They are much brighter than ordinary ones, in the higher orders of spectra, most of the light being thrown on one side for this purpose.
2. Their definition is surprisingly good.
3. Though not entirely free from ghosts, they are reasonably so only faint ones generally appearing.

From recent correspondence with Mr. E. F. SAWYER, Cambridgeport, Mass., respecting his observation of the minimum of *Algol*, reported last month, in connection with others, it ought to be said that his observation of November 28 was not given in exact time. It was stated that it occurred *about* 7 p. m. Mr. SAWYER observed the star in faint light, and near its minimum, and he intended to report it only as a rough approximation. On Dec. 21, at 6^h 40^m he observed it again, at minimum, which accords well with Mr. IRISH's table in Feb. No. of the MESSENGER.

That a periodical devoted to the interests of meteorology should soon make its appearance in this country, is only what observing scientists would naturally expect. There is need of it, and the attempt will doubtless have liberal support. Professor M. W. HARRINGTON, director of the Detroit observatory, Ann Arbor, Mich., who is a professional teacher of meteorology, takes charge of the editorial work, and W. H. BURR & Co. of Detroit are the publishers. It is to be known as the *Amrrican Meteorological Journal*, issued monthly, 24 to 32 octavo pages, subscription price being $3.00 a year.

THE WARNER PRIZES.

In printing the list of prizes bestowed by Mr. WARNER for discovery of comets several errors were made. To correct these, we gladly give place to the following from Professor SWIFT, under date of April 5:—

"I notice in the April number of the SIDEREAL MESSENGER several errors in regard to the successful competitors for the WARNER comet prizes. The following is the correct statement:—

May 1, 1881, Swift	$ 200
July 13, 1881, Schaeberle	200
Sept. 17, 1881, Barnard	200
Nov. 16, 1881, Swift	200
Sept. 10, 1882, Barnard	200
Sept. 1, 1883, Brooks' comet 1812	200

In addition to the above, which were regular, the following special prizes were awarded, viz.:—

For the periodic comet of short period, Oct. 10, 1880, Swift	$ 500
Feb. 23, 1883, comet Brooks-Swift, to Brooks	250
Total	$1,950

Mr. WARNER wishes it understood that in no case will he deviate from the conditions governing the regular prizes, as it would establish a dangerous precedent, and open a door which might in the future be troublesome to shut.

The first *special* prize was given because the comet was a periodic of the very short period of 5.5 years, and the second, because the discovery was made about the time the prize paper was completed, though before its publication.

The following are the elements of the new comet Ross, furnished to A. N. No. 2582 by R. L. F. ELLERY, of the observatory at Melbourne, Australia:

ELEMENTS.

$$T = 1883 \text{ Dec. } 25, 7838 \text{ Melbourne M. T.}$$
$$\Gamma = 125^\circ \; 15' \; 55''$$
$$\Omega = 265 \quad 12 \quad 15$$
$$i = 64 \quad 53 \quad 16$$
$$\log q = 9.502384.$$

Motion retrograde.

$$(C-O) \; d\alpha \cos\beta = +1^s.6; \; d\beta = 24''.0$$

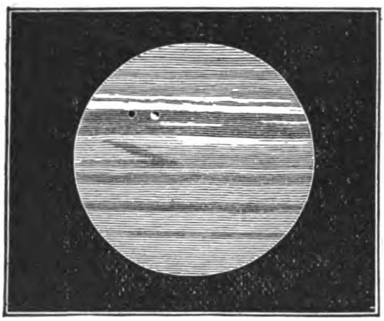
DARK TRANSITS OF JUPITER'S SATELLITES.

At the meeting of the California Academy of Sciences held on Monday evening, March 3, 1884, Professor DAVIDSON, the president, called attention to the observation of the black transits of the third and fourth satellites of *Jupiter* made by Messrs. BURCKHALTER and HILL and himself.

The first observation was upon the transit of the third satellite and its shadow over the disc of the planet on the 15th of January, at $9^h\ 1^m$ local time, by Professor DAVIDSON. It is illustrated in Fig. 1, wherein the small, dark disc is the shadow of the satellite, with the partially dark image of the satellite itself three or four diameters to the right. The figure gives the appearance of the planet, etc., in the inverting telescope.

When it was examined with powers of 120 to 150 diameters, the image of the satellite itself showed nearly as dark as the shadow, but not quite so large. After making the first drawing the atmosphere was steady enough to admit using 255 diameters. This was twelve minutes later, and then the satellite was seen as a circle with a segment of two-thirds the disc bright white and the other segment of one-third the disc dark or black. Upon again testing with

Fig. 1,



Jan. 15, *1884—Jupiter at 17h 11m G. M. T.*

the 120 power the same effect was revealed. The two were moving along, and upon the dark-brown red belt which has been persistent on *Jupiter* for some time, and yet they were very markedly black. The shadow was like a drop of ink. The satellite preceded the shadow. The observations were made with the 6.4-inch equatorial.

Professor DAVIDSON then read two short memoranda furnished by Messrs. HILL and BURCKHALTER upon their observations of the black transit of the fourth satellite on the 24th of February. The observation of Mr. C. B. HILL was made at the Davidson observatory, and that of Mr. C. BURCKHALTER at his observatory in Oakland, and therefore they are independent observations of the same phenomenon.

Mr. HILL reports: "On turning the equatorial on *Jupiter* about eleven and one-half hours I was surprised to see what was apparently the jet black shadow of one of the satellites. On looking it up in the

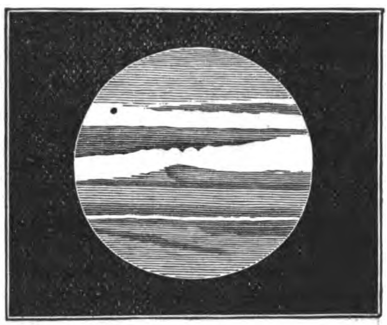
Ephemeris to see what satellite it could belong to, I found that the only phenomenon in progress was the transit of IV, the shadow of which should not come on until 15^h 43^m, or four hours later, so that this was evidently a "black transit" occurrence.

1. Internal contact appeared to take place, 12^h 13^m.
2. First white excrescence visible, 12^h 16.7^m.
3. Satellite, probably tangent to limb, 12^h 21.8^m.
4. Satellite. certainly clear of limb, 12^h 23.6^m.
5. Satellite, one diameter clear, 12^h 30^m to 12^h 31^m.

Hence, the egress apparently took place at 15^h 23.5^m, Washington M. T., the Almanac time being 15^h 23^m."

Mr. HILL has furnished the drawing for figure 2 to illustrate his bservation. It is a reproduction of the original in the note-book.

Fig. 2.



Jan. 24, 1884—Jupiter at 19h 54m G. M. T.

Mr. BURCKHALTER writes: "Last night I observed the transit of *Jupiter's* fourth satellite; the first contact was about two minutes later than the Almanac time, and the satellite was about eight minutes getting completely on the planet's disc. The air was very steady and definition good. The satellite entered the white portion just south of the great, dark-red belt. I observed the satellite for about five minutes after the internal contact, and saw nothing unusual, but on the contrary, could only see the bright satellite on the white belt with difficulty. At the Almanac time of II occultation disappearance (8^h 52^m L. M. T.), Mr. W. H. LOWDEN took the instrument to observe the phenomenon, and he at once announced that there was a shadow of a satellite on the planet. Thinking he must be mistaken, I again looked and found, as he had said, a black spot 'as black as a drop of ink,' and I then noticed that this spot occupied about the position of the satellite then in transit. I then thought I must have made and error, but upon referring to the Ephemeris, I found that no shadow should be on at that time, and that consequently it must be the fourth satellite projected on the disk as a black spot instead of the usual bead of light. This phenomenon so occupied our attention that the occultation disappearance was allowed to pass unnoticed. Thereafter we watched the spot, at intervals for nearly an hour, during which time it remained absolutely black."

It will be noticed that Mr. BURCKHALTER observed the satellite enter as a white disc on the body of the planet, and that it was subsequently seen black. He observed with a ten and a half-inch reflector, but does not report the magnifying power employed, and has furnished no drawings.

Professor DAVIDSON then referred to the earlier notices of these or similar phenomena. It was first reported by CASSINI in 1665, and afterwards more fully described by MARALDI, in 1707.

It was not again mentioned until 1796, perhaps from inattention to the subject; but more recently the grest telescopes have revealed these peculiarities. SOUTH saw two satellites on the planet, but of a chocolate color. BOND, on the 28th of January, 1848, observed the transits of I and II, whilst III itself was seen as a black spot between the two shadows, and not to be distinguished from them except by the place it occupied; it was smaller than its shadow in the proportion of 3 to 5, not duskish, simply, but quite black, like the shadow."

Again, on the 18th of May, 1848, BOND saw the III satellite enter the disc very bright; twenty minutes later it was hardly perceptible; a little after it was a dark spot; then for two and a half hours it was perfectly black and nearly round.

The transit of IV on March 25th, 1873, was remarkable for its absolute blackness, and was seen by many observers in England.

Several dark transits of I were recorded in England in 1880, and it is quite likely that the literature upon the subject of *Jupiter* may reveal other notices.

Several solutions of this curious problem have been offered, and were mentioned by the speaker, but none have been satisfactory.

—*From Sci. Press.*

Subscriptions and orders for the MESSENGER not previously acknowledged, and nearly all received during the month of April, were as follows:—

E. F. Sawyer, Cambridgeport, Mass.; Prof. C. H. McLeod, McGill College, Montreal, Canada; James B. Heiss, Monkton, Md.; J. Addison Campbell, No. 7, E. Penn. street, Germantown, Pa.; Rev. O. C. Clark, Friend, Nebraska; Professor John Haywood, Otterbein University, Westerville, O. Wm. H. Numsen (special order), Baltimore, Md.; L'Astronomie de Paris, Paris, ordered by W. F. Christern, New York City; Professor James Edward Oliver, Cornell University, Ithaca, N. Y.; Dr. T. D. Simonton, St. Paul, Minn.; Dr. C. H. F. Peters, Litchfield Observatory, Hamilton College, Clinton, N. Y. Mechanics' Institute, San Francisco, Cal.; James R. Baxter, Bloomfield, Indiana.

American astronomers can but be surprised at some things said recently in *Science* (Cambridge) in regard to the discussion on the change of the unit of time. This, for instance:—

Unless, then, this matter (question of the unit of time) admits of speedy and permanent decision, one way or the other, with the entire agreement of all parties to the controversy, astronomy would appear to run the serious risk of forfeiting her claim to a place among the exact sciences.

Is this the way our worthy and able contemporary thinks of astronomy, the oldest and the grandest science in the whole circle of exact learning?

If an eminent attorney should make a mistake in applying a fundamental principle of law to a case in hand, for example, would the next issue of the *Law Review* be expected to say that the whole system of American jurisprudence now appears to run the serious risk of forfeiting its place in our national polity? And this, also:—

The controvery on the unit of time is regrettable, but foreign astronomers are abundantly competent to conduct the discussion, as they have done heretofore, without additions to the literature of the subject on the part of any one here.

Comment is unnecessary.

Attention is called to Professor W. A. ROGERS' advertisement of *Standards of Length.* Colleges and Scientific schools in this country can now be supplied from this source at a very moderate cost, with as accurate scientific standards as can be found anywhere.

Mr. TYDEMAN 835 Linden St., Camden, N. J., has a 4-inch, a 7-inch and a 12-inch diameter telescope, and a number of lenses and eyepieces for sale.

In the near future we hope to give our readers some account of Dr. C. H. F. PETERS' late European trip.

On page 94, line 14 from bottom, of MESSENGER No. 23, read appearance for disappearance.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. No. 5. JUNE, 1884. WHOLE No. 25.

WORK IN THE ENGLISH OBSERVATORIES.

The following is a brief account of work done in foreign observatroies, during the last year, which, it is thought, will be interesting to American Astronomers:

Royal Observatory, Greenwich. Under the head of meridian observations, about 1550 stars were observed in 1883, and special pains were taken to secure at least two observations of each of these in the year. Whole number of transits observed were 5318, and of circle observations 5180.

The mean error of the *Moon's* tabular R. A., from 100 observations with the transit circle is $+0.^s03$. Prof. NEWCOMB'S corrections to HANSEN'S *Tables de la Lune* having been applied in forming the tabular places in the Nautical Almanac. The mean error in 1882, when HANSEN'S tabular places, uncorrected, were used was $+0.^s82$.

Five determinations of the flexure of the transit circle show a mean resulting value of $-0.''49$, and is larger than usual. The discordance between the nadir observation and the mean of the results from reflection-stars, north and south of the zenith, was $0.''45$, a slight increase on the previous year.

The equatorials were employed for the usual extra-meridian observations on comets *a* and *b*. Micrometric measures of the positions of five of the satellites of *Saturn*—*Tethys, Dione, Rhea, Titan and Japetus*—have been made; no satisfactory observations of the fainter satellities being secured. Measures of one of the satellites of *Uranus* (*Titania*) were obtained on one night; also some comparisons of *Polyhymia* with neighboring stars, and fourteen nights of observation of double-stars with the double-image micrometer. Nine occultations of stars by the *Moon*, and 37 phenomena by *Jupiter's* satellites are recorded.

The spectroscopic observations with the half-prism on the S. E. equatorial have been on the displacement of the F, *b*, or D, lines in 46 stars, the total number of measures being 309. The chromosphere of the *Sun* has been examined on 25 days, several prominences being seen each day, and the spectra of various *Sun*-spots on eight days. The spectra of comets *a* and *b* and of star, η *Ceti* were observed. The existence of bright lines as supposed by Dr. KONKOLY was not confirmed.

Photographs of the *Sun* have been taken on 221 days of 1883, as against 201, in 1882. Increase is partly due to finer weather, and partly to the use of dry plates instead of wet. *Sun*-spot activity, in number and area, shows no decrease in the year 1883, from that of 1882, although in the appearance of faculæ there is a decided falling off. One hundred and forty-two Indian photographs of the *Sun* for the year 1882 have also been measured and completely reduced, making a total for that year of 343.

The volume of Greenwich Observations for 1881 was distributed in June last, and the printing for the astronomical portion of the volume for 1882 is nearly complete.

Armagh Observatory. During last year most of the time has been taken up by the preparation for the press of the Second Armagh Catalogue of 3000 stars. It is expected that the printing will commence soon.

Cambridge Observatory. The total number of meridian observations is 2289, including 248 observations of clock stars, 69 observations of *Polaris* above the pole requiring 164 circle readings, and 70 below the pole requiring 166 circle readings; and 1902 observations of Zone stars.

The error of collimation was determined 180 times, and the level error and nadir point were each determined 169 times.

An extensive series of observations has been made for the purpose of testing the accuracy of the divisions of the West Circle, which has been used throughout the Zone observations.

The standard star observations have been reduced to the end of 1881, in R. A. and N. P. Distance. The reduction of the observations of 1882 and 1883 are far advanced.

Dunsink Observatory. The meridian circle observations show that R. A. of 437 stars and declination of 474. All have been reduced to their apparent places for date of observation, and the work of reducing to mean places has begun.

Observations of 280 standard stars were taken for determining the right ascensions, the zero of declinations being on every occasion determined by nadir observations from a mercury trough. Part V of the Dunsink Observations is going through the press.

Kew Observatory. The sketches of *Sun*-spots as seen projected on a photo-heliograph screen have been made on 214 days, in order to continue SCHWABE'S enumeration. The *Sun* was found to be free of spots on seven of those days.

The corrections to the area-measurments for fore shortening has been applied to the reduction of *Sun*-spot observations for the last two years, under the direction of Mr. D. LA RUE. The whole series is in the possession of the Royal Society, and is now being revised and arranged for reference by Mr. MATH.

It has been decided to make a trial of watch-rating, and an apparatus has been fitted up for doing this kind of work at extreme temperatures. It is expected that operations will commence soon. The usual magnetic and meterological observations have been carried on as formerly.

Liverpool Observatory. Besides meteorological work, attention has been given to improvements in chronometric navigation. Records of 100 voyages from Liverpool to the west coast of S. America and back again, have been received and discussed at this observatory. The rates of all the chronometers employed were corrected for the change of temperature in accordance with the mean temperature obtained daily at sea. As each ship carried three chronometers, there are three hundred cases in which the daily rates at sea were obtained for an average voyage of 105 days. The average difference between the predicted daily rates and the rates actually made at sea was 0.37 of a second of time. In one hundred out of three hundred cases, the average difference between the predicted rates and the rates made at sea; was only 0.08 of a second of time. The thermal errors of all the chronometers were in the first instance carefully determined at Bidston. When so determined, it is claimed that chronometers will carry on the true time as accurately for a period of three or four months, as will astronomical clocks on the shore; but when rates are not corrected for temperature, their errors at sea are increased in the proportion of about four to one.

Radcliffe Observatory. Transit circle for 1883 are:

Transits	2604.
Circle Observations, (for each the reading of four miscroscopes)	2448.

These totals include:

Observations of the *Sun*	54.
" " " *Moon*	53.
Reflection Obs. of the stars	96.

Eleven observations of occultations of stars by the *Moon*, and 45 phenomena of *Jupiter's* satellites have been made with the extra-meridional instruments.

Oxford University Observatory. The expedition to Abbasseeyeh, near Cairo, Egypt, for stellar photometry, during last year from Oxford observatory was successful, as the following results show: The climate during the winter and spring months is equable in Egypt beyond anything known in Europe. This was shown by the fact that 3385 extinctions of stars were made at Cairo, with the wedge photometer, while only 997 were made at Oxford in the same time. The absorption of stellar light by the atmosphere was equal to $0.^{m}$ 187 sect. Z. D., while at Oxford it was $0.^{m}$ 253 sect. Z. D., indicating as might be supposed, a superiority of transparancy in the Egyptian atmosphere. Still this superiority is not so important as it appears at first sight, for the visibility of stars in Egypt differs from that in England, at an altitude of 30° by only one-fifth of a magnitude; but in the former place photometric work can be carried 15 degrees lower than in the latter. Recently Dr. MULLER of Potsdam, has also made a determination of the absorptive power of the atmosphere; and he finds that $0.^{m}$ 201 sect. Z. D. fairly represents it. The general conformity of all these results, from BOUGUER and SEIDEL to the present day, is gratifying and remarkable.

Photometric measures of all the stars brighter than the fifth magnitude, from the Pole to a little beyond the Equator have been completed and published by the Society in Vol. XLVII of their *Memoirs*. Photometric measures of all the remaining stars, contained in Argelander's *Uranometria* are now being made. This is the first complete attempt of the kind in England.

The measurement of the relative co-ordinates of forty stars of the *Pleiades* has been completed, with the duplex micrometer (together with their photometric magnitude,) with a view of discussing their proper motions, and their grouping into a single system. This memoir will probably be ready this month.

Temple Observatory, at Rugby, during the year 1883 measured 109 double-stars. The results of the last three years of work have been reduced, and are being prepared for printing.

Stonyhurst College Observatory. Sun observations are one of the chief lines of work at this observatory, and results have been obtained on 202 different days. The large pictures of the whole solar surface are 185 in number.

Ealing.—In Mr. A. A. COMMON'S observatory during the past year, attention has been given chiefly to photography. "Negatives of several nebulæ have been obtained, including a series of the Great Nebula in *Orion.*" He has continued the same method of making long exposures as was used in 1882. Results favorable beyond expectation have been realized. He uses a reflecting telescope, mirror three feet in diameter and made by Mr. CALVER with an unusual mounting. To avoid friction, the moving parts are floated in mercury. By improving the driving clock of his instrument and securing the most sensitive plates, he has succeeded in bringing out minute details in the photographs of nebulae that are difficult to see, and quite impossible to represent by drawing. He finds the extreme limit of useful exposure has not been reached in $1^h 30^m$. In thirty-seven minutes stars such as LASSELL'S *a* and *b* mentioned in Professor HOLDEN'S Monograph of the central parts of the nebula of *Orion* are distinctly shown. The value of this work in so important a field can not be overestimated and the success which Mr. COMMON has attained to in it, was duly rewarded by the Royal Astronomical society in presenting him its gold medal.

Dun Echt—At the observatory of the Earl of Crawford attention, has been given to the distribution of comet news. Fifteen circulars referring to comets were printed and widely circulated during the year. In August last, this observatory secured a large grating from Professor ROWLAND of Baltimore, the ruled surface being $5\frac{1}{16}$ by $3\frac{1}{2}$ inches, and having 14,438 lines to the inch. Collimating and view telescopes of four inches aperture and a power of 120 bring out magnificently the spectra of the second order. The duplicity of line D_2 was noticed, and that of D_1 suspected, independent of Prof ROWLAND'S separation of the same. December 14, the strong line wave length 588.32, which was observed double on the *Sun's* following limb was single on the preceding limb, one component being due to iron in the *Sun's* atmosphere, and the other probably due to aqueous vapor in our own. The displacement of the former was due to the *Sun's* rotation on its axis.

During the summer Dr. COPELAND was at Vincocaya, South America which is 14,360 feet above the sea. At this point he detected several close double-stars, β *Muscæ* and *H Velorum* being among the number. The chief gain to observation at this altitude Dr. COPELAND thinks was in the transparency of the air, some idea of which may be known by the visibility of *Sirius* and *Canopus* to the naked eye before sunset. On this account several minute planetary neublæ were discovered by attaching a prism to the eye-piece of the telescope as recommended by Professor PICKERING.

[*To be continued.*]

INTRA-MERCURIAL PLANETS.

H. HARRISON.

In No. 24, page 113 of MESSENGER, appears an article by Prof. G. DAVIDSON, headed as above. I had some time ago prepared an article to the same effect, and, being unfinished will discard same now, and instead, ask the discoverers of the supposed "Vulcan" a question, which I should like to have those gentlemen answer. There is no doubf in my mind that a number of gentlemen started to observe the solar eclipse of May 6th, 1882, with the sole purpose in view to discover, or better search for "Intra-Mercurial Planets," and it seems very strange to me that they will travel thousands of miles with tons of apparatus, and leave at home a feather-light article, like a star chart or a catalogue. When an astronomer searches for comets and picks up a faint nebulosity object, resembling a comet, and, if he entertains any doubt as to its nature, he at once turns to his circles for the Right Ascension and Declination of the object; if, for instance a supposed comet should be picked up under R. A. 16^h 44^m Decl. N. 47044′—the catalogues will settle the doubt at once, as under this position is recorded the planetary Neb. 4244 in Sir. J. HERSCHEL'S Catalogue. I have settled such doubts more than a hundred times. Why did not M. TROUVELOT do so? Now would it have been difficult, with other preparations begun months prior, and for the purpose of observing an eclipse—to procure a small equatorial stand with graduated circles and verniers, reading to $10^{s.h}$ of time and 4′ of arc, and driven by a small clock-work, of ever so inferior quality, and on arrival at the place selected for observation, place same in position, an operation which requires but little time and skill? Equipped with such modest means, there ought not to be a shadow of a cloud entertained whether—a conspicious star like δ *Arietis* observed during totality, and its R. A. and Decl. is read by an assistant, and instantly recorded—is one known to the observer—catalogued in books and charts, or a newly discovered stranger.

I believe many observers will share with Prof. DAVIDSON the opinion that the object seen by Prof. TRAUVELOT and others, was no more or less than δ *Arietis*, and is remarkable that so "scientific" a gentleman as Prof. TRAUVELOT should be induced to believe he had found an intra-Mercurial Planet, without knowledge of *position*, *disc* or *sensible phase*, and with no other evidence but the fact that it was a *red star*.

Jersey City Heights,
May 6th, 1884.

The Sun, by Prof. C. A. YOUNG, (one of the International science series) has been translated into Russian, as well as into French, German and Italian. In England eight thousand copies have been sold. And it has been very favorably received in this country.—*Science*.

NOTES ON THE PONS-BROOKS' COMET.

BY H. C. WILSON.

The following notes are given just as they occur in my observing book, except that the measures are corrected and sidereal times are reduced to mean solar. I have also inserted some explanations in brackets. The instruments employed were: The 11-inch equatorial, with eye-pieces magnifying 90, 150, 230, and 450 times; the 2½-inch finder of the equatorial, magnifying power 30; an opera-glass, magnifying power 2.5. The eye-piece 90 was generally used with the equatorial.

September 5, 1883.—10 to 10:30. Comet was so faint that scarcely any illumination of the micrometer wires was possible.

Sept. 6.—9:15 to 9:45. Comet very faint.

Sept. 10.—13:55 to 14:55. Comet very faint, but condensed in the center. Transits were a little uncertain. Could not see it near the wires with the least illumination. Not visible in the finder.

Sept. 26.—8:30 to 9:40. The comet is much brighter than it was on the 10th. Easily visible in the finder. Has no tail. It is nearly round, strongly condensed in the center, and I thought I could see at times a distinct nucleus of about the ninth magnitude, but was not certain.

Sept. 28.—9 to 10. The nucleus was not distinct, so that it was hard to get the exact times of transit. At times there seemed to be two condensations.

Oct. 8.—8:05 to 8:40. Comet faint in moonlight, but nucleus visible,—equal 9th magnitude star, *Moon* at first quarter.

Oct. 30.—8:15 With power 90 the nucleus is nearly equal in brightness to star *b* [an anonymous star, estimated magnitude 9.5.] A short tail is suspected, but not certainly seen. With power 450 the nucleus is at least one magnitude fainter than star *b*, but is longer. Part of the tail can be seen. [A pencil sketch shows a hazy nucleus, surrounded by an oval coma, and a short spreading tail. The star *b* is placed just at the apex of the head.]*

Oct. 31.—8 to 9. Appearance of the comet is the same as last night.

Nov. 1.—9:30 to 10:10. Appearance not perceptibly changed from last night. With power 450 the nucleus does not appear at all stellar, but is very dense in the center.

Nov. 2.—8:50 to 9:20. [Position observed but no notes, therefore nothing peculiar.]

Nov. 12.—7:55 to 8:25. Comet is very faint in moonlight. Strongly

*Sketches referred to on pages 137, 138, 140 and 141 will be found on page 139.

condensed in the center, so that its position can be quite accurately determined.

Nov. 16.—7:05 to 7:25. [No notes.]

Nov. 17. 7:00 to 7:30. Nucleus almost stellar, tenth magnitude. Coma round, fading equally in all directions from the nucleus.

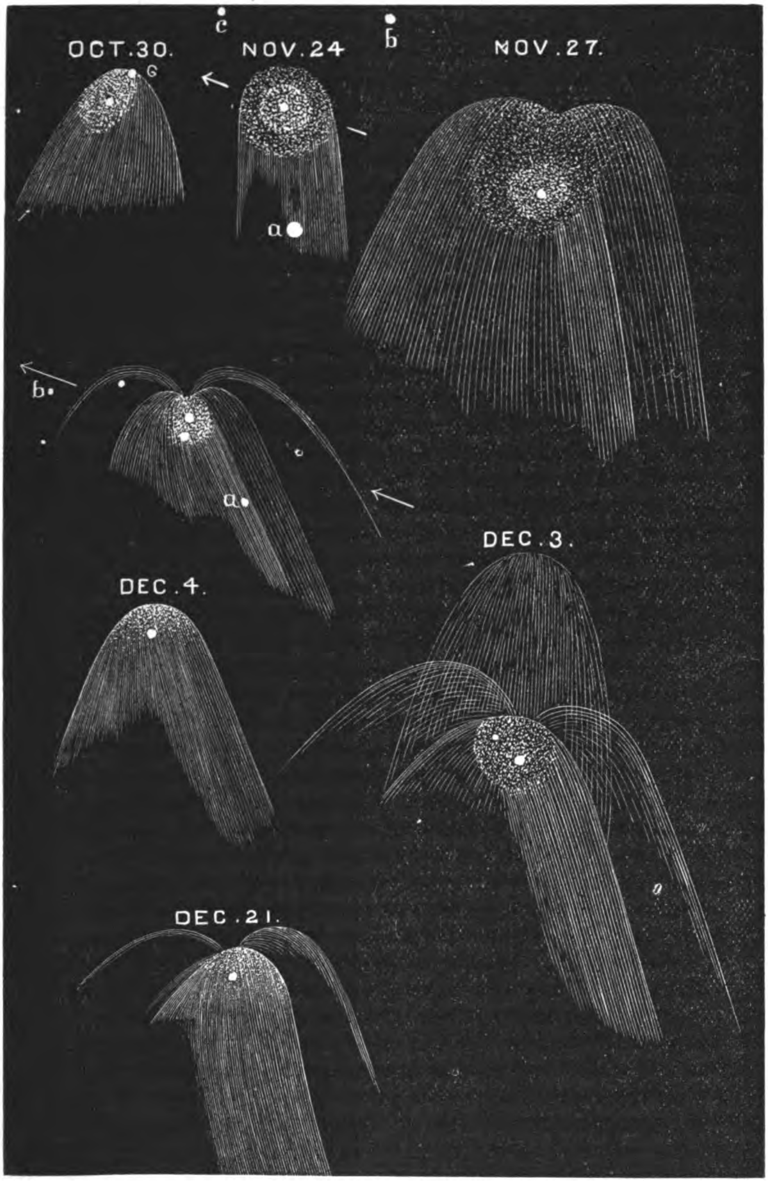
Nov. 19.—7 to 7:35. Comet is a little brighter than on the 17th, and shows more of a tail. The nucleus is dense and almost stellar in appearance. Looked at comet with powers 230 and 450, but could not see it distinctly. Sky a little hazy.

Nov. 24.—9 to 10. Comet is in a group of three stars. [A sketch made with power 90, shows a bright nucleus, round coma, and short faint tail. The three stars are: a=Dm 48° 2652, b=Dm 48° 2655, c= Dm 48° 2651. Magnitudes 6.5, 7.5 and 8.3.] In the finder nucleus is, about as bright as c. In power 90, it is much fainter than c, not brighter than a 9.5 magnitude star. Coma round, bright, fading gradually from the nucleus. Tail is plainly visible to star a. Looked at comet with power 450, but sky being a little cloudy, I could not make out much. The nebulosity is very bright close to the nucleus.

Nov. 26.—7 to 7:40. Comet is considerably brighter than on the 24th. In the finder it is brighter than the comparison star, [Dm 47° 2608 (8.0 mag.)]. It is equal to star b [Dm 48° 2669 (6.7 mag.)] in brightness. With power 450, the nucleus seems a little elongated in approximately the direction of the tail. The nebulosity is most abundant in P. A. 150° roughly.

Nov. 27.—7:40 to 8:50. Comet is of about the same brightness as last night. I examined the nucleus with powers 90, 150, 230 and 450. Nucleus is stellar with each. With 450 it is a little blurred, but much brighter than the surrounding nebulosity. [A sketch with power 450 shows the apex of the head indented.] The apex is certainly not round. The outlines can only be seen by moving the telescope back and forth. Both nucleus and coma seem to change frequently in brightness. Nucleus is very minute, not more than 12th magnitude. At times the nebulosity close to it becomes so bright as to make it appear equal to 9th magnitude. With power 90 nucleus is larger and brighter, equal 9.5 magnitude, and at times 9th magnitude. P. A. of the bright streak in the tail 25°.1.

Nov. 28.—6:50 to 8. Estimated magnitude of nucleus, power 90, 10.0. P. A. of right edge of tail 17°.2 roughly. Right edge can be distinguished to diameter of field [18′], by moving telescope in right ascension. Left side cannot be seen more than ⅓ as far from the nucleus. Outline is about the same as last night. The apex is not convex. [A sketch with power 90 shows three parts to the tail: the first bright and narrow, of about the same width as the coma, the second enveloping the first, and four or five times



OCT.30.
G
c
NOV.24
b
NOV.27.
a
b
a
DEC.3.
DEC.4.
DEC.21.

broader, faint but distinctly visible, the third enveloping the second and only seen with averted vision or by moving the telescope. The apexes of the second and third parts are indented.] There is an 11th magnitude star very near the nucleus. It's light is not at all dimmed by the coma. With power 450 there is a faint stellar nucleus, as on last night. The nebulosity is fainter, owing to the haziness of the sky. It appears to be densest in about P. A. 240°.

Nov. 30.—7:10 to 7:40. Comet is brighter than on the 28th. Tail can be distinguished to one diameter of the field of the finder. The outlines of the head, with power 90, are the same as on the 28th. I am not so sure of seeing the faint outer curves as then. With power 450 the nucleus is stellar and the nebulosity fades away from it equally on all sides. P. A. of wires parallel to right side of tail, power 90, 29°.2. Clouded up suddenly.

Dec. 1.—7:15 to 8:35. Comet is about the same in brightness as on last night. Tail can be traced to nearly one diameter of finder. Outlines of brighter part in power 90, are the same as on the 28th. The fainter outlines cannot be certainly seen. I think there is faint nebulosity extending toward the *Sun* to about 6′ from nucleus. This is so faint as to be very uncertain. It can only be seen by moving the telescope in right ascension. P. A. of wires parallel to right side of tail 32°.4. Estimated magnitude of nucleus 9.5.

Dec. 3.—7:15 to 8:10. Comet is visible to naked eye. I saw it also last night with naked eye. Tail can scarcely be seen at all in the finder, however, moonlight, and sky a little hazy. [A sketch with power 90, shows the outlines of the head similar to those on Nov. 28th, with also an extension of light toward the *Sun*.] A very faint extension can be seen toward the *Sun* to about ⅙ the diameter of the field. Nucleus is stellar with powers 90 and 230. Blurred with 450. It is much brighter than the nebulosity immediately surrounding it. No indication of jets yet. With 450 the outlines are the same as with 90. P. A. of brightest part of tail 31°.7. Very uncertain as I cannot illuminate the wires and see the tail distinctly at the same time. There is no good comparison star near enough to measure position.

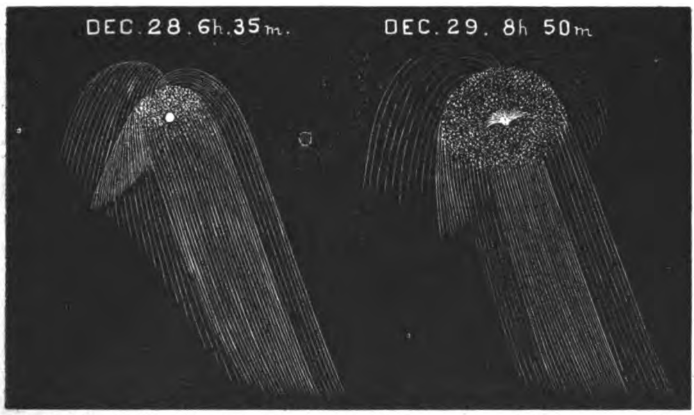
Dec. 4.—6:50 to 8. Nucleus brighter than on last night, and still stellar. Tail can scarcely be seen at all, on account of the moonlight. P. A. of brightest part of tail 34°.2. With wires slightly illuminated, power 90, the appearance was something like this [Sketch shows the inner and brighter parts of the tail.]

Dec. 5.—7 to 7:40. P. A. of right edge of tail 40°.2.

Dec. 8.—7:20 to 7:50. No notes.

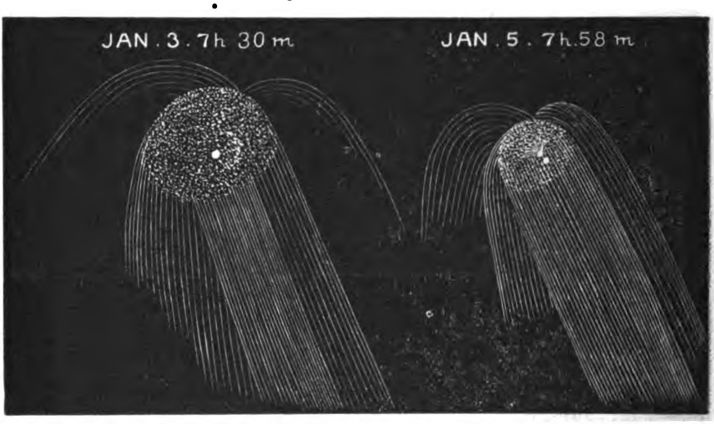
Dec. 11.—7:05 to 7:50. In the finder the comet is brighter than the comparison star, [Dm 42° 337 (6.8 mag.)]. In power 90, the nucleus is very minute, but bright like a star, about 10th magnitude.

Dec. 21.—8:10 to 9:30. Nucleus is 1 magnitude brighter than star *b* [Dm 35° 4157 (9.5 mag.)] in power 90. With 450, nucleus and *b* are nearly equal in brightness, but nucleus has twice as large a disc as star. P. A. of tail with nucleus at edge of field [18′], power 90, 31°.1. width 300″. [The sketch shows that these measures were of the brighter portion of the tail.] Outer curves could not be seen with illumination, power 90, or with power 450. 9:30.—The nucleus will soon pass near a 10th magnitude star. The latter is now in the coma just east of the nucleus, and is visible with power 90, whether on account of the haze of the comet or that of the sky near the horizon. I cannot tell. With 450 the star is yet visible. The nucleus seemed at first to leave a slight pink tinge. It is now almost straw color. There are no jets. In the finder the tail can be traced to nearly one diameter of the field of view [1°.5], and is perceptibly curved, being concave on the right side. That side is much better defined than the left.



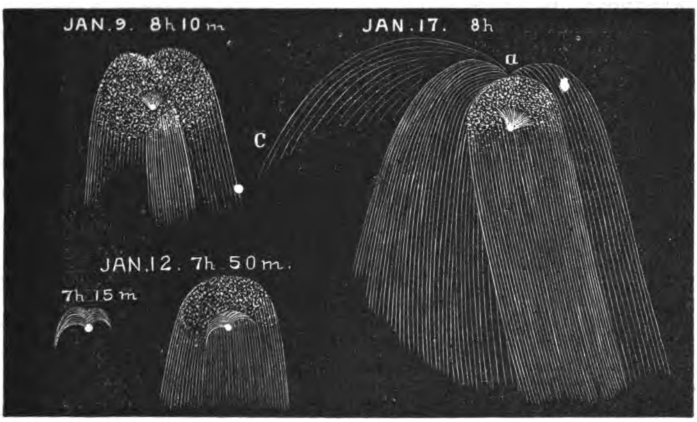
Dec. 28.—6:30. [A sketch with the finder shows the tail extending to and a little beyond the star, Dm 29° 4419. Slightly convex on the right side. Nearly uniform in width, except near the head where there is a short faint projection on the left side.] The tail is not yet plainly visible to the naked eye. In the finder I can trace it to two diameters of the field [3′]. In power 90 I can trace it to five diameters [90′]. The nucleus is brighter than any of the stars in the field of the finder, but not quite so bright as *Zeta Cygni.* The nucleus seems of a pink or fire color with power 90. With higher powers the color seems less brilliant, but still is quite noticeable. With 450 the nucleus has a perceptible size, but is quite hazy, although very distinct from the surrounding nebulosity. P. A. of tail with nucleus at the edge of the field, power 90, 40°.7. 6:35.—[Sketch of the head.]

Dec. 29.—7:30 to 9. The nucleus is larger but not quite so bright as last night. A fan is visible toward the *Sun.* This has no well defined boundaries, but seems to be continually changing,—flashing out sometimes to the heighth of 1′ or more, then again almost invisible. The nucleus is pink or flesh color, less brilliant than last night. With power 450 the nucleus is large and very hazy. With the finder it is brighter than any of the stars in the field of view. 8:00.—[A sketch with the finder shows the tail to a length of two diameters of the field (3°). Slightly convex on right side. Passes centrally over stars Dm 27° 4104; Dm 28° 4140 and Dm 28° 4147]. Could be traced nearly two diameters farther before clouds came over. 8:50.—[Sketch with power 90]. P. A. of wires including bright part of tail, with nucleus at edge of field, 40°.7. [A sketch with the opera-glass shows the tail very narrow, slightly curved toward the north, the south edge grazing the stars *Pi Cygni* and 31 *Pegasi* and extending a little to the north of *Pi Pegasi.*] This sketch is drawn from memory, the sky having clouded over. To the naked eye the head of the comet seemed midway in brightness between *Zeta Cygni* and *Kappa Pegasi*, With the opera-glass the comet was equal to *Zeta Cygni.* With the eye the tail could be traced to 31 *Pegasi*, and with the opera-glass to a distance equal to that of *Pi Pegasi* from the nucleus.



January 3, 1884.—7:15 to 8. [A sketch with the finder shows the tail broader but shorter than on the 29th. The right (*i. e.* south edge) extends to the star Dm 20° 5103. Sketch with power 90 shows the outlines of the head similar to those on the 29th.] P. A. of bright part of tail 37°.2. Estimated magnitude of nucleus 7.5. The sky was quite hazy and the *Moon* shining brightly, so that but little of the tail could be seen in the telescope, and the limits of the head as sketched are quite doubtful. The nucleus had the same appearance as when last observed, a slight pinkish tinge of color. There was no fan or jets, and the nebulosity seemed to fade off gradually and equally in all directions. The bright part of the tail was narrower than the coma) giving the head a bulbiform appearance at moments, when the fainter parts could not be seen. The nucleus and the comparison star seem to be about equal in size, but the light of the star is much more intense, and whiter than that of the nucleus. With powers 230 and 450, the nucleus is enlarged, but no definite disc is revealed. It is very much brighter than the nebulosity immediately surrounding it. To the naked eye the comet appears as a star a little fainter than *Zeta Cygni*, and brighter than *Kappa Pegasi*. At 6 P. M. I looked at the comet with an opera-glass, and could trace the tail to *o Pegasi*, and perhaps a little beyond. A slight curvature was noticeable, the left (south) side being convex.

Jan. 5.—7:20 to 8:30. $7^h\ 58^m\ 7^s$. The nucleus is within 5′ of a 9.5 magnitude star, but will not occult it. P. A. of middle of fan 238°.2. P. A. of brightest part of tail 24°.2. Comet is faint in moonlight. Nucleus is very bright. There seems to be a stellar point within it, and a faint fan or brush of light in the above P. A., and about 100° wide. Nucleus is pink color and the fan pinkish. Coma is very faint; bluish



drab color. In the finder the tail is very faint, and can be traced scarcely more than one diameter of the field. Nucleus is brighter than any of the stars in the field of view. [Sketch in finder shows the tail much broader than before. Extends to the stars Dm 16° 4727 and 4728. Sketch with power 90 shows three parts of the head similar to the sketches on preceding nights.] This sketch was drawn from memory after leaving the dome. The star, although passing so near the nucleus, did not grow perceptibly fainter. With power 450 I estimated the shortest distance between the star and nucleus at 5". With this power the nucleus was quite large and blurred. The fan seemed to be flashing and varying continually, but its central direction was apparently constant, and at a considerable angle with the direction of the tail. To the naked eye the head of the comet appeared equal in brightness to *Lambda Pegasi*. The tail was invisible, except near the nucleus.

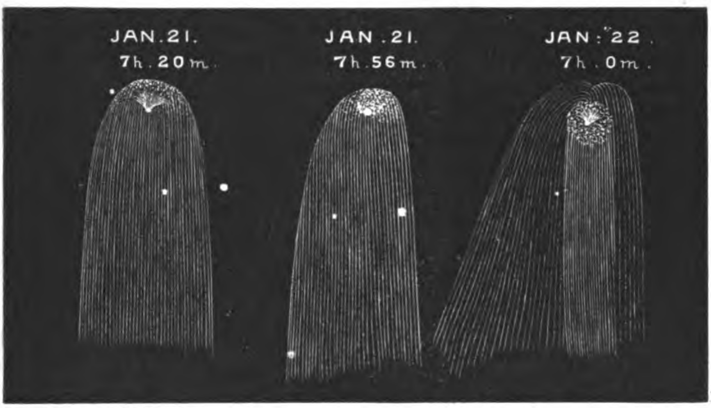
Jan. 9.—7:15 to 8:15. [Sketch with opera-glass shows the tail extending ¼ its length beyond *Sigma Pegasi*. The north edge just graze that star.] Comet is fainter than *Zeta Pegasi*, equal to *Xi Pegasi*, and brighter than *Rho* or *Sigma Pegasi*. 7:32.—P. A. of brightest part of tail, power 90, 35°.7. P. A. of middle of fan 219°.8. Estimated magnitude of nucleus 7.0. [Sketch with power 90.] With higher powers scarcely anything can be seen but the nucleus, and that is blurred and indistinct. In the finder the tail cannot be traced at all, although the nucleus and coma are bright. The sky is quite hazy and the moonlight bright.

Jan. 11.—7 to 8. Sky hazy and moonlight bright. Tail of comet cannot be seen at all, with either naked eye or telescope. There seems to be a very faint "fan" which flashes out one moment and is invisible the next. It is impossible to determine its direction accurately. It is of course on the side toward the *Sun*. Nucleus is bright and planetary in appearance. P. A. of tail, power 90, 40°.7. This is little better than an estimate. It was obtained by turning the light off and fixing in my eye the direction of the tail, then suddenly turning the light on and putting the wires in that direction. Three other measures in the same manner give: 36°.4. 40°.4, 36°.4. Wires moved in opposite direction for each successive measure. With powers 230 and 450 the nucleus is not stellar, but is still quite small. The coma is round and fades off almost equally in all directions. The light is a little stronger on the side toward the *Sun*. The nucleus is pinkish in color, while the coma is almost blue.

Jan. 12.—7:10 to 8:10. P. A. of middle of fan, power 90, 225°.0. Sides can be seen to re-curve to-night for the first time. [Sketch shows only the fan.] This much can be seen plainly, with moderate illumination. 7:50.—P. A. of bright part of tail 27°.7, 27°.7, 30°.0, 27°.0; taken in the same manner as on last night. P. A. of right edge of tail 37°.7. [Sketch shows the brighter part of the head.] The visible diameter of the head is not more than 3′, and the length of the tail, easily seen. not more than 8′. In the finder the tail cannot be traced to any star, The nucleus is brighter than any star in the field of view. With power 90, the nucleus is equal in magnitude to the comparison star [Dm 2°, 4619 (8.2 mag.)] but its light is much less intense. With power 450, nucleus is much fainter than the star, but apparently of about the same size. The fan and coma are almost invisible. To the naked eye the comet equal to *Gamma Piscium.* In the finder it is at least one magnitude fainter than this star.

Jan. 13.—6:10. [Sketch with opera-glass shows the tail extending to a point about 1-5 distance from *Iota Piscium* to *Zeta Piscium.*] Comet equal in brightness to *a Pegasi.* Tail can hardly be seen beyond 12 *Piscium.*

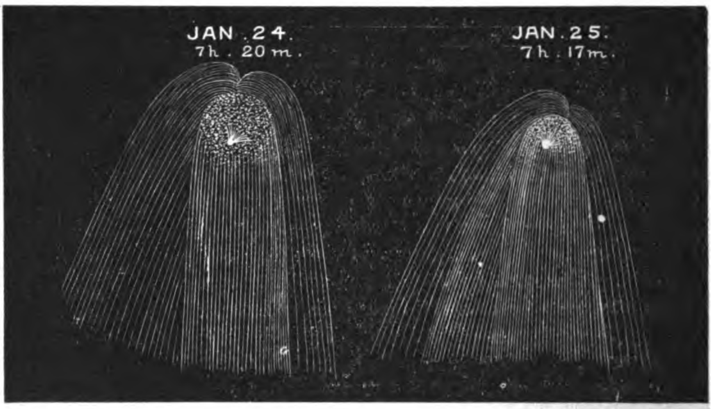
Jan. 17.—8 to 8:15. The head was much brighter than hitherto. The faint outer curves could be seen distinctly. The bright part appeared a little wider and brighter than usual. The fan was bright but not re-curved. Its central direction was not exactly opposite that of the bright part of the tail, but was turned at least 45° to the right. [Sketch drawn from memory on the morning of the 18th.]



Jan. 21.—7 to 8:10. [Sketch with opera-glass shows the tail extending to 44 *Ceti.* Convex on south side.] Comet equal *Tau Ceti* in brightness. [Sketches with power 90, show a great change in the appearance of the head. The bright part has increased in width and brilliancy, and the faint outer curves are entirely invisible.] 7:17.—P. A. of axis of tail 64°.2 P. A. of brightest direction of fan 20[illegible]°.2. Distance of apex from nucleus 116″. Distance from nucleus to right side of head 204″. Distance from nucleus to left side of head 215″. One half of the width of the tail, opposite the star *Lalande* 46929, 304″. $7^h\ 34^m$ [illegible].—The star is now just in the edge of the tail; power 230. 7:56.—[Sketch with power 230 shows the fan less distinctly, and the head is more flattened.] With power 230 the nucleus seems more hazy than with 90, but there is a small bright point in the center. Power 450 produces a similar effect. With 90, the whole head is quite

brilliant, nearly even in all parts except the fan. Perhaps the axis of the tail is a little the brightest, but very little. The nucleus has a flesh color. 8:08.—[A sketch in the finder shows the tail extending to the star *Weisse* 23h 1228.]

Jan. 22.—6:55 to 7:30. [Sketch in finder shows the tail extending to a point about ¼ distance from *Weisse* 0h, 12 to 46.] Through thin clouds. With power 90, the appearance is quite different from last. The central part of the tail is by far the brightest. The fan is scarcely visible. I can see that it is there but cannot define its outlines. 7:08.—Clouded up. 7:25.—Break in clouds. Middle direction of fan 218°.7. Bright part of tail 72°.7. Cloudy again.



Jan. 24.—6:34. [Sketch with opera-glass shows the tail extending to 35 *Ceti.*] 6:48.—[Sketch with finder; tail extends over star. *O. Arg. S.* 133 to *O. Arg. S.* 148.] 7:01.—The fan is quite indistinct, owing to the haze and smoke over the city. The nucleus is almost white, and a blaze of pink light seems to flash out opposite the bright part of the tail. The head fills the whole field of view, power 90. The outlines are similar to those on the last night observed. 7:11.—P. A. of bright part of tail 62°.7. P. A. of right edge 81°.2 P. A. of left edge of bright part 63°.7. P. A. of left edge of tail 28°.7. Middle direction of fan 230°.9; determined with bright illumination. 7:20.—[Sketch with power 90.] Sky is clear at intervals. 7:50.—P. A. of bright part of tail 64°.7. Central direction of fan 218°.8.

Jan. 25.—6:50. [Sketch with opera-glass; tail extends to 57 *Ceti*, passing over *O. Arg.* S. 343 and 397.] Comet midway in brightness between β and η *Ceti.* 7:12.—[Sketch with finder; tail extends to stars W. M. C. Z. (206) 47 and *O. Arg. S.* 198.] 7:17.—[Sketch with power 90; appearance similar to that on the preceding night.] P. A. of middle of fan 211°.7. Right side of tail 74°.7. Middle of tail 58.2.

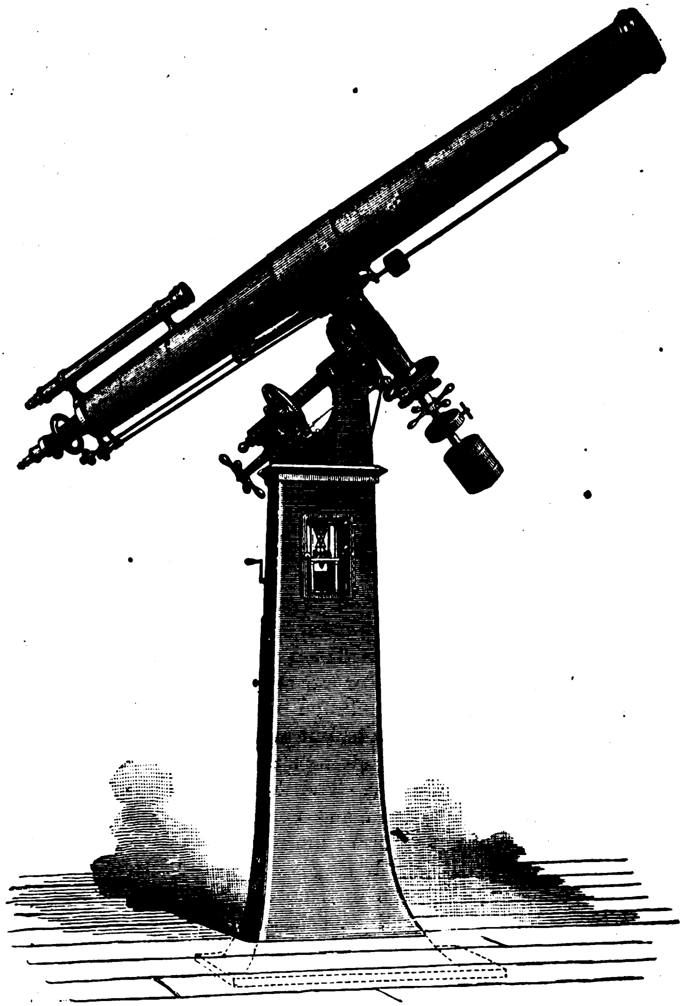
Jan. 26.—6:59. [Sketch with finder; tail is only traced two degrees. Sketch with opera-glass;tail extends to 61 *Ceti*. The axis passes over 33 *Ceti*. The north edge touches *Beta Ceti*.] Faint in haze. Nucleus is distinct however. 7:36.—P. A. of tail 79°. No fan is visible.

Feb. 1.—6:55 to 7. Too indistinct in haze, near the horizon. The nucleus is bright but blurred. Before commencing the position observation, I traced the tail 4° or 5° with the opera-glass. In the finder the tail is very faint, and can be traced only ½ diameter of field. In the large telescope the tail is not at all visible, and the head is round.

THE HARTFORD HIGH SCHOOL TELESCOPE.

It is a pleasure to call attention to the recent step taken by the authorities of the Hartford High School, in securing an equatorial telescope of 9½ inches, clear aperture, a neat cut of which appears on the next page. Its focal length is 11 feet 4 inches; its declination circle is graduated on silver to 15′ and by vernier reads to 1′. The hour circle is graduated to single minutes, and reads by vernier to five seconds. It is mounted on a rectangular iron column, having a broad base projecting to the north, so as to bring the center of gravity, near the center of the base, which is below the floor of the observing-room for convenience. The driving-clock is placed in the opening near the top of the column, and is protected by glass doors. It is controlled by a double conical pendulum, the two balls of which are so connected together that each does its work in governing the movement of the telescope. When the clock is running, a continuous friction is given by leather pads pressing on a hardened steel disc. The friction is diminished or increased, as more or less resistance is given to the movement of the telescope. The pendulum balls are not attached to the levers operating the friction pads, but are, at all times, free to take their theoretical position, thus giving a uniform motion to the telescope under varying resistances. The clock communicates with the polar axis, by means of a worm, and a continuous worm gear, so that no trouble is caused by the worm running out, as is the case when only a segment is used. The driving weights are inside the column. For convenience in setting the instrument, each axis is geared one to four, to the handles shown in the cut, which being near the circles, enable the observer to direct the telescope to any star without touching the tube. Two handles extend to the eye-end of the tube, one communicating with the declination axis, and the other with the polar axis. To clamp the polar axis, the large part of the first handle shown in cut, is given a partial revolution. The slow motion in declination is then obtained by turning the small part of the handle.

The handle governing the clamp, and slow motion in right ascension works in the same manner, thus placing all clamps and slow mo-



HARTFORD HIGH SCHOOL TELESCOPE.

Object Glass 9½ inches Aperture, by ALVAN CLARK & SONS, Cambridge, Mass. Equatorial Mounting by WARNER & SWASEY, Cleveland, Ohio.

tions at the eye-end of the tube, and dispensing with all ropes and cords.

The hour-circle is provided with a movable pointer, which is carried by the driving-clock at the same rate as the circle, but independent of it, as its movement is continuous.

To set the pointer for the evening's work, it is only necessary to direct the telescope to any familiar star near the meridian, and clamp it in position, allowing the clock to carry it.

Then move the pointer till the index coincides with the figure on the circle corresponding with the star's right ascension. The clock will then carry it without further attention.

So much space has been given to these interesting details, because they will be new to most of our readers, and full of suggestion to all.

EDITORIAL NOTES.

Subscribers will please remember that our next issue will be for August.

We are fortunate in being able to present, this time, so full a series of observations and drawings of the Pons-Brooks' Comet, as that given by Professor H. C. Wilson, acting astronomer at Cincinnati Observatory. The work is skillfully done, and it will have special value in aiding astronomers to test new theories pertaining to the physical constitution of comets.

During the last year, Professor Newcomb visited in Europe, the observatories of Paris, Neuchatel, Geneva, Vienna, Berlin, Potsdam, Leyden, Strassburg, and the shops of the Repsolds, at Hamburg. The object of the visit was to collect information respecting the most recent improvements in astronomical instruments, and methods of observation. His official report to the Secretary of the Navy, contains a useful summary of observation for the attention of the practical astronomer, and it will be read by such with unusual interest.

Attention is called to the proper motion of Lacaille, 8262, by Prof. Holden, in the November number of the Messenger. It may be well to mention, that the micrometer measures of this and a companion star may be of some service in determining the amount and direction of the proper motion of the bright star which is B. A. C. 6814. Flammarion has included it in his *Catalogue des Etoiles Doubles et Multiples*, but there the later measures of Burnham and Stone, 1878—1881, are not given. As a double-star, it is known as H 2904.

By kindness of Prof. JOHN HEYWOOD, Otterbein University, Westerville, O., we are able to give our readers some interesting observations made by Prof. HENRY HARRISON in 1877, June 14, 8 P. M. They are as follows: "While engaged at drawings of the *Moon's* terminator, now 84 hours of age, I notice variations of brilliancy along the dark limb, or earth-shine so-called, which present curious characteristics; the light resembles the reflexion of a moving mirror, held in a strong light against the shadow side of a dark hall; streamers of light of a faint greenish-blue, seen to move along the limb, resembling somewhat the moving streamers often seen during a display of our terrestrial Aurora Borealis. (Perhaps optical illusion.) June 16th, 1877.—"Think I discover the same moving light on *Moon's* dark limb, as on the 14th inst., but much fainter." It seems to me that these observations are a strong confirmation not only of my observations, but of my explanation; as the same occurred to Mr. HARRISON.

THE OCTOBER OCCULTATION OF β CAPRICORNI.

There will be but one favorable occultation of this star for American observers during the remainder of the present year. This will occur on the evening of October 26th. Immersion will take place at Washington 9^h 19^m; emersion, 10^h 17^m; duration of occultation will be 58^m, the *Moon* being at its first quarter. This will be a good opportunity for again witnessing the phenomenon of Nov. 6th, 1883. I earnestly request that the occultation of the small 7th magnitude star that precedes *Beta* (on the same parallel) by 14^s be carefully watched. If the phenomenon of last November be repeated (which I do not doubt,) there will be an instantaneous diminution of the light of the star to a minute point—watch closely for this—which point will not be visible more than one, or one and one-half seconds. Probably before the occultation some of our large instruments will have proved the duplicity of the star, nevertheless, the occultation should be carefully watched.

E. E. BARNARD.

Msssrs. GILDERSLEVE and HOOPER, at the observatory of the former. observed a dark transit of *Jupiter's* first satellite, March 31 at 3^h 30^m "It was seen as a dark body on the edge of the south belt, and at that time was more easily seen than its shadow, the air being very unsteady. The satellite was within one-half hours of egress, while the shadow was about one-half hour inward on the *disc.* The satellite continued dark until off the planet.

The great red spot on the planet *Jupiter* is still visible. There has been scarcely any change in its dimensions, since observations were first made at the Dearborn observatory in Sept., 1879. During the present opposition, it may, possibly have become a little fainter than it was last year, but when the seeing is first-class, it still shows a pale pinkish color. It has been stated in foreign journals that the spot had lost it outline, and became merged in a faint belt on the following end. This statement is erroneous Within a month past the outline of the spot has been seen sharply defined, and entirely separate from any belt. G. W. H.

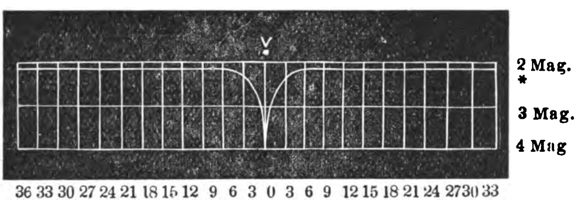
THE THREAD OF LIGHT ENCIRCLING VENUS.

NEWCOMB in his "Popular Astronomy" says:—

"In Dec. 1866 when *Venus* was very near her node at inferior conjunction and passed unusually near the line drawn from the earth to *Sun*, Prof. LYMAN of Yale, examined the crescent of the planet with a moderate sized telescope. He found that he could see the entire circle of the planet's disc, and an exceeding thin thread of light stretching around the side fartherest from the *Sun*."

At the inferior conjunction of *Venus* with the *Sun*, July 11 next, some keen eyes, blessed with favoring atmosphere, may repeat the observation narrated above, although the planet may not be so well situated. J. R. H.

The following cut is kindly copied by Mr. J. R. HOOPER, Baltimore, Md., from FLAMMARION'S *Les Etoiles et les Curiosites du Ciel.* It neatly represents the variation of the star *Algol* in time and stellar magnitude.



The upper horizontal line represents, in the figure, the brightness of a 2d magnitude star. The horizontal part of the next line below represents *Algol's* greatest brightness, and the curved part, the rapidity with which it runs down to a fourth magnitude. The vertical lines and the figures below represent hours, the zero showing the minimum of the star which according to FLAMMARION lasts only six minutes.

The only opportunity afforded in April to observe a minimum of. *Algol* was on the 28th, the lowest point of light being reached at $7^h.39^m$ 75th Meridian time. G. G.

PROGRESS OF THE ZONE-OBSERVATIONS OF STARS 1—9 MAG.

OF THE GERMAN ASTRONOMICAL SOCIETY.

Kasan; Zone 80°—75°: The printing is begun and it gives the star places reduced to the beginning of the year. The reduction to 1875 is still to be made.

Dorpat; Zone 75°—70°: and *Christiania*; Zone 70°—65°:—The work for these Zones is nearly completed.

Helsingfors—Gotha; Zone 65°—55°: the printing is well advanced.

Cambridge (U. S.); 55°—50°: the printing has begun; the work of reduction to 1875.0 is about half-done. A certain number of stars require re-observation. The probable errors of a position are about $0^s.08$ and $0''.8$.

Bonn; Zone 50°—40°: the observations are not yet finished, although near to completion. The mean difference of R. A. of a star from two observations is about $0^s.08$ and $1''.1$. Investigations of the effect of the magnitude of a star on its deduced R. A. show a difference (faint *minus* bright) less than $+0^s.008$ in the mean.

Lund; Zone 40°—35°: the observations are finished.

Leyden; Zone 35°—30°: the work is nearly completed.

Cambridge (England); Zone 30°—25°: 38559 observations have been made from 1872 to 1883. 384 stars have not yet been observed once, 614 have been observed only once, the rest of the total number, 10691, twice or oftener.

Berlin; Zone 25°—20°: Dr. BECKER's observations are completed. Observations on 13 nights of 247 stars show that fainter stars are observed later by $0^s.007$ for a magnitude.

Berlin; Zone 20°—15°: Dr. AUWER's has long since completed the observations. The reductions are not completed.

Leipzig; Zone 15°—5°: the observations are nearly completed, for the Zone 15°—10°; and those for 10°—5° are in progress.

Albany; Zone 5°—1°; the observations are completed, and the reductions very far advanced.

Nikolaieff; Zone +1°—2°: the observations are still in progress.

CATALOGUE OF 6,000 STARS.

Professor SCHEVING writes that Gottingen Catalogue of 6,000 stars is in process of preparation for printing. For account of it see Gottinger *Nachrichten*, 1864, July 13.

During the night of May 17. Prof. SWIFT, of Warner Observatory, discovered five new nebulæ, three of which were near φ *Henculis*. Prof. SWIFT already has a large list of new nebulæ which he hopes soon to publish.

DETERMINING STARS FOR THE SOUTHERN ZONES OF THE ASTRONOMISCHE GESELLSCHAFT.

These 303 stars are being observed at various observatories, as follows:

Cape of Good Hope:—The observations are finished and each star has been observed at least 12 times. The results of observation are all reduced, and for the final publication there are needed investigations of the flexure, the latitude, the refraction, the personal equations of the observers depending (*a*) on the star's magnitude, (*b*) on its declination. The division errors for each 1° have been investigated. The circle is not reversible. The flexure is to be investigated by means of collimators made specially for the purpose by TROUGHTON & SIMMS. Each collimator is furnished with a reversing apparatus and a level, and the horizontal point can thus be determined, either north and south. Combining these horizontal points with nadir-points will determine whether the flexure is the same looking north and south. The latitude is to be determined from observations of Circumpolar stars, at both culminations (already observed in 1880, '81, '82, '83.) The declinations of these stars are to be determined by observing their azimuths at greatest elongations E. and W., with the 3-foot theodolite of the India Survey. South stars culminating at zenith-distances, equal to those of the Circumpolar stars, are to be observed by TALCOTT's method.

For the refraction the Cape has observed a number of north stars, (near the zenith of Leyden), and zenith stars (near the horizon of Leyden,) which have also been observed at Leyden. A discussion of these declinations is now in progress.

For *eliminating* personal equation depending on the direction of the star's motion, each star has been observed over half the wires in the usual way, and over the other half through a reversing prism.

All the observers make the clock *slower* when the stars move across the field from left to right.

Leyden Observatory:—Since 1881, 427 observations have been made, and 1124 in all. 165 of the 303 stars have been observed once, or oftener.

Melbourne Observatory:—The observations will be begun in 1883.

Sydney Observatory:—Sydney also proposes to observe these stars.

Naples Observatory:—The observations will be begun in January, 1884.

Washburn Observatory:—The observations were begun in May, 1884.

Minor Planet No. 236 was discovered April 26, by J. PALISA of Vienna, Austria. It is of the 12th magnitude.

COMET III, 1858.

I have received an autograph letter from Prof. L. SCHULHOF, of Paris, announcing that he had ascertained that comet III, 1858, is a periodic not only, but one of the short period of 6½ years. He inclosed a hypothetical finding ephemeris extending, however, only from April 26 to May 8. A continuation of it has just reached me through *Science Observer*, Circular No. 45. I had, however, already sent to several comet-seekers a copy of the one sent to me.

Among other statements in M. SCHULHOF'S interesting and instructive letter he says "I have not yet determined, because of lack of good positions of comparison stars, the limits of mutability in its time of revolution, but it will in every case be very great; nevertheless I think it will be an object worthy the attention of comet-seeking astronomers to search for this interesting comet, by the aid of my ephemeris. If it appears between Dec. and Aug., it can be re-found, but if on the contrary between Aug. and Sept., search will be fruitless, on account of its too great distance from the earth. Its *third* appearance (of course he means fourth) since 1858 may be already passed, but as its time of revolution is about 6½ years, there are still chances of re-finding it this year till August, and from Dec. to Aug., 1885."

As a periodic comet is an interesting affair, compared with one whose period, if it is one, is unknown, I hope that comet-seekers will devote at least a share of their time to a systematic and thorough search for this comet, which, if found, will increase the number of known periodic comets to 14.

This comet was discovered by H. P. TUTTLE, then of Harvard College Observatory, May 2, 1858, on the very day of its perihelion passage. Its motion is direct. In consequence of its great perihelion distance, (about 111,000,000 miles) it can never be a bright one.

LEWIS SWIFT.

Warner Observatory, May, 17, 1884.

SCHOENFELD'S DURCHMUSTERURG, FROM—2° TO—23°.

At the Vienna meeting of the German Astronomical Society. Dr. SCHOENFELD gave an account of the progress of his work since the Strassburg meeting.

699.3 hours of R. A. with 363351 star-positions have been offered from the beginning. The principal catalogue now contains 113706 stars between—2° and—23° and 1161 stars near these limits. In 21^h *i. e.* from $9^h\ 0^m$ to $6^h\ 0^m$ the work is completed.

It is expected to begin the printing of the principal catalogue in May or June, 1884. Probably some 40,000 stars brighter than 9.1 mag. exist in the region.

DARK TRANSIT OF JUPITER'S 4th SATELLITE

The following interesting paragraph is from the pen of JOHN H. EADIE, Bayonne, N. J.

I was much interested in the account given in the May number of THE SIDEREAL MESSENGER of the dark transits of the third and fourth satellites of *Jupiter*, as seen by Professor DAVIDSON and Messrs. BURCKHALTER and HILL on the 15th of January and 24th of February last. At the March meeting of Royal Astronomical Society of England, a similar transit of the fourth satellite was mentioned by Capt. NOBLE, as seen on the 12th of March. I have not, however, yet seen any account of the transit of the fourth satellite on the 3d of December, 1883. At 11^h 15^m P. M. of that day (local time), I saw this satellite, and the shadow of the third, during a short observation with a 3¼-inch aperture and power of 100, both in transit at the same time. The satellite was a little to the east and south of the shadow, and was on the bright band adjoining the bright belt, south of the equator, and although, of smaller size, was fully as black as the shadow of the third. I did not have time to watch this remarkable phenomenon for more than 15 or 20 minutes, but as others more favorably situated for observation than I was, may have seen better the beginning and ending of this transit, it would be interesting to hear from them on this subject.

DEFINITIVE DETERMINATION OF COMET ORBITS.

For many years Dr. BRUHNS kept a general out look over the matter of the definitive determination of comet orbits, and his annual papers in the V. J. S. der Astron. Gesell. were of great value in directing attention to the cases of comets whose orbits needed attention, in indicating the sources from which observations could be taken, and by preventing unnecessary duplication of such work through correspondence. Dr. WEISS Director of the Vienna observatory has now agreed to fill the same place and those intending to occupy themselves with this branch of computation will do well to address themselves to him.

An observer desires a good second-hand transit instrument, aperture about two inches, focal length 2 or 2½ feet. Any person wishing to sell such an instrument, is asked to give terms and particular description of it to the publisher of the "MESSENGER." A photograph of the instrument also would be desirable.

Messrs. WARNER and SWASEY, of Cleveland, O., have completed the great dome for the new Mc Cormick Observatory at the University of Virginia. It is hemispherical in shape and is 45 feet in diameter. The makers will superintend putting it in place, which probably will be accomplished by the first of this month.

"L'Astronomie" the *French Monthly Review* of Popular Astronomy, for May, 1884, contains the following articles:

Formation of the Solar System, (by M. Faye); Fluctuations in Solar Activity, (C. Flammarion). The double Star, 85 *Pegasi*; Earthquake statistics, (M. C. Detaille); Earthquakes (M. Rey de Morande), and a communication to the Academy of Sciences on the singular variations in the nucleus of the Pons-Brooks' Comet.

M. Faye's article, like all that he has written, is intensely interesting.

Starting with the examples of well known annular and spiral nebulæ, like that in *Lyra* and in *Leo* (H. I. 56), and which show the arrangement of the nebulous matter into a vast spiral, M. Faye traces the possible method of the creations of systems, such as our own.

This method he believes to have been by condensation and rotation. The conclusion we give in a translation of M. Faye's own words.

"It was evident that the planets comprised in the central region, the most dense part of the nebula, from *Mercury* to *Saturn*, were formed under the empire of the first law, while the *Sun* did not yet exist, or had not yet acquired a preponderating mass; and that the planets comprised in the exterior region, much the larger, were formed when the *Sun* was already in existence. If then we should discover a satellite of *Venus*, it will be direct. If we should discover a planet beyond *Neptune*, its rotation and its satellites would be retrograde.

There is seen finally, a consequence of high interest: viz. The *Earth* is much older than the *Sun*. If it were otherwise, as La Place thought, if its formation had been posterior to that of the *Sun*, all would be changed in the aspect of the heavens. The stars would rise in the west, and set in the east. The *Moon* would have a retrograde movement, like that of the satellites of *Uranus* and *Neptune*." The whole article is of much interest, though too long for our pages.

Among the "Academy" communications, is one by M. Ch. Trepied, on the Pons-Brooks' Comet, with a sketch showing the "hour-glass" appearance of the nucleus, on the 19th of January. This change had already been observed on the 13th, with the same general characteristics. In the *Scientific News*, M. L. Descroix gives a Barometric Chart of great interest, taken at the Montsouris Observatory, on the 26th, 27th, and 28th of August, 1883. These charts show sharp indentations corresponding with the Krakatoa eruptions, beginning at 8 p. m., on the 27th, and at 4:30 a. m., on the 28th, the indentations are exceedingly deep and abrupt, showing a sharp decrease of pressure.

The article upon *Saturn* is beautifully illustrated. "In the Observatory of Nice, Messrs. Perroten and Thollon, had some curious observations of the rings, by the aid of an equatorial of 14 inches diameter. On the 16th of March, the exterior ring appeared to be composed of three distinct rings, the largest at the interior; the narrowest at the exterior, but with slight diffences in size. In moments of most favorable definition, these rings themselves presented *Striæ* toward the *Ansaæ*, which appeared to consist of numerous divisions.

The division nearest the planet was seen throughout nearly the whole extent of the ring. It was at a distance from the inner edge of the ring, equal to a little more than one-third of the whole breadth of the ring. This was certainly not Encke's division, which was about center of the exterior ring; as we see in the sketches of DE LA RUE, BOND, and TROUVELOT.

Uranus has been seen by M. PERROTEN, marked with spots resembling those of *Mars*. The edges of the disc were sharply defined. There was a white spot which appeared to mark the pole.

Neptune as seen in Jamaica, by MAXWELL HALL, presented periodic variations in brightness, from which was deduced a daily rotation of $7^h\ 55^m\ 12^s$.

LENGTH OF METEORIC SHOWERS.

Mr. DENNING, who is authority on the subject of Meteoric Astronomy, contends that some of them are of several months duration. Whether this be so or not, I know that the August *Perseid* shower has for several years at least lasted 20 days. As a relaxation for a wearied eye, while comet-seeking I usually watch for meteors, and for the last three or four years I have noticed that this celebrated shower has commenced on July 21—22, and continued until Aug. 10—11, ending abruptly at the latter date.

The *Perseids* have some peculiar characteristics which distinguish them from all others, so that almost without exception it can be decided from their appearance whether they belong to that radiant or not. They are neither very large or bright, but their visible paths are unusually long, and appear to move at about the same velocity. A family likeness in fact seems to pervade them all. I also have noticed that those which appear before the shower proper(Aug. 10—11.) have a westerly motion. They are not numerous, but they all have a radiant agreeing exactly with that of the August shower, and I have no doubt that they belong to the same meteorical family, As no SIDEREAL MESSENGER is to be published in July, I wish in the number for June to call the attention of meteor observers to this fact.

WARNER OBSERVATORY, Rochester, May 19, 1884. LEWIS SWIFT.

In the *Boletin* of the Mexican Department of Agriculture, etc., No. 41, is published a brief account of the telegraphic determination of the San Marcos, state of Guerrero. The following are the co-ordinates:—Lat. 16° 47′ 31″.4, Long $6^h\ 37^m\ 28^s.34$ west of Greenwich. M. W. H.

PLANETS FOR JUNE. (CENTRAL TIME.)

During this month *Mercury* is a morning star, rising before the *Sun*, and reaching greatest western elongation, June 12; June 14, diameter 7".8.

Venus remains an evening star, having greatest brilliancy June 3; June 14, diameter 43".8. June 18, stationary. June 24^d 7^h, in conjunction with the *Moon*. June 5, sets 10^h 46^m; 15, sets 10^h 11^m; 25, sets 9^h 20^m.

Mars, June 14, diameter 6".2. June 5, sets 12^h 20^m; 15, sets 11^h 52^m; 25, sets 11^h 23^m, evening.

Jupiter is in conjunction with the *Moon* June 25^d 10^h, morning. June 11, diameter 31"4; June 5, sets 11^h 3^m; 15, sets 10^h 29^m; 25, sets 9^h 56^m, in the evening.

Saturn is in conjunction with the *Sun*, June 3^d 3^h. June 11, diameter 15".6. June 5, sets 7^h 38^m; 15, sets 7^h 5^m; 25, sets 6^h 32^m, evening.

Uranus is an evening star, in co junction with the *Moon* 28^d 11^h.

Neptune crosses the meridian several hours after sunrise, and so is poorly situated for observation, even with a good glass.

M. E. B.

From the *Anales del Ministerio del Fomento* of the Mexican states, Vol. VII, and from other sources we learn that the National Astronomical observatory is located at Chapultepec, a suburb within easy reach of the city of Mexico. The location is a picturesque one, and the neighboring palace is a favorite residence of the presidents of the states. It is elevated, has a good rock foundation, is fairly retired from commercial activity, and is an excellent place for the location of an observatory, though, there has been some discussion on the question of changing its site. The Military college is already at Chapultepec, and the proposal to change the site is offset by a proposal to locate other government institutions of similar character, (meteorogical, magnetic, geodetic, etic.,) at the same place. The geographical co-ordinates of Chapultepec may be found in the American Ephemeris.

The institution was founded by a decree of the general government December 18, 1876, with the co-operation of General Diaz, President, and considerable enthusiasm among the intelligent classes. Sr. Anguiano was made, and continues, director. The first work was done May 5, 1879, and the first permanent instrument mounted August 27, of the same year, at the time of this report (the volume is dated 1882, but, has been but lately received,) the instruments mounted and used were a Zenith telescope of $0^m.076$ aperture, an altazimuth of $0^m.083$ aperture, (both by Troughton and Simms), a sidereal clock for which they are indebted to a Mexican manufacturer, Sr. Vazquez, two chronometers, and a chronograph. It does not appear whether Sr. Vazquez made, or simply gave them the clock.

The outfit is soon destined to be increased by a meridian circle, and a transit by Ertel, and a 15 inch-equatorial by Grubb, also a 6-inch equatorial by the same maker. They have a small transit, unmounted, and a meteorological outfit.

A chart gives the plans and profile of the building of the observatory, as projected. It is to be 65 meters long, and faces south. The central part is 20 meters front by 32 deep, and is two stories high. It is surmounted by the great dome. It contains the pier and its octagonal gallery and numerous offices, library, work-rooms, and director's and servants' rooms. On each side is a wing, 22 meters long, with a dome at each end, and there is a smaller extension with a dome to the north. The east wing appears to be completed; the stage of progress of the others we are unable to gather from the report. M. W. H.

NEW ASTRONOMICAL MAGAZINE.

The *Bulletin* is assured of the active co-operation of the French Astronomers, who can publish these regularly, either the observations or the notices, or memoirs which they are obliged to send, first to the journals of foreigners. The common meaning (or purpose) between the different observatories, gives them further a valuable facility for arranging their work after the manner the most useful for the progress of Science. Finally the *Bulletin* receives also with eagerness, the observations and the articles which they desire foreign astronomers to send to them.

The Observatory of Paris will support with all its power, all the useful and fruitful work, with the direction of M. Lisserand, with the concurrence of M. M. G. Bigourdan, O. Callandreau and R. Radan, and we hope that it will contribute to the development of Science in general, and French Astronomy in particular.

Subscriptions and orders for the MESSENGER not previously acknowledged, and those received during the month of May.

Public Library, Boylston St., Boston, Mass., ordered by Messrs. W. B. Clarke and Carruth; Minnesota Academy of Science's, Minneapolis. Minn., ordered by Judge N. H. Hemiup, William A. Haren, 1400, Hickory St., St. Louis, Mo., Garrett P. Serviss, 8, Meddagh St., Brooklyn, N. Y., Ellen A. Hayes, Wellesley College, Wellesley, Mass., A. Henry Ferguson, 6 Dana Place, Roxbury Station, Boston, Mass., Dr. Wm. U. Herron, Alleghany City, Pa., Capt. C. A. Curtis, Shattuck School, Faribault, Minn., Professor H. C. Wilson, Cincinnati Observatory, Mt. Lookout, Ohio, A. Lancaster, Librarian, Royal Observatory, Brussels, Belgium, Oharles S. Wells, Portland, Oregon, Messrs. E. Steiger & Co., Publishers, (two copies), 25 Park Place, New York.

BOOK NOTICES.

Empirical and Rational Psychology, Embracing Cognitions, Feelings, Volitions; by A. Schuyler, LL. D., President of Baldwin University. Cincinnati; Van Antwerp, Bragg & Co. 12 mo. pp. 484.

President Schuyler is primarily a mathematician, having published a series of mathematical works, and his book on Psychology shows the mathematician in its methods and processes. In this way the work differs considerably from the ordinary text-book on this subject. It is severely formal and concise; but the reader whose interest is not thereby compelled, or the student who has an enthusiastic teacher to supplement the book, cannot fail to gain from it a well-defined knowledge of the mental processes.

Dr. Schuyler introduces his discussion of the Intuitions at the outset, as the axioms, the fundamental principles, for subsequent investigations. This seems to us wise; for, though this is one of the difficult subjects, the mind that cannot grasp it, is not ready for the study, and a knowledge of the Intuitions helps greatly in understanding the other mental processes.

Small as the book is for a complete presentation of this complex subject, considerably more than one-third is given to a course in Logic—an ample course for those who have not taken up the subject by itself. Especially valuable to the mature reader are the opinions of the leading philosophers, which the author quotes freely and discusses at some length. C. H. C.

A New Political Economy, by John M. Gregory, LL. D., Cincinnati; Van Antwerp, Bragg & Co. 12 mo. pp. 394.

A very hopeful indication of the present time is the increasing interest that is felt and shown in questions of political science and political philosophy. Once entirely ignored in our college curricula, or put off with a little formal instruction, by some overworked professor, in a department not at all related to them, history and political science are coming to receive the attention they deserve, and no subjects excite more general interest or, are attacked with more energy than these.

Dr. Gregory has given,as the results of many years of teaching and thinking on Political Economy, a clear and in the main, sound presentation of the principles of this subject. Rejecting the almost universally accepted definition, "The Science of Wealth," he treats of "Wants, Work, Wealth;" though the difference between him and other economists in this regard, is more formal than real. We find the topics of the ordinary text-book treated in an interesting manner, and illustrated by diagrams, which, though, artificial, may help to an understanding of the true relations of the parts and divisions. On the Tariff question, Dr. Gregory favors protection, though his argument is calm and fair; with this exception we can commend the work. C. H. C.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. NO. 6. AUGUST, 1884. WHOLE NO. 26.

THE STARS OF THE PLEIADES.

BY H. M. PAUL.

In the *Monthly Notices* of the Royal Astronomical Society for May, 1884, is an abstract of a paper presented by Prof. PRITCHARD, upon the "*Proper Motions of Forty Stars in the Pleiades.*" The work was undertaken at the Oxford University observatory, to test the capacity of a new differential micrometer, intended to measure arcs up to 20′, by comparison with the relative positions of the stars of this historic group, as determined by BESSEL with the Konigsberg heliometer about 1840.

The micrometer is not described in the abstract given, but, becoming satisfied with its accuracy as the work progressed, Prof. PRITCHARD extended this work to cover a complete re-determination of the relative positions of 40 of the principal stars; and by a comparison of the results with those of BESSEL'S heliometer measures of 1840, and with WOLF'S filar micrometer measures made at the Paris observatory about 1874, he has deduced the evidence thus far available bearing upon the question of relative proper motion among these stars. He has also re-discussed all the available meridian determinations of the absolute places of

14 of the brighter stars made from the time of BRADLEY, about 1750, to the present time, and compared the resulting proper motions with those deduced from the three sets of differential measures.

Prof. NEWCOMB in his *Catalogue of 1098 Standard Clock and Zodiacal Stars* discussed this same question, making use of the meridian observations and of BESSEL'S and WOLF'S triangulations and his conclusions were expressed as follows:

"I therefore conclude that although a certain amount of relative proper motion must exist in this group, yet the apparent motions, as observed, are as much due to errors of observation as to the actually existing motions, and when the latter shall finally be discovered they will, on the average, be found as near to zero as to the values indicated by all the observations yet made. Consequently, the most probable values of these relative proper motions must be regarded as zero."

Prof. PRITCHARD, from the general agreement of his observations with those of the later determinations, seems to feel authorized to assert a little more positively the actual existence of these relative proper motions. His conclusions are as follows:

"First, with regard to the 14 stars which have been measured by the two thoroughly independent processes; the general accord of the final results points unmistakably to the existence of certain small motions of these stars *inter se*; but of so slight an amount, that their exact determination does not seem fully within the reach of observations as yet extant; these must be left for the effects of a greater lapse of time, which shall make them more directly apparent in amount, and to the astronomy of the future. Of the remaining stars, although meridian observations do not at present exist so as to corroborate the evidences of relative motion afforded by the combined micrometer measures made at Konigsberg, Paris, and Oxford, nevertheless the fact of these minute displacements is, I think, now established beyond doubt."

Prof. PRITCHARD'S results, when published, will form a valuable addition to the literature of this subject; for, the uses to which an accurate knowledge of the relative positions of such a large cluster of stars can be put, are quite various in practical astronomy.

Not the least important of these uses is the possibility of an extremely accurate determination of the occultation semi-diameter of the *Moon* from a carefully observed occultation of as many stars as possible in this group, as pointed out by the late Prof. PIERCE, and as shown by the writer's discussion * of two occultations of the *Pleiades* observed at the Naval observatory in 1877 and '79.

Astronomers, however, will hardly rest contented with the determination of the star positions in this group until it rests upon a thorough measurement with some such instrument as the Yale College heliometer which, both, from its construction and form, its being the largest and most perfect instrument of its kind yet mounted, is by far the best adapted to this kind of measurement. It is to be hoped that Dr. ELKIN will find opportunity thoroughly to attack this group of stars soon, and that, if the aperture will allow it, the measurement may be extended to fainter stars than touched by BESSEL, for upon the dark limb of the *Moon*, the occultation of a tenth magnitude star is just as valuable as any other if only its position is as accurately known, and the filar-micrometer measures of WOLF, extending to stars of about the 9.5 or 10 magnitude, increased BESSEL's catalogue of 53, up to 79 stars; while his catalogue of approximate positions and chart of stars to the 13 or 14 magnitude, increased the number to 571.

U. S. Naval Observatory,
Washington, July 7, 1884.

Observers having large telescopes are requested to bear in mind the 7th magnitude star preceding *Beta Capricorni* by 14 seconds. From the singular behavior of the star, Nov. 6, 1883, during occultation by the *Moon*, Mr. BARNARD of Nashville, thinks it must be a close double. Other good observers noticed the strange appearance during occultation, but all are not satisfied with Mr. BARNARD's explanation.

* *The Occultation Semi-diameter of the Moon*, by H. M. PAUL, Wash. Observations 1879, App. II.

THE PLANETS AND CYCLONES.*

BY WM. W. PAYNE.

In June, 1881, it will be remembered that *Saturn*, *Jupiter*, *Mars* and *Venus* were apparently so near together in the heavens, that the group might be covered with the hand before the eye. About this time much was said and written about the conjunction of four great planets, and the probable effect of such an event in terrestrial affairs. It was claimed by persons acquainted with science and history, that similar conjunctions of the planets had marked epochs, or crises, of special significance in the annals of the past. Some will remember that the conjunctions of *Saturn* and *Jupiter* either a little preceded, or astronomically coincided with, the Deluge, the birth of MOSES, CYRUS, CHRIST, CHARLEMAGNE, and LUTHER, and other notable events; and astronomers know that these computations have been recently reviewed and are mainly correct.

From these facts and others like them, it is easy to see why there should be public interest, and some personal anxiety, in the occurrence of an apparent conjunction of several of the major planets, especially in the minds of those who do not well understand the relations of the planets to one another and to the *Sun*, as expressed by the word "conjunction," which simply means that such heavenly bodies are equally far eastward in their orbits from some given point, as the vernal equinox. If people generally knew and believed that the planets, at such times, move in their orbits as usual, neither themselves changing nor being changed, in any important sense, there would be no real alarm, only a curious interest in such events because they are somewhat rare. The conjunctions of the great planets, *Jupiter* and *Saturn*, may occur at intervals of about twenty years and are, therefore, not novel phenomena, by any means; and hence it is not a wonder, on account of frequency, that they are sometimes coincident with prominent

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historical events. The last two conjunctions of these planets occurred October 24, 1861, and April 21, 1881. *Jupiter* and *Venus* were apparently so three times in 1881 between Feb. 21 and June 6. *Saturn* and *Venus, Saturn* and *Mars,* and *Jupiter* and *Mars,* were respectively once in conjunction before August 1st of the same year. It thus appears that four large planets, nearest the earth, were in frequent conjunction by twos, 1881, one being triple, but no one occurring between three different planets at the same time. A conjunction between three planets at the same time is a rare thing. In 1872, it was shown by Professor D. KIRKWOOD that a conjunction between any three of the four largest planets, *Jupiter, Saturn, Uranus* and *Neptune,* can probably never take place at the same time.

While it is true that a conjunction of the great planets produces no marked disturbance, it is believed by high authority that such events have slight influence on the *Sun* through media and in ways, not yet understood. When either *Jupiter, Venus* or *Mercury* passes nearest the *Sun* in their respective orbits, the solar surface seems to show greater activity than usual, though no marked changes have been observed, nor could they be naturally expected from such a cause. On the other hand, it is well established that intense solar activity produces magnetic storms in the earth's atmosphere, some of which have been singularly powerful in recent years. Whatever influence the perihelion passage of certain planets may have in agitating the solar surface, it is plain that the earth must share in the results. If these be very small, or too delicate to measure by known methods, it should not be forgotten that they may be constant and extend over considerable periods of time, and that conjunctions, or near groupings, of the major planets are favorable times for the exercise of these unknown cosmic forces, whatever they may be in kind or extent.

But the most important thing that the general reader wishes to know probably is, what astronomy can say, if anything, about the causes of tornadoes and cyclones, whether there is any such relation between the perihelia, or the conjunctions, of the planets and the *Sun* as to the effect the meteorology of the earth. Is it known that solar activity from this cause, is so modified or intensified that science can use the configurations of the planets at any time as a factor in forecasting particular changes in the average climate for a year? Certainly not. The known effects of such causes are too small to yield any appreciable influence on the average of temperature or rain-fall.

If it is known that great disturbances of the *Sun's* surface immediately affect the electrical and magnetic conditions of the earth's atmosphere, may not observations of *Sun*-spots and *faculæ* be of advantage in the study of terrestrial meteorology? This is undoubtedly true in a limited degree, but our knowledge of the tremendous forces of the *Sun* is so imperfect and so imcomplete, that their laws can not yet be stated for the meteorologist or the weather-observer. It is a wonder to some that more work in observing the *Sun* is not done in America, in view of the worthy examples of leading English and French observatories. Astronomical photographs and observations of the *Sun* ought to be taken daily, so as to form a continuous annual record, that the same might be compared with continuous Signal Service reports, and especially with the continuous self-recording registers of magnetic force, now wisely cared for by the Coast and Geodetic Survey of the United States. By this means it might be known, in time, how, and to what extent, the *Sun* shapes the seasons of earth from year to year, by the operation of the forces now under consideration.

Recent interesting coincidences invite astronomers to this study. The year 1883, very probably, marks the maximum of a passing *Sun*-spot period. In some locations, certainly, last year will long be remembered for its cyclones and tornadoes. In a group of nine Western States, the Signal Service reports the occurrence of over forty of these dreadful storms within the space of four months.

Enough data have not yet been published for a full comparison with previous years, yet the indications are that the storms of 1883 were more in number and more destructive than in any years immediately before. If the meteorologist is right in supposing that the intensity of the cyclone's power depends largely on the presence of electricity, it is important to know something more of the relation existing between the magnetic state of the atmosphere and the velocity or penetrating power of wind force. With such knowledge, science will certainly better understand the laws of storms, and thereby be able to predict their approach for the safety of life and property.

Carleton College Observatory.

OBSERVATIONS OF A SPLENDID METEOR TRAIN.

WILLIAM R. BROOKS.

A very fine meteor was discovered here on the evening of July 3rd, 1884, about half past eight o'clock, moving from the region of *Polaris* to the northwest point, and downwards at an angle of about 45°. I did not see the meteor itself, looking at the time in an opposite direction; but my little daughter, Anna Caroline, about six years of age, saw it and excitedly called my attention to it with the words, "Oh papa see! a meteor!" I quickly turned but it had disappeared. I was rewarded however by an observation and study of the train—the most brilliant and wonderful it has ever been my privilege to witness. Notwithstanding the bright twilight glow of that early hour the train of light stood out bold and distinct thereon, resembling a brilliant naked-eye comet, for which for a moment it could have been easily mistaken. At first it was quite straight, but in three or four minutes it began to curve in different directions still maintaining its distinct outlines. Then nuclei or points of condensation would form in various parts of the train which slowly expanded and diffused until they became invisible. These nuclei were distinctly seen by the aid of a small glass, and I regret that on account of being about half a mile from the observatory at the time, I was not able to turn the large reflector upon this very interesting phenomenon. The train of light was visible to the naked eye fully ten minutes and in a good telescope could have been seen much longer. I have in several instances while comet-sweeping, ran upon a curious twisting mass of meteoric smoke or *debris* quite invisible to the naked eye, but never anything equaling this in brilliancy and variety of detail.

Red House Observatory,
Phelps, N. Y., July 12th, 1884.

THE TAIL OF THE GREAT COMET OF 1882.

E. E. BARNARD.

Having fortunately secured a number of sketches of the famous comet of the fall of 1882, I have selected those of the naked-eye views that have the most importance as a record of the size, position, etc. of the tail. The two small stars shown near the end of the tail in the later drawings, have been recognized as 10 and 16 *Hydræ*. These stars were found in the Cincinnati observations for 1880–82, where MR. WILSON gives their places for 1882.0, as:

10 *Hydræ* $\alpha = 8^h\ 36^m.3$, $\delta = -15°\ 31'$
16 *Hydræ* $\alpha = 8^h\ 40^m.9$, $\delta = -13°\ 7'$
From Heis's Catalogue.

These objects served admirably for locating the end of the tail and determining its breadth.

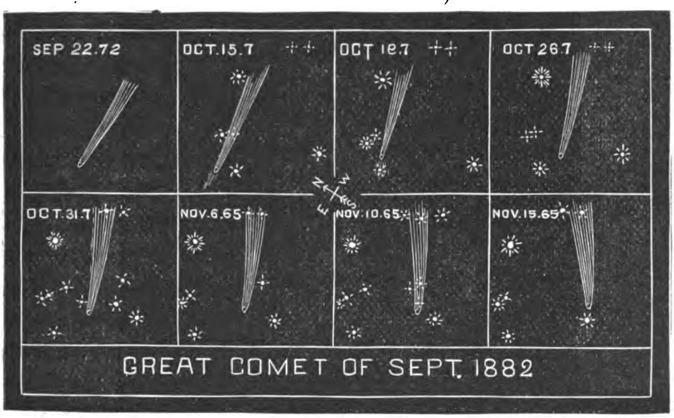
From the original sketches I have formed the following table of length and breadth of the tail.

DATE 1882.		OBS'D LENGTH OF TAIL.		OBS'D BREADTH OF TAIL.	
September,	22.72	15°	Estimated	1°.50	Estimated
October,	15.7	17°-18	Approximately.	...	Br'der than formerly.
"	19.7	17°-18		...	
"	26.7	17°.83	Measurements from sketches.	3°.03	Measurements from sketches.
"	31.7	18°.80		3°.06	
November,	6.65	18°.10		3°.29	
"	10.65	17°.74		3°.50	
"	15.65	17°.16		4°.44	

NOTES IN CONNECTION WITH THE SKETCHES.

Sept. 22.72. Tail projecting above horizon at $16^h 55^m$, very strongly outlined, narrow; dark space along axis reaching nearly to nucleus. Length 15°; broadest part of tail $=1\frac{1}{2}°$; slightly convex to south side, end abrupt and sharply defined. At $17^h 15^m$ angle of tail with S. E. horizon=45°.

Oct. 15.7. Extremity "swallow" or "fish-tailed"; southern part best defined and longest. *Sunward* tail very distinct to naked eye—so yesterday A. M.—as a smeary haze projecting in front of head (some 4° or 5° long in telescope, and very noticeable, the axis of this tail coincides with axis of nucleus, but not with that of main tail.)



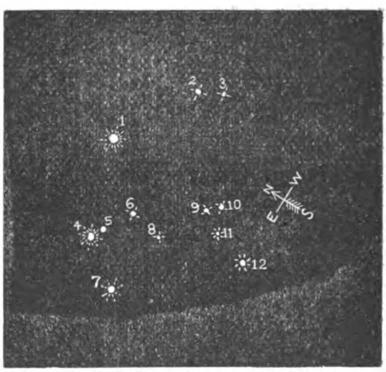
Oct. 19.7. Not so bright as formerly. Nucleus to naked eye equals 3^d magnitude at least; *Sunward* tail faintly visible to naked eye. Large tail, as formerly, abrupt and "swallow tailed." Broader than formerly; southern side much the brighter.

Oct. 26.7. Bright *Moon*. Comet seen through openings in clouds. Conspicuous to naked eye. Nucleus=4 mag. or 5 mag. Tail some 20° long [this estimation too great] carefully located in sketch, the end a little indefinite from moonlight. Not certain of convexity of south side.

Oct. 31.7. End of tail confused, so also the northern side to $\frac{1}{3}$ its length from end. South side best defined. Nucleus as bright, but very much more noticeable than the small star just *n. p.* the head, the distance between this star and nucleus, is a little greater than that between *Lambda* and ν^2 *Hydræ*, its distance from the body of the comet equals the breadth of comet at that place. The body of tail becomes dim at about ½ its length back from head. *n. f.* side very much blended and rather broad. The comet is a bright object with ½ *Moon.*

Nov. 6.65. Very beautiful and bright. Tail extends to and among the two stars [16 and 10 *Hydræ*]. South side brightest and slightly convex. Observation suddenly stopped by clouds.

Nov. 10.65. Tail about as long as ever, but very bushy; almost, if not quite 4° broad near extremity. Cannot certainly make out the "swallow tail," but think it occasionally seen. South side altogether the brighter. There is a small star just back of the nucleus in the head. To naked eye, nucleus is merely a lightish spot. The eastern of the two stars [16 *Hydræ*], just clear of north end of tail; the western [10 *Hydræ*] is involved.



Nov. 15.65. Beautiful. Tail as long as ever, but very bushy; and diffuse at the end where its width is over 4°; a projection from middle of the end suspected. Nucleus 4 mag. or 5 mag.

To avoid confusion, by numbering or lettering, the preceding diagram of all the stars shown in the sketches is more convenient.

Those of the stars that have been identified, certainly, are given in the following table, the numbers refer to those on the diagram:

NO.	STAR.	RIGHT ASC'SION 1882.0.	DECLINATION 1882.0.	REMARKS.
1	α Hydræ.	9h 21m.9	−8° 9′	
2	16 "	8h 40m.9	−13° 7′	Marked 12 on Proctor's new star atlas.
3	10 "	8h 36m.3	−15° 31′	Marked 9 on Proctor's new star atlas.
4	λ "	10h 4m.9	−11° 46′	
5	ν² "	9h 59m.4	−12° 30′	
6	ν¹ "	9h 45m.8	−14° 16′	
7	μ "	10h 20m.4	−16° 14′	
8	Not identified.	9h 50m ±	−17° 59′ ±	Place taken from sketch; Of 5m or 6m.
9	69 Hydræ	9h 27m.8	−20° 36	Cincinnati obser'tions.
10	59 "	9h 21m.9	−21° 50′	" "
11	79 or 80 "	9h 35m.9 9h 37m.0	−23° 4′ −23° 23′	5m or 6m; sketch shows only one star, uncertain which of the two was observed
12	θ Antlia	9h 38m.2	−27° 13′	Place from Proctor's new star atlas, 1880.

These stars are all naked-eye objects. No. 11 was involved in head back of nucleus, (see sketch, Nov. 10.)

No. 10 is shown in sketches for Oct. 31, Nov. 6, Nov. 10, (involved in body of comet.)

Vanderbilt University Observatory,
Nashville, Tenn., June, 1884.

NUMBER OF SUN-SPOTS.

WM. DAWSON, SPICELAND, IND.

The following observations were begun March 28, 1867, for my own satisfaction, and without any view to their publication. But it now seems proper that others interested in the number of spots on the *Sun*, might see what I have recorded of them. The telescope used is 4 6 inches aperture and about 70 inches focus.

Previous to May, 1878, I used a direct eye-piece, with a 2-inch cap, or diaphram over the object-glass; and a red shade-glass on the ocular. Since then I have used a reflecting-prism, and shade-glass of a neutral tint, with full aperture. Nearly all the observations were made with the 100 eye-piece; and generally about 8 to 9 a. m. A description of position, size, etc., accompanies very many of the original observations; and a number of drawings were made at different times.

On June 19, 1870, a power of 200 showed 14 groups and 537 spots; June 22, 675 spots; 26, 250 in one group.

August 27, 1870, I saw 14 groups and counted 950 spots with 200 eye-piece, and 300 with 50 eye-piece. I think this the maximum of that period. About this date my eyesight was failing, which I attributed in part to so much intense looking at sun-spots. So I thought best to quit counting the spots, and simply note the number of groups, large and small. So at the beginning of 1871, the last two vertical lines in the three-line columns, show the number of small groups and large groups, instead of the number of groups and number of spots, as were given previous to 1871, and for 1878 and since.

In one sense I much regret not having the number of spots for several years after 1870; and especially the fewness of observations in 1873–1877. But I am fairly reconciled in the one consideration, that my eyes are still good and strong, excepting long sight, which is beautifully corrected by the use of spectacles.

Various matters combined to prevent a continuous regularity of observations at some other times. However, I have enough to indicate the great irregularity and sudden changes of sun-spots; and also the periodicity. The few observations of 1874–1877, need not be tabulated. They are: 1874—March 29, 2 small groups; May 6, 1 small group and 3 large ones; May 8, 3 small groups and 1 large; July 9, 1 large group and several small ones, and two spots visible to naked eye; July 12, a number of small groups near east edge; July 19, 2 small groups and 1 large; December 3, 2 small groups. 1875—March 27, 1 group and 2 large spots; April 4, 2 or 3 little groups. 1876—July 22, but few sun-spots lately; July 26, 1 prominent spot. 1877—July 12, 15, 19, 26, and August 6, 21, no spots; Aug. 25, 1 group and 8 spots; September 2, no spots; Sept. 25, 2 little spots.

For August 1881, I have the following observations made with a large spy-glass, power 36. 1881—July 27, 2 large spots north of center. Aug. 1, 2 groups; 1 very large spot and several small ones; 8, about the same as 1st; 11, 6 prominent spots, 1 large; 15, no spots; 17, 1 group and 3 prominent spots; 20, 3 or 4 groups; 21, another large group just on at east edge; 24, spots very prominent; 29, spots very prominent, and 1 very large group. September 3, 6 large spots and several small ones; 7, 2 or 3 prominent groups and several spots.

I have noticed *several,* perhaps 30 or more naked-eye spots, at different times. The use of a small glass micrometer indicated their size—the umbra—to be from about 8,000 miles 30,000 miles or more in diameter.

NUMBER OF GROUPS AND SPOTS.

Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.
	1867.		17	0	0	22	1	1	3	2	16	29	2	7
	March.		21	0	0		Sept.		6	4	17	30	1	7
28	0	0	22	0	0	8	0	0	8	2	6	31	3	12
29	0	0	26	0	0	14	1	15	10	1	14		June.	
			28	0	0	15	1	15	13	2	19	3	2	20
	April.			July.		16	1	9	16	2	27	4	2	20
7	3	20	2	1	1	17	1	8	17	2	30	5	2	3
11	0	0	3	1	1	19	1	7	22	1	9	7	3	5
12	0	0	4	1	1	20	1	2	23	1	7	8	3	15
13	0	0	7	0	0	26	0	0	24	2	6	10	1	1
17	0	0	8	0	0		October.		26	1	2	11	1	2
18	0	0	9	0	0	6	2	7	27	1	10	12	0	0
30	0	0	13	1	2	15	1	1	28	1	5	13	0	0
	May.		14	1	1	17	1	1	30	1	2	14	0	0
1	0	0	16	1	1	18	1	1		May.		19	1	1
8	0	0	17	1	1		November.		3	1	1	22	1	4
12	0	0	18	1	1	5	1	1	4	2	2	23	2	7
17	0	0	20	0	0		1868.		5	2	5	24	2	8
24	1	4	21	0	0		February.		6	2	9	25	2	8
26	2	11	22	0	0	12	1	1	8	1	16	26	2	9
31	2	2	29	0	0		March.		9	2	34	27	1	8
	June.		30	0	0	8		5	11	2	21	30	4	12
1	1	1		August.		15	2	25	17	2	6		July.	
2	1	1	3	0	0	17	1	25	18	2	5	6	0	0
3	1	1	6	0	0	19	1	7	19	2	7	7	0	0
4	1	1	7	0	0	22	0	0	20	2	9	9	0	0
7	0	0	9	0	0	29	2	17	22	2	2	11	0	0
10	1	1	14	0	0	31	2	27	24	0	0	15	1	2
11	0	0	15	0	0		April.		26	0	0	16	2	5
14	0	0	16	1	2	2	3	15	28	1	6	20		4

Date.	Groups.	Spots.
21	.	8
22		8
25	1	30
28	2	33
August.		
3	2	8
5	1	6
9	1	1
11	1	6
14	1	5
15	2	15
22	2	10
September.		
3	2	10
4	1	6
17	3	6
27	1	7
30	3	11
October.		
4	3	7
11	4	5
12	4	7
22	2	11
29	10	100
November.		
2	6	126
5	3	32
6		11
8	1	1
12	2	26
14	4	52
15	7	68
22	3	12
23		16
26	2	11
29	4	10
December.		
2	3	6
14	6	29
16	4	10
18	1	1
20	2	2
25	3	14
1869.		
January.		
3	7	15
6	7	16
7		14
20	2	3
22	2	3
23	2	2
28	3	54
31		50
February.		
11	3	30
14	5	50
19	4	9
March.		
14	10	50
April.		
7	0	0
11	1	60
17	4	60
25	3	7
May.		
2	7	95
7		157
8	9	175
10	10	191
15		125
17	4	60
19	4	22
22		20
23	3	38
24	2	25
25	4	43
27	5	77
28	6	82
31	8	144
June.		
1	8	215
2	7	200
3	8	225
6	12	111
7	12	124
10	11	75
14	5	21
16	8	27
17	9	31
18	9	39
19	12	65
20	10	61
24	13	192
25	12	120
July.		
1		33
3	8	50
8	2	32
16	5	32
19	8	100
21	8	63
27	5	32
August.		
1	4	12
2	5	20
3	5	26
8		47
14	7	43
16	7	29
17	7	43
26	9	60
30	3	12
September.		
3	5	60
5	7	119
12	9	83
15	6	50
19	6	30
26	5	63
28	3	45
October.		
3	4	36
10	7	23
17	8	44
18	7	50
31	6	60
November.		
2	6	47
15	8	80
24	5	40
December.		
20	11	60
24	5	40
28	7	25
1870.		
January.		
18	5	38
21	9	50
27	4	56
February.		
4	5	45
7	7	50
8	8	80
10	7	107
12	6	70
13	7	100
20	7	60
21	8	50
23	6	18
24	6	30
25	6	38
March		
2	6	120
9	10	140
10	9	107
18	7	154
23	9	100
24	10	116
29	9	132
April.		
3	9	238
4	9	242
6	8	235
8	8	220
11	6	94
12	7	94
17	6	32
18	8	
21	8	72
22	9	106
24	9	126
26	9	112
29	8	74
30	7	108
May.		
1	8	109
2	9	120
4	8	166
8	9	147
9	8	134
15	8	275
16	8	275
17	10	206
20	9	175
22	8	150
25	9	180
28	10	166
29	9	160
31	6	82
June.		
1	8	76
2	9	82
4	8	102
6	7	116
9	7	110
13	6	86
18	10	226
19	13	349
21	13	382
23	11	340
26	7	440
27	9	472
July.		
3	8	261
5	9	166
17	10	
21	10	
24	7	
31	8	
August.		
4	6	
7	8	
15	11	
16	11	
21	7	
27	11	640
28	14	544
30	12	407
31	13	382
September.		
11	7	31
13	4	44
18	4	370
21	6	460
October.		
6	8	
9	10	
15	20	
23	11	300?
31	9	
November.		
7	12	
12	15	
13	15	
27	6	
December.		
2	13	
4	12	
8	12	
16	12	
29	6	
1871.		
January.		
Date.	Small Gr'ps.	Large Gr'ps.
1	6	2
12	5	5
February.		
20	10	3
27	5	4
March.		
10	7	2
12	7	2
April.		
2	10	4
5	10	2
12	10	3
13	9	4
16	7	5
17	5	5
23	15	2

Date.	Large Gr'ps.	Small Gr'ps.
27	11	1
	May.	
1	11	2
2	10	1
7	8	3
11	9	2
14	8	1
22	14	3
24	14	2
28	10	3
	June.	
7	13	0
9	11	0
11	15	1
26	9	1
	July.	
2	7	1
8	10	2
15	6	2
22	2	9
23	5	6
30	3	4
	August.	
7	4	2
13	3	5
16	4	5
17	5	4
29	3	3
	September.	
1	11	1
	October.	
1	5	1
8	6	2
13	5	3
22	10	1
	November.	
5	13	2
16	14	1
	1872.	
	February.	
9	10	2
	March.	
10	1	0
24	9	4
	April.	
2	6	4
14	7	2
24	5	3
28	2	3
	May.	
5	11	4

Date.	Large Gr'ps.	Small Gr'ps.
10	5	2
19	6	2
26	9	2
	June.	
9	6	4
16	11	2
30	8	4
	July.	
4	4	3
9	7	7
	December.	
4	8	0
	1873.	
	February.	
19	4	5
	March.	
11	11	1
23	3	1
28	6	4
	April.	
6	4	1
	May.	
20	1	0
	June.	
1	4	1
	November.	
16	5	1
	December.	
14	1	0
	1878.	
	February.	
Date.	Groups.	Spots.
6	3	25
17	0	0
21	0	0
26	0	0
28	0	0
	March.	
7	0	0
15	3	20
19	0	0
22	0	0
27	0	0
29	0	0
	April.	
1	0	0
4	0	0
7	0	0

Date.	Groups.	Spots.
10	0	0
12	0	0
16	0	0
21	0	0
23	0	0
25	0	0
	May.	
21	1	2
26	1	5
28	2	16
	June.	
16	0	0
23	1	3
	July.	
14	0	0
21	0	0
	August.	
4	0	0
11	0	0
21	0	0
27	0	0
	September.	
1	1	1
2	1	1
5	1	1
8	1	1
13	1	1
15	0	0
29	0	0
	October.	
6	0	0
13	0	0
20	0	0
	November.	
3	1	3
19	0	0
22	1	1
24	0	0
	December.	
6	0	0
	1879.	
	January.	
18	0	0
21	0	0
26	0	0
28	0	0
30	1	2
	February.	
2	0	0
3	0	0
4	0	0
7	0	0
8	0	0

Date.	Groups.	Spots.
9	0	0
13	0	0
14	1	4
15	1	7
18	0	0
20	0	0
22	0	0
23	0	0
25	1	4
28	0	0
	March.	
1	0	0
3	0	0
4	0	0
5	0	0
7	0	0
8	0	0
9	0	0
11	0	0
12	0	0
14	1	1
16	0	0
17	0	0
18	0	0
23	0	0
24	0	0
25	0	0
27	0	0
28	0	0
29	0	0
31	0	0
	April.	
2	0	0
5	0	0
6	0	0
7	0	0
11	1	5
12		16
13	1	9
16	1	25
20	1	7
21	1	1
22	1	1
23	1	1
24	0	0
26	0	0
28	0	0
29	0	0
30	0	0
	May.	
1	0	0
2	0	0
4	0	0

Date.	Groups.	Spots.
5	0	0
6	0	0
7	1	4
8	1	12
9	1	11
10	2	9
11	1	9
12	1	4
13	1	1
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
21	0	0
23	0	0
27	0	0
28	0	0
30	0	0
31	0	0
	June.	
3	0	0
4	1	3
5	1	4
7	0	0
8	0	0
9	0	0
10	1	2
11	0	0
12	0	0
14	0	0
16	0	0
17	0	0
19	0	0
20	0	0
23	0	0
24	0	0
25	0	0
27	1	14
29	1	30
30	2	38
	July.	
1	2	30
2	2	16
3	2	17
5	2	3
6	0	0
7	0	0
8	0	0
9	0	0
10	1	14
11	1	20
12	1	14

Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.
13	1	8	18	0	0	13	4	37	5	3	30	23	3	56
14	1	15	19	1	1	15	3	55	6	2	17	24	3	27
15	1	8	20	0	0	17	2	32	7	3	28	25	4	40
16	1	10	21	0	0	18	2	18	8	2	24	26	3	24
17	1	4	23	1	1	21	0	0	12	13	11	27	2	26
18	0	0	24	1	1	23	0	0	13	2	11	28	2	30
19	0	0	25	1	1	25	1	6	14	2	4	29	2	24
20	1	1	26	1	1	26	1	4	15	0	0	30	1	12
21	0	0	28	1	1	27	2	13	16	1	4	31	2	10
23	0	0	October.			February.			17	0	0	August.		
24	0	0	7	1	4	1	2	13	19	2	5	1	1	5
25	0	0	8	1	14	3	3	18	23	1	2	2	1	20
26	0	0	9	1	25	4	3	8	27	1	40	3	1	35
27	0	0	10	1	25	5	3	8	28	1	50	4	1	25
28	1	7	11	1	20	6	3	22	30	2	63	5	1	25
29	1	4	12	3	20	15	0	0	31	2	43	6	2	57
30	0	0	13	3	30	19	0	0	June.			7	4	46
31	0	0	14	4	21	20	1	1	1	2	21	8	5	59
August.			18	1	13	21	1	3	2	2	53	9	5	33
1	0	0	20	2	25	22	1	3	3	2	24	10	4	33
2	0	0	22	0	0	24	1	6	5	1	2	11	4	33
7	0	0	23	0	0	26	1	11	7	1	8	12	4	37
8	0	0	24	0	0	March.			10	3	25	13	5	57
9	0	0	25	0	0	1	2	4	11	2	16	14	4	60
10	1	8	26	0	0	2	2	8	12	2	10	15	5	81
11	2	15	27	0	0	9	1	5	13	2	7	17	5	60
12	2	29	29	0	0	15	2	6	16	1	7	18	4	55
13	2	14	30	0	0	17	2	2	17	2	26	19	4	57
14	2	9	31	0	0	23	0	0	18	2	54	20	4	35
17	0	0	November.			29	2	11	19	3	62	21	2	29
18	0	0	2	0	0	30	3	14	20	3	85	22	2	46
19	0	0	3	0	0	31	3	10	24	3	80	23	3	42
20	0	0	4	1	1	April.			25	3	80	24	2	9
21	0	0	6	1	4	3	2	12	27	2	45	25	1	8
22	1	2	12	1	25?	4	2	15	28	3	28	26	1	3
25	1	15	13	1	25	5	2	11	29	5	26	27	2	16
26	2	13	16	1	3	9	4	11	July.			28	3	19
27	3	21	18	1	1	13	1	17	1	2	15	29	3	27
28	2	22	19	0	0	14	2	11	2	2	6	30	2	20?
29	3	26	21	0	0	17	1	2	4	2	16	31	2	19
30	3	16	24	0	0	18	1	4	8	2	25	September.		
31	3	19	25	1	2	20	1	5	9	2	17	1	3	21
September.			30	1	9	21	1	3	10	2	10	3	3	7
4	1	4	December.			22	2	16	12	1	1	4	3	4
5	1	2	5	1	2	24	1	1	13	0	0	5	4	24
6	1	1	9	1	3	26	2	42	14	0	0	6	4	27
8	1	1	16	1	3	27	1	50?	15	1	1	8	9	60
11	1	2	22	1	1	29	1	50	16	1	4	9	6	80
13	0	0	26	0	0	30	1	40?	17	0	0	10	6	140
14	0	0	31	1	4	May.			18	2	18	13	5	90
15	0	0	1880.			1	3	60	19	2	20	14	5	90
16	1	5	January.			2	3	34	20	2	35	15	5	62
17	1	1	10	3	17	33	3	22	22	3	40	16	4	26

Date.	Groups.	Spots.
17	5	24
18	5	43
19	6	44
21	4	31
22	4	31
23	5	28
24	4	19
28	5	80
29	4	85
October.		
1	4	108
2	4	75
5	5	8
6	4	20
7	4	16
8	3	16
9	3	33
12	3	10
13	3	13
20	4	50
21	3	55
29	4	18
31	3	12
November.		
2	4	35
8	1	2
9	3	6
12	1	3
14	1	15
18	3	21
19	3	29
22	3	12
23	3	7
27	5	53
December.		
2	2	12
9	3	10
29	2	3
30	3	8
31	4	20
1881.		
January.		
1	5	11
7	1	3
8	1	4
10	1	6
11	2	9
17	1	2
24	3	23
28	5	66
February.		
13	2	3
14	3	4

Date.	Groups.	Spots.
15	6	24
17	6	26
19	4	9
21	6	23
22	6	45
25	5	16
March.		
7	2	3
9	5	65
10	5	78
14	8	75?
15	8	133
17	6	65
24	2	28
26	2	4
27	2	7
April.		
4	5	20
6	6	14
10	2	6
14	4	24
16	7	50
21	6	135
22	6	145
27	1	20
May.		
6	4	29?
8	5	66
11	4	25
13	3	34
15	2	6
17	4	13
19	3	18
22	4	30
25	5	38
27	4	80
31	4	65
June.		
3	2	65
9	5	27
10	5	33
11	4	35
16	7	35
21	3	8
25	5	
30	4	90
July.		
6	8	55
9	3	44
September.		
8	3	24
9	1	43

Date.	Groups.	Spots.
11	4	55
12	4	65
16	2	20
17	1	40
23	2	4
24	2	4
29	6	25
October.		
9	3	28
10	4	21
20	4	60
22	4	45?
25	4	
26	4	20?
November.		
1	1	1
6	5	10
13	7	33
28	4	25
December.		
6	3	62
8	3	40
23	3	10
24	2	12
1882.		
January.		
9	3	12?
14	4	25?
17	3	10?
27	4	30
30	5	57
February.		
1	4	25
3	5	20
6	4	30?
8	5	100
13	6	60?
14	6	60
15	8	72
25	4	14
March.		
1	2	7
2	2	20
5	4	35
15	6	20
19	4	60
31	7	30
April.		
1	8	33
4	6	56
5	7	60
11	8	36
12	7	65?

Date.	Groups.	Spots.
13	5	65
14	7	75
15	9	140
16	8	160
17	9	175
21	6	95
24	3	35
25	3	30
27	5	25
28	3	20
30	3	18
May.		
1	3	32
7	5	60
10	7	72
15	5	125
17	7	150
20	4	75
22	2	18?
24	2	10
26	2	4
29	3	4
30	3	3
June.		
1	3	4
5	2	7
7	3	17
8	4	16
12	2	30
15	2	75
16	2	50
21	2	30
24	3	14
25	4	21
27	5	65
July.		
1	8	45
2	4	25
August.		
15	2	13
September.		
3	7	90
5	5	82
6	3	70
7	3	50?
8	3	45
12	4	32
13	2	22
14	5	40
16	1	40
17	2	55
18	2	60
19	2	30

Date.	Groups.	Spots.
22	3	25
23	4	28
24	6	40
25	6	60
27	6	75
28	5	70?
29	5	60
30	6	75?
October.		
1	6	100
2	5	113
4	8	80
5	9	82
6	4	61
7	6	19
9	3	8
10	2	4
12	4	17
13	3	20
14	2	45
15	3	60
16	2	42
19	2	110
20	3	108
21	5	122
22	6	17
24	5	80
26	4	63
29	2	35
30	3	42
November.		
2	4	65
4	6	70
11	5	42
14	5	27
20	6	50
22	8	80
23	8	80
25	8	68
28	8	80?
December.		
1	6	50?
1883.		
January.		
7	3	14
16	3	45
18	3	50?
24	6	12
February.		
12	5	75
18	4	30
21	1	10
23	0	0

Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.	Date.	Groups.	Spots.
25	1	12	18	2	35?	15	5	70	22	7	40	20	6	28
28	2	12	19	5	100	19	4	40	25	5	60	22	6	40
	March.		20	4	110?	21	2	17	31	7	70	24	7	45?
1	2	6		July.		24	3	7		February.		28	5	65
4	1	1	1	3	100	26	2	7	2	7	70	29	4	75
8	4	10	3	4	70	28	4	17	14	5	60?	30	5	70
9	5	16	5	2	40	29	5	22	23	5	40?	31	4	53
13	6	60	7	2	40		October.		29	8	60?		June.	
18	3	21	9	2	40	3	2	4?		March.		1	5	53
22	4	95	13	7	60	7	7	50	12	8	95	2	5	60
24	3	70?	16	8	90	8	7	71	14	6	90?	4	5	40
31	4	30?	17	8	110?	9	6	135	21	4	50?	5	6	60
	April.		19	10	165	13	6	100?	22	5	50	1	5	53
3	7	25	21	7	185	15	6	150	23	6	54	2	5	60
8	5	42	24	8	230	25	5	90	24	6	42	4	5	40
10	4	22	27	6	110?	30	8	80	27	3	23	5	6	60
11	6	40	28	6	56		November.		28	3	20	7	5	37
12	5	80	29	3	35	1	9	95	20	3	11	13	3	12
16	6	120	31	5	52	4	8	80		April.		15	3	6
17	6	112		August.		11	5	60	1	5	40?	17	6	21
20	5	75	4	3	8	13	5	68	3	4	65	18	6	45
25	6	32	6	2	7	17	7	95	4	4	100	19	5	25
27	6	20	7	4	14	24	9	63	6	6	60	21	5	57
	May.		11	5	23	28	4	40?	14	3	15	23	4	36
1	4	22	12	5	33		December.		17	4	48	27	5	20
4	3	5	15	4	20	1	4	19	25	6	125	30	5	40
6	1	3?	18	7	21	5	2	12	25	5	80		July.	
16	4	12	20	4	7	8	4	23	26	5	112	3	7	90
23	2	15	22	3	40	9	5	60?	28	4	115	6	5	55
27	0	0	24	6	30	12	9	120	29	3	150	9	4	32
31	2	8	27	5	85	21	8	100?		May.		10	2	27
	June.		28	5	85	28	8	125	2	3?	60?	11	3	33
1	3	50	30	6	115		1884.		7	5	40	14	3	50
2	5	84		September.			January.		8	4	43	16	3	35
4	6	110	1	7	90	3	5?	50?	11	9	85			
5	6	105	3	8	66	9	10	100?	12	5	80?			
8	6	55	5	6	60	13	8	80?	1	7	65?			
13	3	60	10	5	50	16	6	90	16	6	25?			
14	3	75	14	6	80	17	6	67	18	6	36			

Up to July 15th, the phenomenon of red skies continues as remarkable as ever. It occupies the northwestern skies in the evening, and northeastern in the morning. The phenomenon always repeats itself—that is, it will fade out and in a few minutes re-appear at about the same altitude. I have attributed the repetition to a reflection from the first, which at that time will have just sunk below our horizon.

This repetition in the mornings preceds the real phenomenon.

E. E. BARNARD.

OBSERVATIONS OF THE COMPANION OF THE SIRIUS, MADE AT THE U. S. NAVAL OBSERVATORY.

BY PROF. A. HALL.

[Communicated by Commodore S. R. Franklin.]

Date.	Sid.	Time.	p.	s.	
		h	°	"	
1884.	170	5.6	39.0	8.89	very faint.
	206	6.1	38.0	8.76	faint.
	209	6.2	37.5	8.64	faint.
	225	6.8	36.5	8.76	very faint.
	231	6.7	37.5	8.87	
	247	7.3	37.8	8.95	faint.
	250	7.4	37.2	8.87	
	269	7.9	37.8	8.74	

Mean Results.

		p.	s.
			"
1884,	226	37.67	8.810

This companion has been unusually faint during the present year.

The best quick motion of the equatorial telescope in right ascension is that adopted in the Washington telescope, where the obsêrver pulls an endless rope hand over hand, and can lock and unlock the gearing which connects the turning-wheel with the telescope at pleasure. The quick motion of the equatorial telescope in declination, by means of a loose rope attached to the two ends of the telescope, requires too strong a pull, the best method of giving this motion is through a gearing turned by an axis passing centrally through the polar axis on the Repsold plan. But it is preferable to have this motion made by turning a crank or pulling a rope rather than by taking hold of a wheel.—*Newcomb.*

EDITORIAL NOTES.

The double number of the MESSENGER, 2 and 3, Vol. I., is exhausted. Any persons returning copies of that number to our office in good condition, will be paid fifty cents each.

The call for the last number (25), has been unexpectedly great. Subscribers re-placing this number will be credited for it, by advancing their subscriptions two numbers.

Several copies of the present issue have been sent to professors and teachers of Astronomy, in colleges and secondary schools in the United States. It is common place to say that such a publication ought to be a constant help to every instructor in this delightful branch of study. And, if it furnish only the news of discovery and general work, it ought to be worth two dollars a year.

It will interest the student of cometary astronomy to know that Dr. SWIFT of Warner observatory has consented to furnish for the MESSENGER, at an early date, a complete supplemental catalogue of comets discovered since the publication of the Catalogue found in Chamber's Astronomy, (Ed. 1876). The few errors found in that good Catalogue will be corrected.

The relative proper motion of the stars of the *Pleiades* is a theme well worthy of the attention of Astronomers with measuring apparatus adapted to this difficult work. The suggestion by Assistant PAUL, of the Naval observatory at Washington, that possibly Dr. ELKIN may find time soon to use the large heliometer of Yale College observatory in this work, is indeed most fitting. Dr. ELKIN'S skill, and his fine instrument would give certain promise of the best results possible at the present time.

In the *Astronomische Nachrichten* (No. 2602), Professor HALL, Naval observatory, Washington, calls attention to the need of a uniform ephemeris of clock stars for general use. He thinks the work of securing and continuing such a catalogue should be under the direction of one office, and that the work should be so elaborate that the apparent position of a star could be interpolated with ease and certainty for any time. The cost of such a work ought not to be great, and as Professor HALL indicates, it would be very useful.

The Board of Directors of the Cincinnati University, at their meeting in June, appointed Professor J. G. PORTER to the position of Astronomer, and H. C. WILSON to the position of Assistant Astronomer of the Cincinnati observatory. These appointments take effect September next. Professor PORTER was formerly an assistant at the Litchfield observatory of Hamilton College, Clinton, N. Y., has since spent several years in Europe, studying mathematics and astronomy, and now holds an important position in the U. S. Coast Survey. H. C. W.

We are indebted to Mr. WILSON, acting astronomer at the Cincinnati observatory for the following:

"As the sky was clear here July 11, I took the opportunity to observe *Venus* in conjunction. By shutting out the light of the *Sun* from the object-glass, and reducing the aperture of the eye-piece to about one-thirtieth of an inch, I obtained a very distinct view of the planet. The crescent on the north limb was very brilliant and was much thicker than I had anticipated. The cusps extended considerably more than half way around the planet. At times they seemed to flash out, so as to cover more than two-thirds of the circle. The janitor who has been accustomed to bright light from counting Sun-spots for six years, was positive that he could see the complete circle. Thought I caught a glimpse of a thread of light opposite the crescent, once or twice, but was not satisfied of its reality."

A very careful search was made by me with the nine-inch reflector on the same night the telegram was received for the suspected comet found at Vienna on May 26th, and recorded as a nebula.

On the following night also I swept very slowly, and with the greatest care, a large region of the heavens radially from the recorded place, but no suspected object was found. WILLIAM R. BROOKS.

A new Minor Planet (237), was discovered by J. PALISA, at Vienna, June 12th, 1884. It is of the 12th magnitude. The positions given by Dr. KRUEGER, Kiel, June 29th, to the *Science Observer*, in Greenwich mean time, were as follows:

	α			δ		
	h.	m.	s.	°	′	″
June 27. 4101	16	19	46.7	—19	38	25
" 28. 3729	16	19	10.6	—19	41	10

Lord CRAWFORD, Dun Echt observatory, says that the search in Europe for the suspected comet (1858 III), has been fruitless. He thinks it is very probable that the object observed at Vienna was not a comet.

In the *Monthly Notices* of the R. A. S. for May, 1884, appear three sets of measures of the position-angle and distance of the companion of *Sirius*, made by Professor HALL with the Washington 26-inch refractor, and by Professor HOUGH and Mr. BURNHAM, with the 18-inch of the Dearborn observatory at Chicago. The results are all for nearly the same epoch, and may be considered as measures of the same absolute quantities. The mean results for the opposition of 1884 are given below, and to them are attached the probable errors resulting from the residuals of the individual observations as printed in the *Monthly Notices*. They serve to show how different observers will differ by systematic amounts which are far outside the probable errors computed from the accidental errors of their individual observations, especially in the measurement of the *distance* of the two components of such a double-star as *Sirius* and its companion.

Observer.	Date.	No. of nights	*p*.	*s*.
Hall	1884.226	8	37°.66 ± 0°.17	8″.810 ± 0″.024
Hough	.179	11	36 .68 ± 0 .12	8 .510 ± 0 .030
Burnham	.189	10	36 .39 ± 0 .35	8 .392 ± 0 .033

H. M. P.

COMET 1858, III (TUTTLE).

We learn from Special Circular, No. 46, *Science Observer*, "the possibility that the third comet of 1858 has been seen on its return to perihelion, was announced by cable message from Dr. A. KRUEGER, on the 19th inst. An observation of an object, supposed to be a nebula, was made at the Vienna observatory, on May 26, the following position having been secured:—

R. A. 17h. 43m. Decl. +35° 32′

Search for this object, on the 19th inst., showed that it was no longer in the same position, hence the supposition that it was a comet.

A second cable message was received on June 21, from Lord CRAWFORD, at Dun Echt, giving the finding ephemeris, as below. A third message, received June 24, from Dr. KRUEGER, gives also an ephemeris. Telescopes of large aperture, only, will now be able to observe the comet, should it be found."

EPHEMERIS.—LORD CRAWFORD.

Greenwich. Midnight.	R. A. h.	m.	s.	Decl. °	′	Light.
June 21.	17	23		+28	51	1.16
25.	17	21		27	1	
29.	17	19	20	25	9	
July 3.	17	18	36	+23	14	0.80

R. A. COPELAND, Computer.

EPHEMERIS.—DR. KRUEGER.

Greenwich. Midnight	R. A. h.	m.	s.	Decl. °	′	Light.
June 25.	17	32	56	+25	14	1.04
29.	17	32	28	23	29	
July 3.	17	32	32	+21	40	0.80

DR. L. SCHULHOF, Computer.

VARIATIONS IN THE SUN'S DIAMETER.

A pamphlet of 17 pages by Dr. HILFICKER, of the observatory of Neuchatel, treats the 3468 observations of the *Sun* made by 8 observers during the years 1862—1883, with the object of determining whether the *Sun's* diameter varies. The meridian circle has an aperture of 115 mm., and a magnifying power of 200 is used, and each limb of the *Sun* is observed on 13 threads, so that these observations are more suitable for the purpose, than many other series which have been used for the purpose. Beside the Neuchatel series, others are quoted; though several papers on the subject are not referred to.

Dr. HILFICKER gives two conclusions, which he regards as satisfactorily proved by his discussion. These are, 1st; that the variations in the diameter of the *Sun*, shown by the Neuchatel observations are real. 2d; that these changes depend upon the period of the Solar spots; that is, that the largest diameters co-exist with the minimum *Sun*-spots, and *vice versa*.

It will be noticed that this conclusion does not agree with those of other discussions, notably with the very satisfactory one of Dr. AUWERS, based on the results of the observations of seven observatories, or with the discussion of corresponding observations at Greenwich and Washington, by Professors NEWCOMB and HOLDEN.

OBSERVATORY OF ALGIERS.

This observatory was re-organized in 1881. The director is M. TREPIED, and the assistant M. RAMBAUD. The appropriation is 12900 francs (about $2,600). The principal instruments are, a reflector of 20 inches aperture; a reflector of 13 inches aperture; a Thollon spectroscope, giving the dispersion of 31 flint prisms; a small meridian circle; spectroscopes; apparatus for solar photography. An account of this observatory is given in *Bulletin Astronomique*, April 1884.

THE ARMAGH OBSERVATORY.

Dr. DREYER has printed (for private circulation) an historical account of the Armagh observatory, in a pamphlet of 20 pages. The frontispiece gives an autotype picture of the buildings. This account is of much interest since the history of the observatory extends from 1791 to now.

NEW CATALOGUE OF STARS.

The Armagh observatory is preparing for the press, a second Armagh catalogue of about 3000 stars, most of which have been observed from 3 to 5 times with the Mural Circle.

STATISTICS OF COMETIC ORBITS.

Dr. PAUL LEHMANN of Berlin, has re-printed a compilation with the above title, which contains much interesting information in a tabular form. 294 cometic orbits are more or less well known: of these, 221 have parabolic orbits, and of the elliptic orbits

7	have a period	from	10,000	to	50,000 years.
23	" " "	"	1,000	"	10,000 "
6	" " "	"	500	"	1,000 "
9	" " "	"	100	"	500 "
6	" " "	"	50	"	100 "
5	" " "	"	10	"	50 "
17	" " "	"	—	"	10 "

All the comets whose periods are under 10 years, have *direct* motion, and of the 28 comets whose periods are under 100 years, only 3 have retrograde motion.

An interesting table of comets with similar orbits which are yet not identical, is also given: and further a table of those comets which are related to each other in groups, so that all their orbits intersect in a line. These comets may be supposed to have had a common origin.

A NEW AND FAINT NEBULA.

I have discovered a new and exceedingly faint nebula in

$$\left.\begin{array}{l}\alpha=17^h\ 16^m\ 45^s.8\\ \delta=-38^\circ\ 26'\ 18''\end{array}\right\}\ 1884.0.$$

It is a small and faint object with 6-inch telescope. The light seems to be of an even tint.

It lies $2^m\ 22^s$ following, and 3°.9 south of General Catalogue No. 4290. The place is the mean of three equatorial pointings.

General Catalogue, No. 4290, I make the place of this object to be

$$\left.\begin{array}{l}\alpha=17^h\ 14^m\ 24^s\\ \delta=-38^\circ\ 22'\ 24''\end{array}\right\}\ 1884.0.$$

This place is the mean of four careful equatorial pointings. It is exceedingly faint with 6 inches, and precedes two 9^m stars by a few minutes of arc.

There is a faint star or so, close south which confuse the light of the nebula. The description of this object in General Catalogue is "!!!; ⊙; *eF*; *S*; *amSt*." It was impossible to make out its annular character.

E. E. BARNARD.

Vanderbilt University Observatory, Nashville, Tenn.

Mr. H. H. WARD has recently published a pamphlet of sixteen pages, in which he sets out a new theory of cometary tails. Briefly enunciated the hypothesis is this:—"A comet's tail is the comet's own light transmitted through, and made co-extensively visible by the cometary shadow." Four arguments are given in support of the theory:

1. Comet's cast shadows; 2. Comet's are self-luminous chiefly; 3. Cometary light would itself be visible in transmission through the

shadow; and 4. The shadow hypothesis accounts for the phenomena attendant on cometary tails.

The paper shows thought on an important theme. Points three and four are the chief ones, and they are very difficult propositions to prove by observation, if the attention of the observer were confined to that part of the tail which always extends from the *Sun*. For instance, unequal brightness on opposite sides of the tail, while the nucleus and coma seem perfectly uniform in the telescope, definite outline to the end of the tail and there clearly divided; two, three or six tails, each having different curvature and pointing in different directions; and then what shall be said of tails that point towards the *Sun?* There are several such observations of recent record. These are a few of many such facts that seem to us difficult to explain by the new theory.

The thirty-third meeting of the American Association for the advancement of science will be held at Philadelphia, Pa., Sept. 4th to 10th. The time is later than usual to allow an interchange of courtesies between the British and American Associations, and to enable the members of the two associations to attend both meetings. The American Association and the local committee of Philadelphia have invited the members of the British Association, with their near relatives who may be with them, to take part in the Philadelphia meeting. Invitations have also been sent to the leading scientific societies abroad, inviting them to send delegates to the Philadelphia meeting. It is probable, therefore, that this meeting will be largely international in its character, and it is likely that steps will be taken, at this time, to form an International Scientific Association. The Philadelphia meeting promises to be one of very great interest in character and numbers. J. P. LESLEY, Philadelphia, is president; F. W. PUTNUM, Cambridge, permanent secretary, and JOHN WELSH president and secretary of the local committee of arrangements at Philadelphia.

TERRIFIC SOLAR ERUPTION.

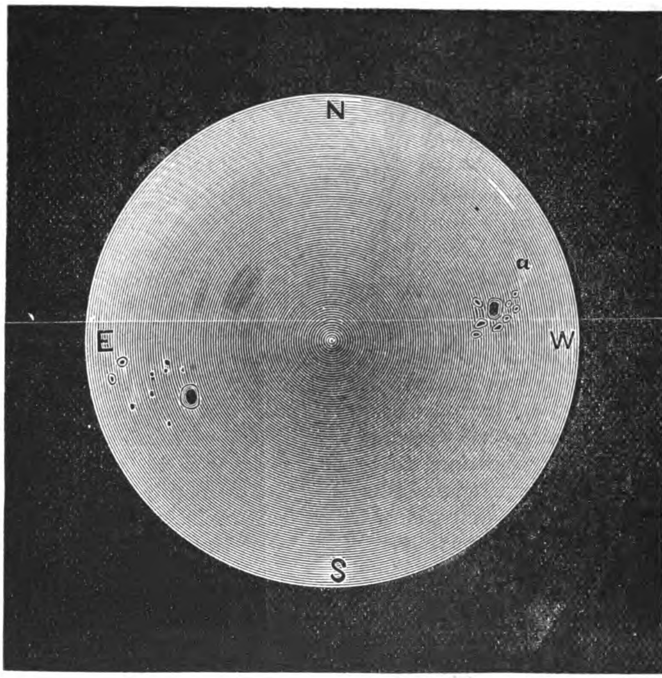
In May we received a private letter of great interest, from Engineer C. W. IRISH, Iowa City, concerning a wonderful solar outburst which he observed on the 10th day of last April. We immediately asked for drawings of it and were favored by Mr. IRISH with three fine representations of what he saw. In presenting the views we are sorry to say that our engraver has come far short in giving the details of the drawings which showed great agitation of the solar surface over a considerable area.

We give the observations and explanations of the figures in Mr. IRISH's own words from several private letters.

"I have been observing the *Sun* quite often, this spring, and noting the changes on his surface. I have to report for the MESSENGER a phenomenon which I observed on the 10th day of last April.

"At 10 A. M. I observed two large spots, one of which was approaching the western edge of the disc, and was within 12 or 14 minutes of it. The other was coming on, and about the same distance from the western limb. The faculæ were very large and very distant in the vicinity of the two spots.

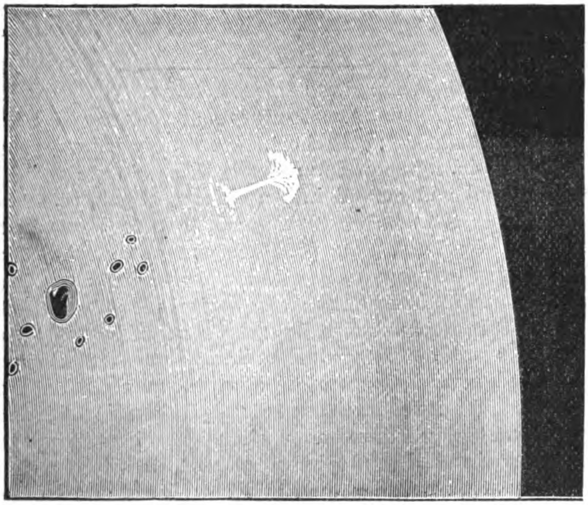
(Fig. 1).



Sun's Disc April 10, 1884.
a. Place of Solar Outburst.

"At 2 o'clock P. M. (10th) I saw, about half way between the first described spot and the edge of the *Sun*, a bright object on the *Sun's* surface. It had the appearance of a column of brilliant matter standing upon the *Sun*. I viewed it every way, by increasing and decreasing the powers, but all the alterations which I made in the instrument still showed it as a column of very brilliant light about eight or ten seconds high. At 4 o'clock I again viewed, when, to my astonishment, it had become somewhat more elongated and had taken on the form of a sheaf of grain, and was about fifteen or twenty seconds high. Its projection from the face of the *Sun* was just what it should be, if it were a column standing perpendicular to the *Sun's* surface at a point where it appeared.

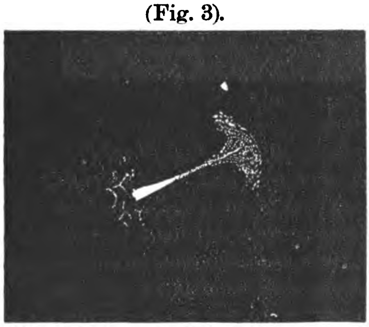
(Fig. 2).



"Figure 2 is reproduced from sketches made at the time of observation. Mrs. IRISH, who saw the phenomenon with me, thinks that sketch No. 3 following is quite perfect.

"In figure 2, I endeavored to show how very much agitated the face of the *Sun* was, in the vicinity of the object, but I must despair of being able to show, by a drawing, those fiercely raging waves, the crests of which seemed as sharply defined on that day as the markings of the *Moon* seen with the same instrument, but they did not equal

(Fig. 3).



Diameter of Sun about 43 inches.

the bright and sharply defined jet which I have pictured. When first seen it had the same breadth and length as in figure 3 from the base to the place where the top begins to spread out, and it continued as a bright, straight streak for three and one-half hours, after which the top formed in about one and one-half hours.

"I have watched the *Sun* intently since, when the weather would permit, in hope of a repetition of the phenomenon, but none has been seen."

TELESCOPIC METEOR TRAIN.

July 12, 1884, 9h. 30m. A meteor of near first magnitude darted across the southeast sky; path short. Faint train instantly lost. Examining with 5-in. refractor I found very thin strip of lightish smoke; this rapidly bent and curved into a sinuous streak, with moderate motion towards the southeast. Though the *Moon* was just above the horizon I could watch this for three or four minutes. The strip faded from view leaving a small nebulous knot, like a small comet or nebula; this was followed quite easily as it moved among the stars. It would have been impossible to have distinguished this from a nebula save in its motion. It gradually melted from view, having, meanwhile, moved several degrees in a southeasterly direction. The direction of flight of the meteor was from the south to the northeast. This is the first train I have had a chance to observe in sometime, though I have invariably swept the paths of all bright meteors seen —many very much brighter than this one—but there was no train left. I would note that the drifting motion of the train was, as usual in my observations, *easterly* (southeast in this case). E. E. B.

COMET *b*., 1884, (BARNARD.)

On the night of July 16th, while sweeping in the south-western part of my zone, I discovered a suspicious object, which from its absence from my memory and the catalogues at once suggested the probability of its being a comet. A series of pointings were begun with the 6-inch equatorial upon the object and neighboring stars. The mean of four careful pointings gave its place at 9^h 33^m 55^s, Nashville M. T., right ascension, 15^h 50^m 40^s, south declination, 37° 9′ 52″. It was close *n. f.* a star of 8^m(?), which star I noticed was of a reddish tinge. The following night (17) was cloudy. On the 18th, the sky was clear for a short time, and the object was examined again. It was located precisely the same with respect to a star which I called 8^m or 9^m, the declination was the same. I at once concluded it was a nebula, but thought it brighter than on the 16th. The sky quickly clouded. On the 19th, the sky was badly clouded, but through breaks I glanced at the object and saw at once it had moved. I had been deceived the night before by the striking similarity of position of comet and star. I described it as brighter, but as it was seen for a few seconds only, may have been deceived. The 20th being clear, the comet was again observed and described as fainter. It is large for a telescopic comet;

gradually a little brighter in the middle. On the last date I suspected an indefinite rapid brightening to a nucleus near the middle, possibly *f* the centre. It sperads out into hazy indeterminate outlines. Its motion is very slow toward the east, some 20′ daily, with an almost insensible southern motion. E. E. B.

Vanderbilt University Observatory,
Nashville, Tenn., July 21, '84.

The British Association for the advancement of science holds its annual meeting, this year, at Montreal, Canada, August 27 to September 3. Mr. J. D. Crawford is general secretary; his address is P. O. box 147, Montreal, Ca. Of local committee Thomas Cramp is chairman, and David A. P. Watt is secretary. Address Molsons' Bank Chambers, 198 St. James street, Montreal. A recent note from Professor C. H. McLeod, McGill University, states that the invitation of the British Association is extended only to Fellows of the American Association.

ERRONEOUS DESCRIPTION OF A NEBULA.

I have observed a small nebula (since March 24, 1882) that is identified as *General Catalogue* (Herschel's) No. 4036. In that catalogue it is described "eeF(?)." This is erroneous. It is pretty bright, visible in moonlight. I can see it with 1¼-inch finder. When seeing is good, it is very small and very bright, resembling a hazy star; the least change in definition blurs it into a slightly larger mass of light; the description of it in this condition would be

S; PB; vsvmbM * 7^m(?) $1° \pm$ *n. p.*

The place in *Gen. Cat.* for 1860, 0 is $\begin{cases} \alpha\ 14^h\ 57^m\ 46.^s9. \\ \text{N. P. D. } 122°\ 34'\ 35''.2. \end{cases}$

E. E. B.

THE MOON INHABITED.

Recently the newspapers have been freely copying the news of wonderful discoveries said to be made at the astronomical observatory, in Berlin, in respect to the *Moon*. A distinguished professor at that place, whose name is unknown to astronomy, is now prepared to furnish convincing proofs that the *Moon* is the "abode of living, intelligent beings." The discovery was made by accident. As the account has it:

"This learned Doctor found that the observations of the *Moon* gave but very unsatisfactory results owing to the intensity of the light power of the *Moon's* atmosphere, which is that strong that it affects the correctness of the observations in a very high degree."

(If these are the Doctor's own words it is to be feared that he had an attack of *lunacy* when he wrote them.) He then darkens the object-glass with the smoke of camphor, toiling for months, until he gets the right shade, which is then in excellent condition for work as a photographic lens. It is said to do very sensitive work in catching the details of the lunar surface.

"One of these pictures was placed in a sun microscope which gives it a diameter of fifty-five and one-half feet (the ½ is important). The revelation was most startling. It perfectly overturned all hitherto entertained ideas of the *Moon's* surface. Those level plains which formerly were held to be oceans of water proved to be verdant fields, and what formerly was considered mountains turned out as deserts of sand and oceans of water. Towns and inhabitants of all kinds were plainly discernable, as well as signs of industry and traffic.

If the distinguished SCHROETER had lived long enough to know that such astronomical discoveries were accredited to any of his countrymen, we would doubtless have had, as a consequence, some vigorous German, akin to the strong English which Mr. PROCTOR uses, for the benefit of the so-called earth flatteners.

COMET (*b*), 1884.

The new Barnard Comet is so far south that northern observers will have poor opportunities for seeing it. The comet is quite large in the telescope, but very faint and the moonlight of early August will put it out wholly.

From *Science Observer* we have the following

ELEMENTS.

T	Aug. 17. 63 (Greenwich, M. T.)
ω	304° 12′
☊	357° 53′
i	7° 2′
q	1.4054

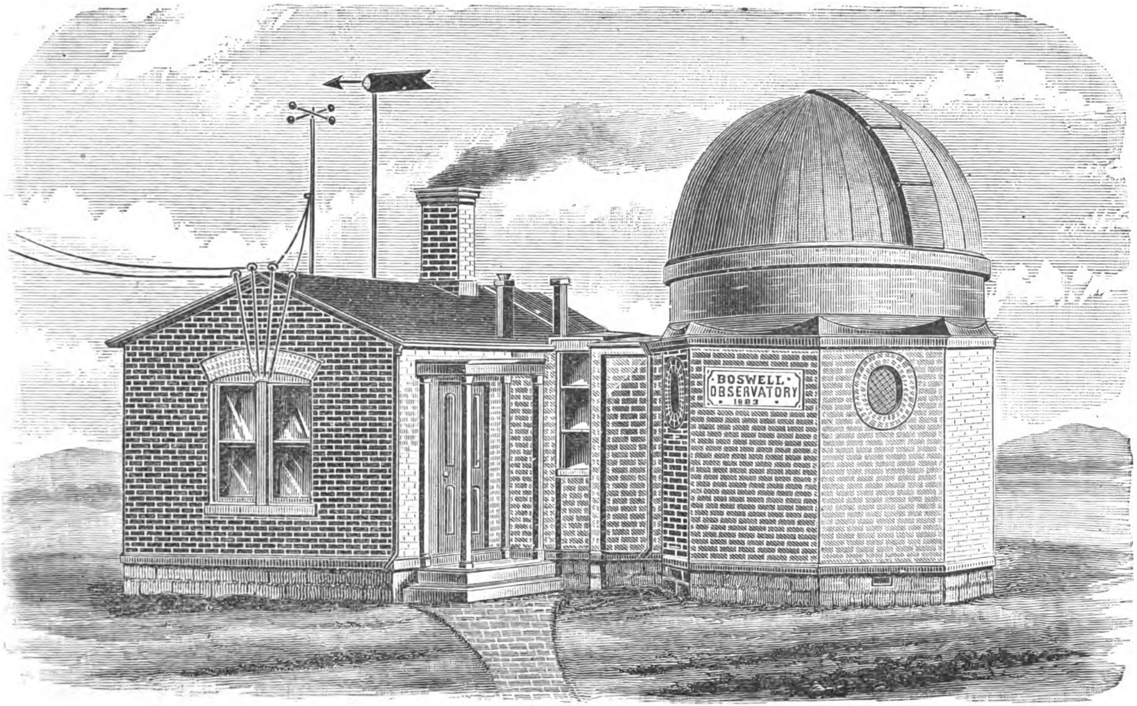
EPHEMERIS.

	α	δ
Aug. 2	$16^h\ 29^m$	37° 12′
" 6	16 41	37 4
" 10	16 53	36 52
" 14	17 9	36 31

BOSWELL OBSERVATORY.

A new observatory at Doane College, Crete, Nebraska, has been recently erected, and is now being supplied with astronomical instruments. A cut of the building is given on the opposite page. The equatorial telescope has an object-glass of eight inches aperture, made by the CLARKS. The mounting is furnished at Madison, Wis., Professor G. D. SWEZEY, under whose directions the observatory is being equipped, has already secured a Buff and Burger Transit instrument, a Howard mean time clock, a Sewell break-circuit Chronometer, a Seth Thomas clock and a set of meteorological apparatus.

The building and instruments have cost about $7,000. The observatory will furnish good facilities for instruction in astronomy, and for some branches of original work.



BOSWELL OBSERVATORY.

LARGE METEOR.

April 25, at 10^h 27^m (Ninetieth meridian time), a magnificent meteor burst into view among the stars of *Corona Borealis*, and moved rather slowly in a southern direction. Place of appearance was about, right ascension 15^h 30^m, and declination $+30°$; disappearance about, 16^h 12^m, and 0°; no train, very intensely white, illuminating surrounding objects quite distinctly. The meteor flashed out in the rear like a flame. Swept at once with a 5-inch telescope, but found no train. Its extinction was preceded by a great outburst of light, many times brighter than *Venus*. Upon the disappearance of the greater part of the light, the meteor continued its course a few degrees further, as a dull red speck of second or third magnitude. Its total duration seemed to be about two seconds. E. E. B.

PERSONAL.

CHAS. S. WELLS, Portland, Or., formerly of Dudley observatory, Albany, N. Y., kindly gave us interesting astronomical notes recently.

E. E. BARNARD, Nashville, Tenn., gets $200, the Warner prize, for the discovery of second comet belonging to 1884.

On the night of the 25th of July, Professor SWIFT, Warner observatory, discovered five new nebulæ near *Beta Draconis*, and three others previously. One of them is exceedingly elongated, and ought to have been seen before.

Professor SWIFT has our thanks for the names of several new subscribers to the MESSENGER.

Mr. JOHN R. HOOPER, of Baltimore, followed the planet *Venus*, at time of inferior conjunction, and saw her pass the *Sun*, but could not get more than 180° of the circle of light. "The thin crescent was very beautiful, and seemed, in the telescope, to be so large and so near."

Subscriptions and orders not previously acknowledged are as follows:—Robert Elliott, (Vols. I, II and III,) Hannibal, Missouri; Alfred Rordame, Box 1010, Salt Lake City, Utah; Thomas Bassnett, Box 936, Jacksonville, Florida; Wm. C. Pond, Care of Conn. Mutual Life Ins. Co., Hartford, Conn.; Mrs. E. M. Burnham, 187 Schermerhorn Street, Brooklyn, N. Y.; L. P. Venen, Olympia, Washington Territory; School of Mines, Columbia College, New York City; J. C. Street, 47 Dwight Street, Boston, Mass.; John Nicholson, 18 Ward, Pittsburgh, Pa.; Professor James Edward, Oliver Cornell University, Ithica, N. Y., (Vols. I and II); Chester Guild, 88 Summer Street, Boston, Mass., (Vols. I, II and III, first two bound); Professor R. Henry Ferguson, Roxbury Station, Boston, Mass., No.'s 2 and 3, Vol. 1; Professor Wm. R. Brooks, Red House Observatory, Phelps, New York, Vol. III; Lawrence Oberlies, 44 Grand Street, Rochester, N. Y.; J. Gaylor, Ridgewood, Bergen County, N. Y.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. NO. 7. SEPTEMBER, 1884. WHOLE NO. 27.

LARGE TELESCOPES OF THE WORLD.

THE EDITOR.

The *English Mechanic* and some other foreign scientific papers have recently published a list of the principal equatorial telescopes (refracting and reflecting) of the world. A single glance at it impresses the reader with the thought that this is, indeed, the era of great telescopes as well as enterprises of magnitude in commerce and the arts. While it is true that there is plenty of desirable work to be done in every department of Astronomy within the reach of small telescopes, it is also true that the great questions of the science, and some of the new ones claiming the attention of the astronomer seem to demand better instrumental facilities, if they are to be mastered in the near future. The solar parallax, physical constitution of the *Sun* and attendant phenomena, proper motion of stars, stellar parallax and physical study of the planets are a few examples in which the need is apparent, either in seeing details, or in measuring very small quantities accurately. Naturally enough, the first thing thought of is to make larger telescopes, and improve known methods of study as much as possible, for, a faithful use of the known will certainly lead to that which is new in kind or principle, before there is waste in the uses of the old. This principle is as rigidly true in Astronomy as in Ethics, because all truth is one and from one Supreme Being.

We first present as complete a list of equatorial refracting telescopes as we are able to do from information at hand. Later a list of large reflecting telescopes may be given.

Following the plan used in the *Astronomical Register* (English), we give only refractors whose apertures are not less than 9.8 inches, for obvious reasons. A * indicates that the telescope is dismounted at present, or that no information as to its having been in use for some time could be obtained; a † that the instrument is in process of construction.

LIST OF REFRACTING TELESCOPES.

Observatory or Owner.	*Aperture.*	*Maker of Object-Glass.*
Rio Janeiro, Brazil.........	9.8	Henry Bros.
Toulouse, France...........	9.8	Brunner.
Upsala, Sweden............	9.8	Steinheil.*
West Point, New York......	9.8	Fitz.*
Leyton (private), England....	10.0	Cooke.
Orwell Park (private), Eng.	10.0	Merz.
Col. Knight " "	10.0	Ross.
Fairford " "	10.0	Merz.
O'Gyalla " Hungary.	10.0	Merz.
Hamburg, Germany.........	10.1	Merz.
Marseilles, France..........	10.2	(?)
Ancetri, Florence...........	10.5	Amici.
Paris, France..............	10.6	Henry Bros.
Constantinople, Turkey......	10.6	Plossl.*
Moscow, Russia.............	10.7	Merz.
Geneva, Switzerland........	10.9	Cauchoix. (?)
Ancetri, Florence...........	11.0	Amici.
Elchies (private)...........	11.0	Ross.*
Columbia College, New York	11.0	A. Clark.
Copenhagen, Denmark......	11.1	Merz & Mahler.*
Munich, Bavaria............	11.1	Merz & Mahler.*
Cordoba, Argentine Republic.	11.2	Fitz.

Observatory or Owner.	*Aperture.*	*Maker of Object-Glass.*
Cincinnati, Ohio............	11.25	{ Merz & Mahler. / Clark & Sons.
Sydney, Australia...........	11.4	Schroder.
Cambridge, England........	11.5	Cauchoix.
Bothkamp......	11.5	Schroder.
Turin, Italy................	11.5	Merz & Son.†
Potsdam, Prussia...........	11.7	Schroder.
Dunsink, Ireland...........	11.8	Cauchoix.
Sunderland (private), Eng...	12.0	Grubb.
Brooklyn (private), N. Y....	12.0	A. Clark.
Middletown University, Conn.	12.0	A. Clark.
Vienna, Austria.............	12.0	A. Clark & Sons.
Lick Obs'y, Mt. Hamilton, Cal.	12.0	A. Clark & Sons.
Paris, France...............	12.2	Secretan.
Oxford University, England.	12.2	Grubb.
Glasgow, Missouri..........	12.3	A. Clark.
Vassar College, New York...	12.3	A. Clark.
Ann Arbor, Michigan.......	12.5	Fitz.
Algiers....................	12.5	Henry Bros.
Lyon......................	12.7	Henry Bros.
Greenwich, England........	12.8	Merz.
Dudley Obs'y, Albany, N. Y.	13.0	Fitz.
Allegheny Obs'y, Pa.........	13.0	Fitz.
Columbia College, N. Y.....	13.0	Ruth'd & Fitz.
Cadiz, Spain...............	13.0	Brunner.
Markree Obs'y, Ireland.....	13.2	Cauchoix.
Hamilton Coll., Clinton, N. Y.	13.5	Spencer & Eaton.
Lisbon, Portugal............	14.6	Merz & Mahler.*
Bordeaux, France...........	14.9	Merz & Son.
Pulkowa, Russia............	14.9	Merz & Mahler.
Nice, France................	14.9	Henry Bros.
Royal Society, England.....	15.0	Grubb.
Harvard Col., Cambridge, Mass	15.0	Merz & Mahler.
Paris, France...............	15.0	Lerebours.
Rio Janeiro, Brazil.........	15.0	(?)
Madrid, Spain..............	15.0	Merz.
Brussels, Belgium..........	15.0	Merz & Son.

Observatory or Owner.	Aperture.	Maker of Object-Glass.
Paris, France..............	15.0	Henry Bros.
Dun Echt, Scotland	15.1	Grubb.
Washburn Obs'y, Mad'n, Wis.	15.5	A. Clark & Sons.
Warner Obs'y, Roch'ter, N. Y.	16.0	A. Clark & Sons.
Vander Zee Obs'y..........	18.0	(?) Fitz. *
Dearborn Obs'y, Chicago....	18.5	A. Clark.
Milan, Italy................	19.1	Merz.*
Strassburg, Germany........	19.1	Merz.
M. Porro, private (?).......	20.5	Porro.*
Buckingham Obs'y (private),	21.2	Buckingham & Wray.*
Etna......................	21.8	Merz.†
Halsted Obs'y, Prin'ton, N. J.	23.0	A. Clark & Sons.
Newall Obs'y, London, Eng..	25.0	Cooke.
McCormick Obs'y, Univ. of Va.	26.0	A. Clark & Sons.†
Washington...............	26.0	A. Clark & Sons.
Vienna, Austria.............	27.0	Grubb.
Paris, France...............	28.9	Martin. †
Nice, "	29.9	Henry Bros.†
Pulkowa, Russia............	30.0	A. Clark & Sons.†
Lick Obs'y, Mt. Hamilton, Cal.	36.0	A. Clark & Sons.†

As might be expected, the mounting of these large object-glasses would present difficulties that might not easily be overcome. One can readily anticipate that the skill of the mechanist might be taxed to make an equatorial mounting heavy enough for stability, and, at the same time, secure that uniform delicacy of motion adapted to the ready and certain measurement of small quantities which high power and large glasses bring to the astronomer's eye. This problem has long been in the observer's mind, and he will watch the trial of these giant telescopes, now in process of construction, with the liveliest interest, to learn if the astronomer can certainly see more and measure better with them than can be done with others of inferior dimensions considering the disadvantages of unwieldy size.

In this direction, it is a pleasure to say that we have greatly profited by a perusal of the late report of Professor Simon Newcomb to the Secretary of the Navy on the recent improvement in astronomical instruments, already previously noticed in these pages. We give place to his remarks in full concerning the great Russian telescope:

"In 1879, Privy Counsellor OTTO VON STRUVE, director of the Pulkowa observatory, visited this country and contracted with the Messrs. CLARK for the construction of an objective 30 inches in aperture. It was completed and delivered during the year 1882. The mounting is now being completed by the Messrs. REPSOLD, of Hamburg. Although still unfinished, I was desirous of gaining all the information possible respecting its construction, and therefore visited Hamburg for the purpose of examining its parts. The following are some essential points in the structure:

"The most striking feature of the instrument will be the absence of friction rollers from the declination axis. With so large an instrument the friction on the declination axis will be too great to admit of the telescope being conveniently turned either by hand or by rope attached to the two ends, as at Washington and Vienna. The quick motion in declination will be given by a system of cog-wheels turned by an axis passing through the polar axis of the instrument and coincident with it. This axis will be turned by a crank at the lower end, or by the observer taking hold of the circumference of a wheel, at choice. Although the turning of the crank is a more convenient motion for the purpose than that of taking hold of the handles of a steering-wheel, I do not consider it so convenient as pulling a rope. This system of wheel-work will also be connected with the axis of a crank at the eye-piece which the observer can take hold of and turn without leaving the eye-end of the telescope. A second crank will be furnished for the motion in right ascension.

"Instead of using a sector for the clock motion the screw will gear into a complete wheel about two meters in diameter. The trouble of having to turn the sector back will thus be avoided. The illumination of the finding circles and the arrangements for reading them will, in their results, be similar to those used on other large telescopes; that is, the arrangement will be such that the observer can read either circle from the eye-piece. The system of illuminating the field wires, micrometer, position circle, &c., though extensively employed in Europe, is so little known in this country that attention should be called to it. The side of the telescope at a convenient distance above the eye-end is pierced by an opening on the opposite side from the declination axis. Through this opening passes a conical tube parallel to the declination axis. At the outer end of this tube is a reflector inclined at an angle of 45 degrees to the axis of the cone, but turning on an axis coincident with that of the cone The illuminating lamp shines upon this reflector and turns upon the same axis with it. It is also hung upon gimbals so as to turn upon a secondary axis coincident with the axis of its own line of light. The result of this arrangement is that the lamp always hangs vertically, whatever the position of the telescope, and that the horizontal beam of rays thrown from it always strikes the mirror at an angle of 45 degrees in such a way as to throw the light directly through the conical tube and into the telescope.

"The slightly divergent beam which fills the cone is divided into two or three concentric portions. One of these is reflected upward to the object-glass, and by reflection from the glass itself illuminates the field of view. Another portion shines upon four whitened surfaces around the sides of the micrometer, by which both sets of wires are illuminated. The portion of light which is not needed for this purpose is so arranged as to illuminate the two verniers of the position circle and the heads of the micrometer. So far as I could judge, the working of this plan leaves nothing to be desired in the way of convenience to the observer.

"Worthy of special attention are the eye-piece micrometers now made by the Messrs. Repsold. They include every contrivance necessary for rapid and convenient use.

"*Support of the polar axis.*—Another important feature, which has been applied by the Repsolds in their other large instruments, is the method of supporting the polar axis. This axis has to bear a large part of the instrument, counterpoises included. As ordinarily made, it is necessarily subject to an end thrust equal, in our latitude, to two-thirds the weight of the instrument. How to support this thrust without interfering with the ease and freedom of motion has been one of the difficult problems in mounting a telescope. In the Repsold instrument the thrust is nearly avoided by supporting the polar axis upon a vertical friction-wheel under the center of gravity of the entire instrument. Counterpoises can be placed at the lower end of the axis so as to balance the instrument upon this wheel. So far as I can judge, this plan leaves nothing to be desired."

The planet *Vesta* was in opposition August 6, 1884.

Investigation of the Repsold Meridian Circle at Strassburg, by Dr. W. Schur.

In the *Astronomische Nachrichten*, No. 2601, Dr. Schur has a very interesting account of the 6-inch Repsold circle, of Strassburg.

Dr. Schur's investigations began in 1882, with the determination of the division errors of the two-minute circle (A. N. 2532,) of the thread intervals, R. A. micrometer screw, etc.

OBSERVATIONS.

Comparison stars for comets, and the comet 1882 I have been observed.

Since August, 1882, the instrument has been regularly used for the observation of the *Moon*, and *Moon*-culminating stars, etc.

In the beginning of 1883, the *mires* were arranged so that they could be observed by day or by night, and the regular observation of the *Sun* and fundamental stars near it were begun.

Two observers participated in the *Sun* observations, one making the pointings, the other at the microscopes. Each limb of the *Sun* was observed over 5 wires, and pointings were made on both N. and S. limbs. The circle was reversed after each pair of *Sun* observations, thus eliminating possible errors in the thread-intervals; and in Decl. the pointings began with N. and S. limbs alternately. α and δ *Urs. Min.* were regularly observed for the determination of the latitude, and for fixing the azimuth of the line joining the *mires*.

The 303 stars for the Southern Zones of the *Astron. Gesell.*, are next to be observed according to the Leyden programme.

The Mires.—A full description of the mounting of the *mires* is given, and the manner of illuminating them is described. The azimuth of the line joining them has been determined from observations of α and δ *Urs. Min.*, both U. C. and L. C.

In the mean the determinations U. C. and L. C. agree within 0ˢ.02. The two determinations on the same day agree to within about 0ˢ.07 from *Polaris*. The azimuths from the two polars observed on the same day, agree in the mean within about 0ˢ.02. Dr. SCHUR attributes some of the changes in the values of this azimuth to the fact that the pivots were not completely in contact with the Y's. It may be mentioned here that 12 pounds pressure on each Y has been found to be enough weight and not too much, with the circle at Madison.

AZIMUTH OF THE INSTRUMENT.

From the assumption of a constant direction of the line joining the *mires*, the azimuth of the instrument has been computed, and is given in tabular form. The azimuth is thus shown to be remarkably constant. The question of a dependence of the constants on temperature is not examined.

NADIR-POINTS.

After a trial of the method, the horizontal-point determinations from levelled collimators have been abandoned, and recourse had to Nadir observations. The pointings on the Nadir are alternately made N. and S. of the instrument, and a constant difference of 0″.11, has been found between the two sets. No trace of this difference has been found at Madison, and at Strassburg it possibly may have been due to the weight of the observer, transferred from one side to another.

The Nadir point itself appears to be quite constant.

It appears that in spite of all precautions, the floor beams of the meridian circle room were in indirect contact with the piers. This has been remedied.

HORIZONTAL FLEXURE.

This constant has been determined to be 0″.13, but the investigation is not completed.

COLLIMATION.

This is determined by a reversal on the collimator, and appears to be pretty constant.

It is worthy of notice that at the Washburn observatory, during 1883, a reticle of spider lines (like that at Strassburg) was used. The collimations are given in *Publ. Washburn Observatory*, Vol. II., p. 61. Since 1884, a glass reticle is employed, and the collimations are even steadier.

THE PIVOTS.

The figure of the pivots has been investigated by a collimator in the prime-vertical, and found to be practically perfect.

THE TEMPERATURE.

A very interesting table of temperatures is given, by which the excellence of the construction of the room is shown. The thermometers in the foundations of the piers have varied between 6° C and 10° C.

The whole investigation shows the instrument and its mounting to be of the highest class.

What is particularly striking, is the frequency of reversals; and also the fact that reflex observations appear to be unusually difficult to make. EDWARD S. HOLDEN.

A list of recent Comets compiled by Dr. LEWIS SWIFT, *of Warner Observatory, Rochester, N. Y.*

From queries that have been made from time to time by our readers, concerning the more recent comets, it has seemed desirable to present a complete list arranged according to the plan of comet catalogues generally, and which is supplemental to the catalogue found in the last edition of *Chamber's Astronomy.* It will be understood at a glance that the pages of the table facing each other belong together, and are read horizontally across both. The blank columns in the last table are left so for the convenience of those who may wish to write in the data received in the future. Especial care has been taken to get the elements correct, yet some data at hand, Dr. SWIFT thinks may not be the best. Any changes observed by those who give particular attention to this branch, that ought to be made, will receive prompt attention if communicated to us.—ED.]

Year.		Perihelion passage.			Long. of perihel-ion.		Long. of node.		Incli-na-tion.		Perihelion distance.
		m	d	h	°	′	°	′	°	′	
1867	i.	Jan.	19	20	75	52	78	35	18	12	1.5725
"	ii.	May	23	22	236	9	101	10	6	24	1.2870
"	iii.	Nov.	6	23	276	21	64	58	83	26	0.3304
1868	i.	April	20	23	116	2	101	14	29	22	0.5968
"	ii.	June	25	23	287	7	53	40	48	11	0.5823
"	iii.	Sept.	14	16	158	10	334	31	13	6	0.3339
1869	i.	June	10	23	275	55	113	33	10	48	0.7815
"	ii.	Oct.	9	18	123	24	311	29	68	23	1.2306
"	iii.	Nov.	20	19	41	17	192	40	6	55	1.1026
1870	i.	July	14	1	303	32	141	44	58	12	1.0087
"	ii.	Sept.	2	12	17	49	12	56	80	34	1.8171
"	iii.	"	23	0	318	41	146	25	15	39	1.2808
"	iv.	Dec.	19	21	4	8	94	44	32	43	0.3892
1871	i.	June	10	14	141	49	279	18	87	36	0.6543
"	ii.	July	27	0	115	43	211	56	78	0	1.0835
"	iii.	Nov.	30	0	116	5	269	17	54	17	1.0301
"	iv.	Dec.	20	8	147	2	264	30	81	36	0.6944
"	v.	"	28	18	158	12	334	33	18	8	0.3329
1872	i.	Oct.	6	4	109	45	245	50	12	22	0.8600
1873	i.	May	9	1	237	39	78	45	9	44	1.7695
"	ii.	June	25	9	306	10	120	54	12	43	1.3445
"	iii.	July	18	12	50	3	209	39	11	22	1.6826
"	iv.	Sept.	10	19	64	26	230	38	96	0	0.7944
"	v.	Oct.	1	19	50	28	176	43	121	29	0.3849
"	vi.	"	10	12	116	6	101	16	29	23	0.5935
"	vii.	Dec.	1	6	85	43	250	20	30	1	0.7345
1874	i.	Mar.	9	22	300	36	31	31	58	17	0.4394
"	ii.	"	13	23	245	53	274	7	148	25	0.8860
"	iii.	July	8	21	271	6	118	44	66	21	0.6758
"	iv.	Aug.	86	20	344	8	251	30	41	49	0.9827
"	v.	July	17	17	5	26	215	51	34	8	1. 690
"	vi.	Oct.	18	17	298	47	218	38	99	26	0.5197
1875	i.										
1875	ii.										

Eccentricity.	Direction of motion.	Calculator.	Discoverer.	Name of Comet.
0.8490	D	Searle	Tempel	
0.5196	D	Sandberg	"	Tempel's I.
	R	Oppolzer	Bucker	
0.8081	D	Bruhns	Tempel	Brorsen's
	R	Plummer	Winnecke	
0.8491	D	Von Asten	"	Encke's
0.7519	D	Oppolzer	"	Winnecke's
	R	Oppenheim	Tempel	
	D	Bruhns	"	
	R	Dreyer	Winnecke	
	R	Hind	Coggia	
0.6349	D	Leveau	Winnecke	D'Arrest's
	R	Schulhof	"	
0.9978	D	Holetschek.	"	
	R	Schulhof	Tempel	
0.8210	D	Fischer	Borelly	Tuttle's
	R	Schulhof	Tempel	
0.8493	D	Glasenepp	Winnecke	Encke's
0.7559	D			Biela's
0.4620	D	Sandberg	Temple	Tempel's I.
0.5441	D	Plummer	"	Tempel's II.
0.5774	D	Moller		Fay's
	R	Weiss	Borelly	
	R	Weiss	Henry	
0.8089	D	Plummer		Brorsen's
	D	Weiss	Coggia	
		Schulhof	Winnecke	
	R	Weiss	"	
		Schulhof	Coggia	
0.9987		Gruber	Borelly	
0.9622	D	Holetschek.	Coggia	Winnecke's
		Holetschek.	Borelly	Encke's

Year.	PP.	π—☊	Long. ☊	*i.*	Log. *q.*
		° ′	° ′	° ′	
1877 i.	Jan. 19.225	347 16	189 20	153 1	9.9071
" ii.	Apr. 17.712	63 9	316 37	121 .8	9.9777
" iii.	Apr. 26.865	116 47	346 4	77 .9	0.0040
" iv.	June 27.093				
" v.	June 27.093	103 19	184 16	115 41	0.0301
" vi.	Sept. 11.408	143 21	250 58	77 42	0.1977
1878 i.	July 21.263	178 02	102 18	78 1	0.1433
" ii.					
" iii.					
1879 i.					
" ii.					
" iii.	Apr. 28.037	3 5	45 34	107 0	9.9489
" iv.	Oct. 4.600	115 19	87 07	77 6	9.9959
" v.	Aug. 29.279	84 10	32 22	107 45	9.996
1880 i.	Jan. 27.611	82 20	359 58	143 34	7.822
" ii.	July 17.184	158 46	260 0	122 35	0.216
" iii.					
" iv.	Sept. 6.963	323 17	45 6	141 50	9.553
" v.	Nov. 18.597	106 17	296 46	5 24	0.027
" vi.	Nov. 9.408	13 21	249 39	60 41	9.830
1881 i.	May 20.597	174 36	125 1	78 51	9.769
" ii.	June 16.370	360 33	270 58	63 26	9.867
" iii.	Aug. 22.774	122 12	96 26	139 50	9.800
" iv.	Sept. 13.829	9 8	269 24	113 47	9.694
" v.	Sept. 12.834	112 1	66 9	6 53	9.860
" vi.	Sept. 14.144	6 21	274 11	112 48	9.652
" vii.					
" viii.	Nov. 17.407	116 30	180 59	144 58	0.284
1882 i.	June 10.308	209 21	204 43	73 .39	8.769
" ii.	Sept. 17.275	69 29	345 58	141 59	7.882
" iii.	Nov. 13.035	254 22	249 7	96 11	9.980
1883 i.	Feb. 20.202	113 19	77 33	280 4	9.879
" ii.					
" iii.					
" iv.	Jan. 25.047	199 20	253 57	74 41	9.878
1884 i.	'83 Dec. 25.34	138 39	264 25	114 59	9.491
" ii.					

Calculator.		Discoverer.		Name of Comet.
Hartwig.		Borelly		
Plath.		Winnecke		
Nichol.		Swift		
				D'Arrest's
Ginzel.		Tenpel		
Plummer.		Coggia		
Holetschek.		Swift		
				Encke's
				Tempel's, II
				Brorsen's
				Tempel's, I
Winnecke.		Swift		
Zelber.		Palisa		
Hartwig.		Hartwig		
Oppenheim.		Gould		
"		Schaeberle		
				Fay's
Oppenheim.		Hartwig		
Chandler.		Swift		Swift's
Chandler.		Pechule		
Zelber.		Swift		
Frisby.		Tebbutt		
Hepperger.		Schaeberle		Encke's
Oppenheim.		Barnard		
Chandler.		Dennning		Denning's
"		Barnard		
				Encke's
Boss.		Swift		
Egbert.		Wells		
Fabritius.		Finlay		
Zelber.		Barnard		
Hepperger.		Brooks		
				D'Arrest's
				Tempel's, II
Oppenheim.		Pons-Brooks		Pons-Brooks'
"		Ross		
		Barnard		

ASTRONOMICAL CLOCKS.*

In most astronomical work of the first class, especially in meridian observations, the perfection of the clock is as necessary as that of any other instrument. But it seems to be an observed fact that no certain way has yet been found of securing an approach to perfection in the rate of the clock. All we can say is, that clocks of marvelous excellence are now and then made, sometimes by one maker and sometimes by another, and that of these clocks some are permanently good while others, in the course of time, deteriorate. I found a few examples of clocks preserving their rate with remarkable uniformity through considerable periods. One of these is the Normal clock of the Berlin observatory, made by TIEDE. It is inclosed in an air-tight case in order to prevent changes of rate arising from variations in the barometric pressure. The temperature compensation is unfortunately imperfect, so that the rate is subject to an annual change. This fact has prevented the exact discussion to which I desired to subject it. It would seem, however, from a cursory examination, the materials for which were courteously afforded me by Professor FORSTER, that the annual change from temperature does not exceed 10 or 15 seconds per year, and that when this is allowed for the differences between the actual and the computed errors will be a very few seconds per year. In recent times the clocks furnished by HOWHU, of Amsterdam, have secured a reputation for uniform excellence which has never been surpassed; that is, instead of being able to occasionally turn out a clock of remarkable excellence, all the clocks of this artist, so far as they have been discussed, are of the first class.

The following exhibit of the observed and computed errors of one of his clocks through a period of nearly two years has been selected, not from a belief that this particular clock was better than others, but because the data for the examination were at hand:

* From Prof. NEWCOMB's report on improvements in astronomical instruments.

Comparison of the observed and computed corrections of Clock Howhu 2:, at the observatory of Leyden, 1865, December 1, to 1867, October 25.

[FORMULA FOR COMPUTED DAILY RATE: $+0^s.759-0^s.03642\ (T-14°) +0^s.0106\ (B-760^{mm})$.
T=temperature, cent.:
B=height of barometer.]

	CORRECTION.		
	Observed.	Computed.	Difference.
1865.	s.	s.	s.
December 1	20.9	20.9	0.0
29	56.3	54.8	+ 1.5
1866.			
January 26	89.1	84.2	+ 4.9
February 23	119.8	112.1	+ 7.7
March 30	161.1	148.0	+13.1
April 27	188.9	172.5	+16.4
May 25	215.3	195.5	+19.8
June 29	236.5	216.0	+20.5
July 27	249.7	231.7	+18.0
August 31	265.0	252.3	+12.7
September 28	277.9	270.0	+ 7.9
October 26	297.4	293.4	+ 4.0
November 30	327.8	326.5	+ 1.3
December 28	356.9	355.9	+ 1.0
1867.			
January 25	385.2	386.5	— 1.3
February 22	414.3	416.1	— 1.8
March 29	452.2	454.5	— 2.3
April 26	476.1	479.1	— 3.0
May 31	505.8	505.3	+ 0.5
June 28	524.7	522.9	+ 1.8
July 26	540.8	539.4	+ 1.4
August 30	559.9	559.5	+ 0.4
September 27	575.4	577.2	— 1.8
October 25	594.6	600.6	— 6.0

In this connection I may be allowed to call attention to the unsatisfactory character of the data usually presented for estimating the excellence of clocks. In my judgment the estimate of the clock should be founded upon its errors, determined from time to time through a period of not less than a year. These errors should be exhibited in connection with the mean temperature of the clock-room, and if the clock is not in an air-tight case the height of the barometer should also be given. A calculated error should then be carried through the whole period, in which the corrections for temperature and height of the barometer should be introduced. A clock which stands this test well may be presumed beyond doubt to keep its rate during short intervals, which is generally the important point.

It is very common to present as sufficient data for judging of a clock and exhibit of its daily rates from time to time. If these rates were really determined with the last degree of accuracy they might be sufficient for the purpose. But as found in practice they will be the result, not merely of the actual rates of the clock, but of various personal differences among the observers and changes in the pointing of the instrument as well as the accidental errors of observation. From these causes, although the clock were perfect, we might expect an apparent difference of several hundredths of a second between the apparent rate on successive days.

The barometric change in the rates of all clocks of the usual construction is so important a drawback that it should no longer be tolerated in work of the first class. Two methods have been proposed; the one, that already mentioned, of inclosing the clock in an air-tight case; the other, to supply it with a barometric compensation. The latter method is undoubtedly the easiest, but where the necessary perfection of arrangements can be secured the former must be considered greatly preferable. The grounds of preference are that the air can be exhausted from the case to any extent, thus diminishing its resistance to the motion of the pendulum and permitting a diminution in the driving power. Again, if, instead of air, the case be filled with some gas which does not act on the oil, the slow oxidation of the latter may be prevented. It may therefore be expected that under this system a clock could be allowed to remain undisturbed for a longer period than under any other.

How Time Observations are taken with a small Transit at Carleton College Observatory.

By a small transit instrument is meant one whose clear aperture is from two to three inches, and is usually portable, with or without reversing apparatus.

A few suggestions are offered in respect to a convenient way for observing stars to determine the error of the sidereal clock, for the amateur, or for the experienced timekeeper who does not care to go through the usual reductions for each star observed, whenever the clock-error is to be examined. It is supposed that the student understands the theory of the transit instrument well enough to determine accurately the azimuth, collimation and level errors, and that this has been done after placing the instrument in the meridian as nearly as possible. We will assume for the present that other instrumental errors are so small by the skill of the maker, that they need no attention. The observer then determines the equatorial intervals of the wires of the eye-piece as carefully as possibe, by repeated observations of a close circumpolar-star, and writes out the results in convenient tabular form, in the time observing-book, for easy reference, for they will be frequently needed. He then must refer to the *American Ephemeris*, and should have the *Berliner Astronomische Jahrbuch*, which give the mean and apparent places of a large number of well determined stars, from which he can select stars, and group them in sets of four each, according to the plan which is herein to be given.

If the errors of the instrument before named, (azimuth, collimation and level) are small, four stars may be chosen, and their observations so combined, as to reduce these errors so much that they will be wholly unappreciable. The set should consist of two pairs of stars, each pair containing a north and a south star.

The following rough table will suggest the zenith distances of the members of each pair at the place of observation, which will destroy instrumental errors, as before indicated:—

TABLE.

S. Z. D.	N. Z. D.
°	°
0	0
6	5
14	10
25	15
41	20

For this purpose, a star whose south zenith distance is 6° should be observed with one whose north zenith distance is 5°. A south zenith distance of 25° corresponds to a north zenith distance of 15°, and so on throughout the above table. It is undesirable to choose stars for time of greater zenith distance, either north or south, than those of 20° and 41° respectively, for the same reasons that such stars are avoided in other methods, unless observed by fixed instruments whose errors are known.

The best way to illustrate the working of this method is to take a set of stars in use at this observatory, find their *a, b, c* factors in the ordinary way, and then combine their equations of condition, so as to deduce a single new equation in what *a, b* and *c* are practically zero.

The latitude of this observatory is 44° 27′ 40″.8, and its longitude $1^h\ 4^m\ 23^s.8$ west of Washington. One of the star groups used for determining the error of the sidereal clock at the present time is as follows :

Mag.	Name.	*a*	*b*	*c*	*h*	Time.	
					° ′	h m	
2.6	*β Draconis*	+0.226	+1.623	+1.638	82 5	17 28	N.
3.3	*μ Herculis*	—0.324	+1.083	+1.130	73 20	17 42	S.
4.0	*θ Herculis*	—0.157	+1.247	—1.256	82 48	17 52	S.
2.3	*γ Draconis*	+0.197	+1.594	—1.606	82 57	17 54	N.

The mean gives — 0.014 + 1.387 — 0.023.

The resulting equation would then read : $T = -0.014a + 1.387b - 0.023c$, in which T is the mean of the observed errors of the four stars, and the signs of the co-efficients of *a* and *c* have been previously determined by circumpolar star observations, or other common methods, and are applied to the stars on any particular occasion as the position of the instrument requires. As the signs are entered in the example above, it is evident that when the transit points south of the zenith, it is also pointing west of the meridian which is indicated by the minus sign. Whatever the error of azimuth is it should be subtracted from the apparent star time to give the true time if only one star, were observed. When the instrument is pointing north of the zenith the sign of azimuth changes, as every one knows, because the great circle of azimuth intersects the meridian in the zenith and nadir points if no other errors exist. The instrument is not reversed in taking the first two stars, hence the sign of collimation will be the same for both, and in the exercise above it is known to be plus, and in this position the instrument under consideration swings in a small circle east of the meridian. Between the second and third stars the transit is reversed which, of course, changes the sign of collimation for the two following stars while the signs for azimuth remain the same. If the level error, represented by *b*, is nearly or quite eliminated at the outset, and remains unchanged throughout the observation of the four stars, no attention is paid to it. It is best, however, to test the level of the instrument before or immediately after observing each star, and when a level correction is necessary apply it as in any other case, for the manner of observing and relating the stars gives no aid in destroying this error, as any observer will readily see.

On the evening of August 14, the above stars were observed for time by the assistant at this observatory, Miss Mary E. Byrd, and the observed clock-error by each star was as follows :

β	*Draconis*	$-35^s.27$
μ	*Herculis*	-35.22
θ	*Herculis*	-35.81
γ	*Draconis*	-35.90
	The mean	-35.55

In as much as the level was steady within a half division during the entire observation, there was no appreciable correction to apply on this account, though it is to be noticed that small level errors would give nearly maximum effects because three of the stars have small zenith distance.

Now if we take the observed time of each of these four stars and apply to it the instrumental errors of collimation and azimuth, we have the following results:

Star.	Obs. Error.	*a*	*c*		Corr't Error.
β *Draconis.*	—35ˢ.27	+0ˢ.07	—0ˢ.33	=	—35ˢ.53
μ *Herculis,*	—35.22	—0.10	—0.22	=	—35.54
θ *Herculis,*	—35.81	—0.05	+0.25	=	—35.61
γ *Draconis,*	—35.90	+0.06	+0.32	=	—35.52

The mean of the corrected observations is —35.55

It is of course accidental that the mean of the corrected observations in this example is the same to a hundreth of a second as the mean of the uncorrected ones, for the errors of observation certainly would not warrant so close an agreement of values generally. It should, however, be said that the above set of stars is not especially well or ill related, as will be seen by examining the final equation of condition. It works only fairly well. It is also true that the observations of August 14, were taken for this illustration only because they were the last taken preceding this writing and were consequently at hand for the purpose. That night was unfavorable for observation. The stars were "woolly" and unsteady, so that the middle wire of a group of seven was corrected in the observation of each star as much as one-tenth of a second, which is considerably larger than ordinary observing gives.

The instrument used was a transit of three inches aperture, by Messrs. FAUTH & COMPANY, Washington, D. C., and is only in fair condition for work. Its azimuth error is about 0ˢ.3, while the error of collimation varies only a little from 0ˢ.2. These errors were obtained by taking the mean of many observations of the *Sun*, circumpolar-stars, and high and low stars. Fairly good results were obtained. The reductions given above were all made by the use of the ordinary formulæ:

$$R.\ A. = T + dt + a . \frac{\sin\ (\varphi - \delta)}{\cos\ \delta} + b\ \frac{\cos\ (\varphi - \delta)}{\cos\ \delta} + \frac{c}{\cos\ \delta}$$

in which,

R. A.=the right ascension of the star.	a=azimuth.
T=observed time.	b=level error.
dt=correction for error of clock.	c=collimation.
	φ=latitude.
	δ=declination.

The rate of the sidereal clock was $-0^s.25$ per day and hence *dt* would be too small to take notice of during less than one hour's observation.

Star-sets like the one given above, may be arranged for every month in the year, and when put in convenient form very much simplify the labor of accurate time-keeping under almost any circumstance now in mind in connection with important observatory work.

Professor H. A. Howe of the University of Denver, some time ago called our attention to these points. The method may be in use elsewhere; if so, we are not aware of it.

THE DOUBLE-STAR 85 PEGASI.

We have in this one of the most interesting binary systems in the heavens. Its discovery * is attributed to the French astronomer, Flammarion, at whose request I began, at Chicago the study of the double, by measure, and its motion is rapid as one may see:

MEASURES OF THE TWO REMOTE STARS A=6.; C=9.0.

Epoch.	Angle.	Distance.	
	°	"	
1855.00	105.0	30.0	Argelander.
1870.00	77.0	16.0	Brunnow.
1877.94	49.8	14.0	Flammarion.
1878.54	33.6	14.4	Burnham.
1879.27	30.4	15.0	"
1880.57	25.0	15.4	"
1881.54	20.8	16.3	"
1882.77	17.1	17.3	"

* The history of this discovery is curious on account of more than one claim. But perhaps Mr. Burnham does not yet know the precedence, at least he may not have read the printed note on page 172 of our work, *The Stars*.

It was in seeking the measures asked by the French astronomer that I discovered the companion of the principal star. This couple is very close and very difficult, even with the 18½-inch equatorial ($0^m.47$). These are the measures:

MEASURES OF THE CLOSE COUPLE. A=6; B=11.

Epoch.	Angle.	Distance.	
	°	″	
1878.73	274.0	0.67	Burnham.
1879.46	284.6	0.75	"
1880.59	298.3	0.65	"
1881.54	311.5	0.58	"
1882.	in contact.	meas. impossible.	"
1883.75	333.	in contact.	"

These measures show already nearly 60° of revolution since 1878. At this rate the entire period will require only 30 years for completion. This is one of the shortest periods we know of among the systems of double-stars.

S. W. BURNHAM,
Astronomer at Chicago.

Remark.—This close couple forms a physical system in rapid orbital motion. On the contrary, the more distant star is independent of this pair, and will always remain stationary. It was employed in 1870 by the Astronomer BRUNNOW, as a point of reference in measuring the annual parallax of the star 85 *Pegasi.* The parallax was found to be only 0″.054, which gives the distance about 3,805,000 times the radius of the Earth's orbit, or about 129 *trillions* of leagues. At the rate of 75,000 leagues per second, it would require not less than 64½ years for light to reach us from it. If this parallax were certain (but it is so very small that it is uncertain,) and if the mean distance of the small star were about 0″.7, as an element of the absolute orbit, the period of thirty years would give for the mass of this system compared with the *Sun*:

$$\text{Distance A B} = \frac{0.7}{0.054} = 12.9$$

(the radius of the Earth's orbit being 1).

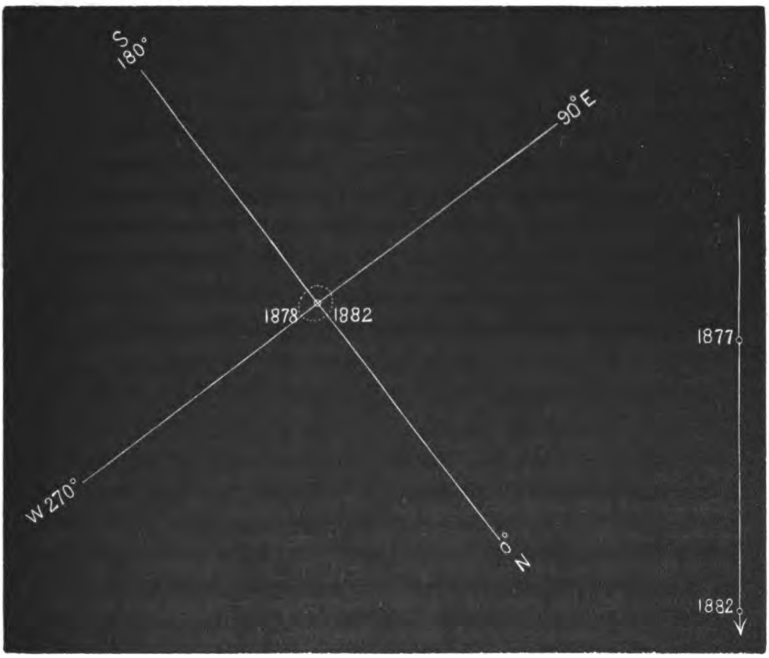
$T = \sqrt{(12.9)^3} = 46.4$ years for one planet of our system.

$$\frac{46.4}{30}=1.55$$

$$\mu=(1.55)^2=2.40.$$

This small system will accordingly be two and one-half times the mass of the *Sun*. But evidently this is only the first very premature approximation.

The discovery of the learned American astronomer, however, reveals, at once, a new world before which the whole Earth is only a shadow.



The Binary System of the Double-Star 85 Pegasi and distant star.
(Scale: $4^{mm}=1''$)

This group is represented in the (accompanying) figure by a scale of 4^{mm} to $1''$. The arrow indicates the motion of the distant star in perspective from the first special measure made by us in 1877 to the last made by Mr. Burnham in 1882.

In reality, it is not the star that moves: it is the binary system that moves in an opposite direction.—*L'Astronomie.*

C. F.

EDITORIAL NOTES.

We issue No. 27 for September, this year, ahead of time, that hereafter the volume may begin with January which doubtless will be agreeable to all concerned.

W. F. DENNING discusses the great red spot of *Jupiter* in the August number of the *Astronomical Register*. During the opposition just past the motion of the spot as observed at Bristol, England, is about the same as noticed at the previous opposition of 1882–3, so that now there appears to be no increase in retrograde motion, in longitude, as was seen from 1879 to 1882, but on the contrary its motion is uniformly retarded. The spot is still visible, but faint, especially in its outlines. It is a singular fact noticed by Mr. DENNING, that as the spot has grown faint during the last two years its retrograde motion has been diminishing.

Professor HOUGH of Dearborn observatory, who has given special attention to the markings of *Jupiter*, observed the outlines of the great spot in May last, and speaks of them as being sharply defined still and entirely separate from any belt. It is certain that its color is very much fainter than when first seen in 1878. It is possible, as Professor HOUGH suggested in 1883, that this is the same spot that has appeared and vanished eight times between 1665 and 1708. "In 1664–6 a great red spot was observed by HOOK and CASSINI. It was situated one-third of the semi-diameter of the planet south of the equator in latitude 6″. Its diameter was one-tenth of the diameter of *Jupiter*, or about 8000 miles. * * * If the ancient observation extending over half a century refers to the same object, we would naturally infer that it was a portion of the solid body of the planet; being sometimes rendered invisible by a covering of clouds."

Mr. DAVID GILL, astronomer at the Cape, in a late lecture at the Royal Institution on "Recent Researches on the Distances of the Fixed Stars," etc., as reported by the *Astronomical Register*, said:

"Art is long and life is short," and that in the long run careful observations are superior to the most brilliant speculations. He would not, however, undervalue the imaginative mind which seeks after truth; for without it no man was fitted for the work to be done, or can be sustained during the watches of the night in his noble labor of love.

Speaking of the history of stellar parallax he said that previous to 1832 the parallax of no fixed star had been rendered sensible. Between 1835 and 1838 the parallax of *a Lyræ* was found to be one-fourth of a second of arc, a quantity as difficult to determine as it would be to measure a globe one foot in diameter at a distance of eighty miles.

It was also said that the earth's orbit from the star 61 *Cygni* would appear as small as a silver three-penny a mile away.

"These early measurements were taken by ascertaining the changes of position of certain stars in relation to each other; but the first to make a direct measurement of their parallax was HENDERSON of the Cape observatory; the second was BESSEL. Of late years Dr. GILL and a young American astronomer, Dr. ELKIN, had been measuring the distances of some fixed stars in the southern hemisphere by means of a telescope with a divided object-glass (heliometer), and with the following results as expressed in the number of years in which light travels from them to the earth: *Alpha Centauri* 4.36 years; *Sirius* 8.6; *Lacaille* (9352) 11.6; *Epsilon Indi* 15.0; o² *Eridani* 19.1; *Epsilon Eridani* 23.0; *Xi Toucanæ* 54.0. So far as observations have yet gone *a Centauri* is the nearest of the fixed stars, and eye-observations as to the relative brilliancy of stars are no guide to their relative true distances."

It is further stated in the *Astronomical Register* for August that Dr. GILL believes with Mr. LOCKYER that the future progress of this branch of astronomy will depend much on photography. It is estimated that it would take ten years to make a complete photographic map of the heavens, and it is said, that Dr. ELKIN is willing to do the work in the northern hemisphere, and Mr. GILL in the southern, if the necessary apparatus can be supplied.

In the matter of parallax of the stars the results of careful study of *a Lyræ* and 61² *Cygni* by Professor HALL of the Washington observatory, from observations of 1880 and 1881 may be properly appended. They are as follows:

a Lyræ	18.11	Julian years.
61² *Cygni*	6.803	" "

The parallax of the former was found to be 0".1797; of the latter 0".4783.

DR. DUBJAGO of the observatory at Pulkowa, has published the first orbit that we have seen, for Mr. BURNHAM'S binary star, *Beta Delphini.* Since 1873, the time of its discovery, more than 180° of the orbit have been described. The entire period as found by Dr. DUBJAGO is 26.07 years. There are but two known double-stars with less period than this. They are 42 *Comæ Berenices* whose time is 25.71 years, and *Delta Equulei* to which Mr. BURNHAM gives the marvelously short period of 10.8 years. The study of the binary and multiple star systems is intensely interesting.

E. E. BARNARD of Nashville, rightly enjoys another triumph which has come from skill and care in observation. It will be remembered that we have often spoken of the small star preceding *Beta Capricorni* which Mr. BARNARD observed some time ago while it was being occulted by the *Moon.* The strange appearance it presented during the phenomenon led him to believe that it was a close double-star, but his instrument was too small to divide it. It was also tried by some large telescopes, though under unfavorable circumstances, and its duplicity was not made out, so that several good observers were inclined to think that Mr. BARNARD'S explanation of the star's appearance was wrong.

As the star came into favorable position this year, it was examined by Professor HOUGH and Mr. BURNHAM of Dearborn observatory, Chicago, during the last days of July, and by the aid of the 18½-inch refractor it was clearly seen to be double. The measures given by the above named observers are:

Position Angle 108°.6
Distance 0".86

BRORSEN'S Comet of short period is again near the time of its perihelion passage. We have seen no published ephemeris of its return. It is stated in a recent copy of *Nature*, "that the perturbations since its last appearance in 1879, will not have been very material, and the mean motion of that year would fix the time of the approaching perihelion passage near September 14.5 G. M. T. If the longitudes of Dr. SCHULZE'S orbit for 1879 are brought up to 1884.75, the following expressions for the comet's heliocentric co-ordinates result:

$$x=r[9.94286]\sin(v+207^\circ\ 56'.7)$$
$$y=r[9.98506]\sin(v+126^\circ\ 22'.0)$$
$$z=r[9.73705]\sin(v+60^\circ\ 33'.4)$$

Taking September 14.5 for the epoch of perihelion passage, the comet's approximate positions are:

12h. G. M. T.	R. A.	Decl.	Distance from Earth.	Sun.
	h. m.	° ′		
August 24	7 58.0	+10 37	1.284	0.720
" 26	8 11.0	11 10		
" 28	8 24.2	11 40	1.295	0.679
" 30	8 37.5	12 8		
Sept. 1	8 51.0	+12 33	1.312	0.644

If we suppose an acceleration of four days in the time of perihelion passage, the effect on the geocentric position is:

On August 16 in R. A. +15m.1; in Decl. +2° 1′
On August 28 in R. A. +16 .7; in Decl. 1 41

In 1873 when the circumstances approached nearest to those of the return of the present year, the comet was detected at Marseilles, on the morning of September 2, the distance from the earth being 1.02, and that from the *Sun* 0.94, the intensity of light 1.08. At the last appearance it was seen by TEMPEL at Arcetri, on January 14, when the intensity of light was only 0.13, an exceptional case, since at no previous appearance had it been observed under less value than 0.33.

From the first discovery of the comet in 1846 by BRORSEN, an astronomical amateur at Kiel, the period of revolution has gradually diminished from the effect of the planetary perturbations; subjoined are the times of perihelion passage in those years when the comet has been observed, and the sidereal periods corresponding to those times:

				Days.
1846	Feb.	25.37	G. M. T.	2034.1
1857	March	29.25	"	2022.7
1868	April	17.41	"	2002.4
1873	Oct.	10.48	"	1944.4
1879	March	30.54	"	1994.9

From its unfavorable position the comet was missed at its returns in 1851 and 1862.

It is well known that the present orbit was due to the action of the planet *Jupiter* in 1842: at the perijove passage at 6 P. M. on May 27 in that year, the comet's distance from *Jupiter* was 0.0547 of the earth's mean distance from the *Sun*; consequent on its near approach the inclination of the orbit in which it previously moved was diminished nearly 15° according to the calculations of Dr. HARZER, who has very fully investigated the consequences. It is probable that there had been a great perturbation in the elements from the same cause in 1759–60, and that in 1937 (according to D'ARREST) this may occur again."

The last volume (47) of the Memoirs of the Royal Astronomical Society is at hand. It contains the following important papers:

1. On the *Moon's* photographic diameter, and on the applicability of celestial photography to accurate measurement, by Professor C. PRITCHARD.

2. Observations of the transit of *Venus*, 1874 Dec. 8–9, Colony of Victoria, Australia, communicated by R. L. J. ELLERY, Government astronomer.

3. (Title same as last); made at stations in New South Wales; communicated by H. C. RUSSELL, Government astronomer, Sidney.

4. (Title as above); made at Windsor, New South Wales, by JOHN TEBBUTT.

5. (Title as above); made at Adelaide, New South Wales, by CHAS. TODD.

6. (Title as above), as observed at Mooltan, Punjab, India, by A. C. BRIGG-WITHER.

7. (Same as given above); made at the Cape of Good Hope; communicated by E. J. STONE, Royal astronomer at the Cape.

8. Measures of SIR JOHN HERSCHAL'S Cape stars together with a list of new double-stars, by H. C. RUSSELL.

9. Double-star observations made in 1879 and 1880 with the 18½-inch of the Dearborn observatory, Chicago, by SHERBURNE WESLEY BURNHAM.

10. On solar motion in space, by WILLIAM E. PLUMMER.

11. Photometric determination of the relative brightness of the brighter stars north of the equator, by Prof. C. PRITCHARD.

The volume has five full-page plates illustrating phenomena attendant upon the transit of *Venus*, and closes with a list of persons to whom the medals or testimonials of the society have been adjudged.

The treatment of photography as a means of accurate measurement, in the first paper of this volume is clear, full and very conclusive.

As a simple illustration of how this means of measuring was studied to give knowledge of its accuracy, and therefore confidence in it, we notice one table shows that a large number of micrometric measures were taken between prominent points widely separated on the lunar surface (arbitrarily and variously selected), and that these measures were compared with those of the corresponding points in the image impressed on the photographic film. And it was shown by the small residuals in the comparison, that "the photographic film and the visual telescopic image were for all purposes of measurement interchangeable." The photographs were taken and the measures made which were intended for comparison by different instruments and at times as nearly simultaneous as possible.

The points carefully studied in this valuable paper are:

1. The reliability of instrumental means and of the angular measures obtained therefrom.

2. The reliability of telescopic fields over which the measures extend.

3. The practical identity of the photographic image with the telescope image itself.

4. The effect of the irregularities on the *Moon's* limb.

5. The effect, if any, of temperature, time of exposure, motion of the *Moon* in declination, altitude of the *Moon*, or of any other suspicious circumstances, likely to modify the image impressed on the film.

Volume II of the publications of Washburn observatory is at hand. It is a companion to volume one in appearance, though much larger, as it contains nearly 400 pages. Large space is given to the study of the new REPSOLD Meridian Circle, in which every important part of that instrument apparently has been tested by severe trial and rigid scrutiny. We have before spoken favorably of the way the work of the REPSOLDS on this instrument has so far stood the tests to which it has been subjected during the last year.

The Hohwu sidereal clock is the standard for other time-pieces of the observatory and the extended time service given to railway and telegraph companies. This clock, though lacking in some minor adjustments at the present time, is apparently one of excellence, as will be seen from a comparison of computed and observed rates, in one hundred cases from January, 1882, to December, 1883, in which it is shown that the sum of the one hundred residuals taken without regard to sign was 14s.28, giving an average residual of 0s.14. This is a surprisingly accurate record for a new or old time-piece. Professor HOLDEN also states that the average daily error of railway time-signals was

For	September, 1883,	0s.08
"	October, "	0.07
"	November, "	0.11
"	December, "	0.06

This interesting report also gives a list of one hundred and eleven new double-stars and two nebulæ encountered in the sweeps from September, 1881, to January, 1884. Observations of one hundred and nineteen red or colored stars between 1881, Dec. 26, and 1883, Dec. 31, being a continuation of work reported in Vol. I.; occultation of forty stars by the *Moon*; the reduction of the star-gauges of Sir WILLIAM HERSCHEL to 1860.0, (first series Nos. 1—683); tables showing the counts of stars from the manuscript charts of Dr. C. H. F. PETERS, Professor J. C. WATSON and from CHACORNAC'S charts compiled by Dr. PETERS; an interesting paper by Mr. GEORGE C. COMSTOCK, on a new method of observing with the Prime Vertical transit; investigations of the micrometer of the fifteen-inch equatorial by Mr. JOHN TATLOCK, and a full series of meteorological observations at Madison during 1882–1883.

From the annual report of the Observatory of Paris which is just received, some interesting facts pertaining to the work of 1883, are presented. In the department of meridian service, special attention has been given to the observation of the stars of LELANDE'S catalogue. In addition to this, the large planets, minor planets, comparison stars for equatorial work and the *Moon* have been observed. Four meridian instruments have been employed in this service. Special study of the errors of the new circle one of the meridian instruments, began in December, 1882, and ended in July, 1883. The fundamental positions of 60° and 120° have been examined three hundred times, those from 20° to 20° forty times, from 5° to 5° thirty times, from degree to degree twenty times, and finally the positions of 5°, six times. Flexure has been carefully determined.

During the year the GAMBEY telescope has been furnished with a zenith collimator for the purpose of determining collimation in zenith position, and consequently, the lateral flexure as ascertained by comparing the values of collimation at the zenith and horizon.

Curious experiments were made with what is called a bath of mercury amalgam. A square basin of silvered copper 0m.15 on the side, with layer of mercury 0mm.6 deep, showed that jars from the street and in the room scarcely affected the mercury. The only inconvenience resulting from its use was the fact, that the mercury amalgam was somewhat dull and its power of reflection was diminished. The surface seemed to be normal, and this device was used even with portable instruments.

The two large equatorials in use at this observatory are respectively 14 and 12 inches. The larger instrument has been repaired, and is now provided with new and needed attachments. With the smaller instrument, Mr. BIGOURDAN has observed 150 days in nine months. The objects studied were the Great Comet of 1882, Comet Brooks, Comet Pons-Brooks, and eleven of the minor planets, besides 400 observations of double-stars, occultations and eclipses of *Jupiter's* satellites. The report also gives considerable space to meteorology, meteorological instruments and local observations with the same.

The *Oakland Daily Evening Tribune* (Aug. 9), contains a long article particularly descriptive of the great observatory founded by Mr. JAMES LICK and located on Mt. Hamilton, Cal. Later important parts of this description will be given; we now have space only to notice what is said about the costly glasses which will distinguish the great equatorial as by far the most powerful refracting telescope in existence. The writer says: "On the extreme end and south of the observatory building will be the dome of the great 36-inch equatorial. The diameter of the dome will be 70 feet; the length of the instrument 60 feet, and the cost of the same $101,000. FEIL & Co. of Paris, sub-contractors with ALVAN CLARK & SONS, have succeeded in casting one of the disks which is now being worked by the CLARKS at Cambridgeport, Mass., but the Paris contractors after trying nineteen times to cast the second disk have not yet been successful. The cost of the object-glass when ready for its place in the telescope will be $51,000, and the probable cost of the mounting will be an additional $50,000, making a total as given above."

A curious phenomenon was noticed on the evening of July 30, by many residents of the neighborhood of Philadelphia. Several independent accounts have been forwarded. Perhaps it can be best described by the following letter written by an intellegent doctor of Atlantic City, N. J.:

"About five minutes before 10:00 in the evening I first saw what for a few minutes I thought was a narrow thin white cloud, extending from a point about 30° above the horizon in the west to perhaps 20° beyond the zenith in the east. It struck me at first as looking like the tail of a comet, but this I hardly thought possible, until after watching it a few minutes I found it moving bodily across the sky. In 20 minutes the western end had reached the zenith; the whole thing seemed rather shorter, the eastern end possibly a little fainter. The whole thing passed from view in about 30 to 35 minutes from the time I first saw it. The form, exactly that of a large comet, was maintained throughout. Neither end seemed to the naked eye brighter than the other." I. S.

THE RED SKIES.

If the phenomenon of our red skies is due to the volcanic eruption in Java, and the proof seems to point to that as a cause, my frequent observations of bright rapidly moving particles near the *Sun* can readily be explained, on the supposition that they were minute particles of ashes drifting through the atmosphere, which had their origin in the awful catastrophe of Krakatoa. Though great numbers of these floating bodies were visible in the instrument, the number too small to be seen must have been far greater. Around the *Sun* to a distance of 15°, the sky has presented a greenish appearance. The outer border of this glare of light is always terminated by a brick-dust reddish ring, showing that the phenomenon of morning and evening attends the *Sun* for the entire day. During the first part of the year, the red glow preceded the rising of the full *Moon*, though of course not so conspicuous as in the case of the *Sun*, indicating that it does not exist simply in the direction of the *Sun*, for the full *Moon* appears almost constantly surrounded by a pearly glare, resembling that around the *Sun*. E. E. B.

H. E. MATHEWS, Secretary of the Board of Trust of Lick observatory, 606 Montgomery st., San Francisco, Cal., has himself taken a number of interesting photographic views pertaining to Lick observatory and its surroundings. The pictures are about 4½ inches by 7½ inches in size, and are neatly mounted. The following are some of the prominent features represented:

Lick Avenue, at Junction House. five miles from San Jose; Grand View of Lick Avenue; Lick Observatory from Middle Peak; Mount Hamilton, Middle Peak; Lick Observatory, Front View; Interior, long North Hall; Lick Observatory, Small Dome; Lick Observatory, Central Roof; and more than forty others, making a desirable collection of views of this great observatory.

From the August number of *L'Astronomie* (French), it appears that the observers PAUL and PROSPER HENRY of the observatory of Paris, have made important observations of the surface markings on the planet *Uranus*. They have seen two gray belts, straight and parallel, situated nearly symmetrically on opposite sides of the diameter of the planet's disc. Between these lies a bright zone which probably corresponds to the equatorial region of the planet. The two polar regions are dark, the upper in the telescope appearing brighter than the other. As the result of a large number of measures, these observers have found that the direction of the bands of *Uranus* do not coincide with the projection of the major axis of the apparent orbit of the satellites, but forms with it an angle of 40°. Thus, the angles of position observed are: 56° for the bands and 16° for the projection of the major axis for the same epoch.

A new minor planet was discovered by J. PALISA of Vienna, Aug. 18, 1884. Its magnitude is 13, and its position, at the time,

R. A. $22^h\ 9^m\ 38^s$.
Decl. $-5°\ 30'\ 25''$

Motion in R. A. = — 12′; in Decl. = —7′.

This is number (239). No. (237) is called *Coelestina.* No. (238) is waiting for a name.

JOHN TATLOCK, JR., has been appointed Director of Smith observatory, Beloit College, Wis., and is already at his post. The choice is a wise one.

In our list of recent comets the Egyptian Comet, as it is called, was inadvertently omitted. No serious omission, however, for it was but once seen, if memory serves us rightly.

Messrs. WM. BOND & SON, chronometer and watch-makers, Boston, Mass., have removed their place of business from 97 Water st. to 112 State st. This house has earned its solid reputation by a prosperous business for nearly a century past in Boston.

Subscriptions and orders for the MESSENGER received in August: Messrs. E. STEIGER & Co., P. O. box 298, New York City. Vol. I., Nos. 1, 4, 7, 8, 9; Vols. II. and III., LEVI K. FULLER, Brattleboro, Vt., J. C. McCLURE, Red Wing, Minn., C. W. SEELEY, Box 266, Eastport, Maine; JOHN TATLOCK, Jr., Smith observatory, Beloit, Wis.

BOOK NOTICE.

Epitome of Ancient, Mediæval, and Modern History, By Carl Ploetz. Translated, with extensive additions, by William H. Tillinghast, of the Harvard University Library. Boston: Houghton, Mifflin & Co., 1884. Crown, 8vo., pp. 618.

Prof. Dr. CARL PLOETZ'S "Auszug aus der Geschichte" has passed through many editions in Germany, and has taken rank as the best book to be found for the purposes for which it was intended. It is a complete dictionary of chronology, and yet it is better than any mere dictionary could be; for it not only gives prominence to the prominent events and shows the relations of the subordinate events by the use of different types, but it gives more than a bare list of events. By a remarkably good arrangement it packs an immense amount of historical information into a comparatively small space. As the translator says:

"The distinguishing feature of the epitome is the arrangement whereby a *brief connected narrative* is accompanied by a clear, well-graduated chronology which emphasizes the sequence of events without breaking up the story or fatiguing the mind."

Valuable as is the original work, the labors of the translator and his associate, Dr. EDWARD CHANNING, have added much to its value, especially in giving to English and American history the fullness that the author reserved for the history of his fatherland.

An index of more than fifty closely printed pages completes the work, rendering accessible for ready reference the contents of the book. We commend the work most heartily, as one indispensable to the student and teacher of history. C. H. C.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. No. 8. OCTOBER, 1884. WHOLE No. 28.

Translation of part of a paper by Dr. A. Steinheil on the Errors and Adjustments of Oject-Glasses of two Lenses, by Miss. Emma Gattiker.

In Dr. STEINHEIL'S paper, (A. N. 2606), he first gives the five conditions which objectives of two lenses can and must fulfill; and after an interesting general analysis of the whole problem, he proceeds to give certain practical processes which enable anyone to examine an objective for himself. The whole paper should be read in the original. The following translation of the practical part can not fail to be of interest.

"Different tests, corresponding to the nature of the errors, are to be applied according as the errors affect the point on the axis at which the image is formed, or the entire image extending beyond the axis.

In considering those errors which affect the point on the axis at which the image is formed, it is best probably to study the image formed by a single luminous point.

Let the telescope be pointed at a luminous point, say the image of the *Sun* on a polished ball of black glass of small diameter, and observe what is the disposition of the light in the discs into which this image is resolved by moving the eye-piece in the direction of the optical axis toward or away from the objective, before placing it at the image formed on the axis, so that using the eye-piece as a magnifying glass, the cross sections of the cone of light may be examined on each side of the plane of the image.

Before I attempt to describe how the various errors manifest themselves, it is necessary to notice that the eye of the observer must first be examined, because the errors in it make themselves apparent in the appearance of the discs of light into which the image appears to be resolved in the planes on either side of the plane of the image.

For this purpose let the farthest point of distinct vision be fixed at 6–8 in. (16–22 centimetres) by means of a good lens, unless the eye be naturally near-sighted. Place the glass ball with the picture or image of the *Sun* on it at this point, then fixing the eye on the image, move the glass ball toward and from the eye.

If the ball be moved beyond the point fixed as the farthest point of vision, the image will be immediately resolved, if, however, the ball be brought toward the eye, the image can be preserved until its proximity is so great that it can no longer be overcome by the accommodation of the eye. If it be brought still nearer, the image will break up into discs as before.

The limits within which the image can be preserved intact depend upon the power of accommodation of the eye, which again depends largely upon the age of the observer.

Care must be taken in making the observations, that the line of sight toward the artificial star fall upon the axis of the lens.

If the eye be perfect, the image will be resolved into similar, circular, brightly illuminated discs, on being moved in either direction beyond these limits; while if the eye be imperfect, the form or illumination of these discs will be affected.

In case of regular astigmatism, the discs are oval, not round, and the direction of the long and short axes changes in passing through the plane of the image, for instance passing in, the long axis may be vertical, passing out the short one. If the eye contain imperfectly transparent places, the illumination will be less at certain points, etc.

If it be necessary to observe with an imperfect eye, its errors must be taken into account in testing the objective. A good eye will, when the eye-piece is moved as above described, in or out from the plane of the image, see the image resolved into round equally illuminated discs. If we examine the influence of the various errors which affect the focus we shall have of the errors occurring in the construction of the objective, the chromatic and spherical aberrations.

We call an error uncompensated when it is of the same sort as that of a single positive lens.

We shall find when the chromatic aberration is not compensated, that is, when the more highly refrangible rays have too short a focal distance, that the disc will be red toward the edge when the eye-piece is moved in, while on moving it out it is bordered by red (if the error is small, by orange), if the error of color is over-compensated, that is, when the more highly refracted rays have too long a focal distance,—the converse.

If the rays entering near the edge of the objective have a shorter vocal distance than those of the same color entering near the axis, the spherical aberration has not been compensated, and the disc will be sharply defined on the edges on pushing in the eye-piece, while on drawing it out it will have an ill-defined radiating edge.

The light per area is much less near the edges.

If the spherical aberration be over-compensated (the focal length of the rays near the edge *ceteris paribus* longer), the edge of the disc is radiating on pushing in the eye-piece, and sharply defined on drawing it out. Of errors in the construction there are two in centering which come next under our observation.

The optical axes of the two lenses may be displaced, though still parallel, in which case the image of the *Sun* on the glass ball will be red on one side; or the axes of the lenses may be inclined toward each other, in which case the light will be unequally distributed on the disc on drawing the eye-piece in or out, one side being very light and sharply defined, the other ill-defined and dissolving the disc nearest the image appearing not unlike a comet with tail.

A large variety of errors of construction are the errors in the figure of the surfaces (deviation from a spherical surface); they are generally concentric, on account of the method of polishing, and cause a part of the light to focus in another place. This destroys the evenness of the distribution in the discs, so that on pushing the eye-piece in or out from the plane of the image, an intensely bright spot appears in some planes while others are too dark.

Errors of surface may cause the same results as errors of form (sphericity), though the disturbances are generally more irregular.

Irregularities in the discs occur when the lenses are bent out of shape in mounting or when there has been too great or too irregular pressure in polishing, or any surface, which on being removed causes a change of shape. From both of these sources the discs suffer changes like those occurring from regular or irregular astigmatism of the eye.

Of the errors of construction scratches or streaks in the polished surfaces have the least influence, and even when they are very marked they produce hardly any effect.

Of the flaws in the material, gritty places, bubbles, etc., do not cause much disturbance. They take up a little of the light, and when they are very large they cause (by reflection) a lustre on the image, because the light which they reflect does not unite to form the main image.

These errors generally are only disturbing when very bright objects are observed.

Waves in the glass on the other hand exert a strong disturbing influence, because comparatively large parts of the light which fall upon the objective from a point are wrongly refracted and focus elsewhere than in the plane of the image. The larger the area of these waves, the more do they injure the image, while those which are thread-like in form, though they are easily apparent, are not very injurious because they affect only a small portion of the light.

The waves are most easily seen by pointing a telescope at a bright object, unscrewing the eye-piece and placing the eye in the focus of the objective; its whole surface will then be evenly illuminated, and the waves are discernible by their differing intensity of light.

This exhausts those errors which affect that point in the image which falls on the axis, and we have yet to consider the errors which arise from the inequality of the real focal distances, either between the centre and the edge of the objective (distortion), or between two differently colored rays, (inequality in the size of the different-colored images).

If the "Haupt punkte" alone are different, the image in the axis will still be good.

But the real focal distances may be dissimilar when errors of sphericity and color are also present. In this case, however, the distinctness of the image has already been destroyed.

If any objective is free from errors of sphericity and distortion, and is pointed at a distant line, dark against a light back ground, and the eye is brought into such a position that it can distinctly see the image of the line formed by the objective, this image will remain straight on tipping the objective. The image bends, however, to one side or the other, according as the true focal distances of the edges and middle are unequal. In case the focal distance of the edge is longer, the sides of a square would be concave toward the outside, if the focal distance is longer at the axis, the square would be convex toward the outside.

With objectives consisting of two lenses only, it is difficult to bring out important errors in the size of images of different colors if there is not present at the same time a second error, either distortion or a color-error.

The effect of such errors is that large images are bordered by bands of that color which has the longest focal distance."

A catalogue of variable stars, by Mr. J. E. GORE, published in Vol. IV of the *Proceedings* of the Royal Irish Academy, contains about 190 stars with notes, and will be found useful to those prosecuting this interesting branch of astronomy. —*Nature.*

RECENT PECULIAR ATMOSPHERIC CONDITIONS.

BY J. R. HOOPER, BALTIMORE.

Having noticed during the last six months, an unusual amount of bad "seeing" and especially so in daytime, the cause became a subject of inquiry, and as a result, I beg leave to submit for record, the following notes which may also serve to call out other and more valuable observations.

At night, up to August, the power of the telescope to define has been very unsatisfactory, and in daytime there has been a constant and marked trouble in seeing even second magnitude stars. The unprecedented cloudiness of the first three months of the year, has greatly lessened the number of clear days usually enjoyed. When the clear skies came, the difficulty of doing such daytime work as I had formely done, was noticed, and still exists at this time of writing.

I therefore raise this query: Is there a change in the atmosphere, or is there in it a foreign material which is capable of modifying the visibility of other than the brightest objects?

Every observer is acquainted with the deceptive "apparent" blue skies, but as bearing on the above query, I append a few data from my own observations made at 8 A. M. and 4 P. M., from April to August of the present year, as follows:

The marked trouble in seeing stars as bright as the second magnitude; frequently not seeing *α Andromedæ* when near the zenith at 8 A. M.

A corresponding indistinctness in first magnitude stars.

In following *Mercury* in 1883, I readily found him sixteen days after inferior conjunction, though in the *Sun's* rays, and I could see the crescent very neatly defined a week later.

In 1884, though searching carefully, it was thirty-one days after inferior conjunction before I could see the planet, and then it was five days after greatest elongation. At no time has the disk been fairly defined, while last year the reverse was the rule.

In all observations during these months, the definition of details of every kind on the *Sun's* face has been superior to that of last year. Hence, the idea comes to mind that there may be some substance in the air which diffuses the *Sun's* light to an unusual degree, but does not affect the seeing at night, nor make bad definition for the *Sun's* surface. The stars may seem fainter because of the whiteness of the sky otherwise unnoticeable.

In January and February of this year, I sometimes noticed a peculiar pearly whiteness around the *Sun* before sunset, and outside of that a dingy reddish tint, the radius of the arc being from 20° to 30°. In March I began to see at midday, a complete halo of the same color, having a radius of about 20°. When the sky was very blue it was well defined, but on days when the whiteness was present it was not seen. In July I measured it on one occasion, and made the inner edge nine degrees from the *Sun* with a breadth of seven degrees.

I find in looking back through the notices of the red sunsets, that Mr. Capron at the January meeting of the Royal Astronomical Society, mentioned the existence of a circle of red tint about the *Sun* at midday. In April, several writers spoke of a suspected connection between the red sunsets and the bad definition of the telescope. In a letter to the *English Mechanic* for June 20, a Fellow of the Royal Society writes:

"As to the bad definition incident on the visibility of the after-glow, I should like to remark that for some time past, daylight definition of celestial objects has been worse than ever I remember it during my tolerably long observing experience.

Transit-taking in daylight, save with the large stars, has been quite impracticable, and over and over again I have looked in vain for *Mercury.* * * * Of course every one who is in the habit of using a telescope in the daytime, is familiar with the fact that on many seemingly cloudless days there is an otherwise invisible kind of haze which impairs or destroys definition; and that the best and brightest vision is obtained in the blue sky visible below large floating *Cumuli*. But this curious obscuration has been just apparent during the latter condition of the atmosphere as during the former."

In July, another writer speaks in the same way of the difficulty of seeing objects within 30° of the *Sun's* place, and mentions the dusky red halo as having been under his notice for some months. We notice also, that on page 79 of the SIDEREAL MESSENGER for August, in the Washington report of observations upon *Sirius* is the significant remark:

"This companion has been unusually faint during the present year."

We need add at present only one other interesting notice of these late atmospheric conditions taken from the *Scientific American*, (Aug. 16), as follows:

"Since the appearance of the brilliant sunsets, Messrs. THOLLON and PERROTIN have noticed that the sky at Nice seems to have lost much of its ordinary transparency. They have been accustomed, on every fair day, to examine the sky in the neighborhood of the *Sun*, placing themselves near the border of the shadow projected by one of the observatory buildings. When thus sheltered from the direct rays of the *Sun*, they have noticed in former years that the blue of the sky continued to the very borders of the solar disk. If they were so placed that the disk was almost a tangent to the border of the screen, but still invisible, no increase in the brilliancy of illumination indicated the place where the point of tangency would be found. This is now no longer the case. Since the month of November, even upon the brightest days, the *Sun* appears constantly surrounded by a circular fringe of dazzling white light, slightly tinged with red at its outer edge, and with blue on the inner edge. There is a sort of ill-defined corona, with an apparent radius of about fifteen degrees. It would be interesting to know whether this fact is general, and whether it can be considered as connected with the volcanic dust or other causes of the late brilliant twilights."

REV. T. E. ESPIN publishes in the *Transactions* of the Liverpool Astronomical Society a catalogue of the magnitudes of 50 stars in Auriga, Gemini and Leo Minor, which have been determined from photographs taken by means of the equatorial stellar camera of the Society's observatory.

THE U. S. NAVAL OBSERVATORY.

In the Washington *Post* of August 10, 1884, there is a long article upon the Naval observatory, from which the following extracts are made:

THE STAFF OF OFFICERS AND PROFESSORS.

In addition to Com. Franklin, who as already stated, is in charge of the observatory, the working staff of the observatory is as follows: Com. W. T. Sampson, Assistant to Superintendent; Lieuts. E. C. Pendleton, C. G. Bowman, John Garvin and J. C. Wilson; Ensigns W. H. Allen, Hiero Taylor and J. A. Hoogewerff; Professors Asaph Hall, William Harkness, J. R. Eastman, Edgar Frisby and Stimson J. Brown, scientific corps; A. N. Skinner, W. C. Winlock and H. M. Paul, aids or assistant astronomers; William M. Brown, Jr., R. S. Woodward, A. S. Flint, A. Hall, Jr., computers; Thomas Harrison, clerk.

In the institution, as on board ship, naval discipline is observed, although, of course, not with the same rigidity. The methods of the observatory, the manner in which the work is outlined, and its character, are so little known that the following recent general order will be novel and interesting:

GENERAL ORDER NO. 2. The Board formed under the General Order of June 18, 1884, having met on the 1st of July and decided upon the plan of work to be pursued at the Naval observatory for the six months ending December 31, 1884, it is hereby directed that in accordance with that decision each officer and observer shall see to the due prosecution of the work with which he is specially charged. The several divisions of the work are as follows:

Division A—The Great Equatorial. 1. Observations of a selected list of double stars will be continued. These stars are such as have rapid orbital motions, or which present some other interesting peculiarity.

2. Conjunction of the inner satellites of *Saturn* during the next opposition of the planet will be observed. There will also be made a complete micrometrical measurement of the dimensions of the ring.

3. There will be made three drawings of *Saturn*; one before opposition; one at or near opposition and one after opposition.

4. The observations which have been begun for stellar parallax, and for the temperature co-efficient of the screw of the micrometer, will be finished.

Division B—The Transit Circle. 1. Observations of the *Sun* will be made whenever the necessary ephemeris stars can be observed and the required instrumental corrections determined.

2. The *Moon* will be observed through the whole lunation.

3. The major planets will be observed from fifteen to twenty times near opposition.

4. Each minor planet will be observed at least five times near opposition.

5. Observations of the list of miscellaneous stars will be finished as soon as practicable.

The officer in charge of this instrument will be furnished with corrections to the ephemerides of the minor planets on application to the officer in charge of the 9.6-inch equatorial.

Division C—The Transit Instrument. 1. Observations will be made as often as practicable for time, for the correction of the standard mean time clock; and computations will be made daily for such correction.

2. Observations for the right ascensions of *Sun, Moon*, and inner planets to be made as frequently as possible; observations of the major planets and the brighter of the minor planets to be made near opposition; those of the *Moon* through the whole lunation.

3. The observations made during 1883 will be prepared for publication; and the computations of those of 1884 continued.

The officer in charge of this instrument will be furnished with the list of stars observed on the mural circle. The right ascensions of these stars will be observed on the transit instrument and the observations furnished to the officer in charge of the mural circle.

The corrections to ephemerides of minor planets will be furnished by the officer in charge of the 9.6-inch equatorial.

Division D—The 9.6-Inch Equatorial 1. Observations of all the minor planets whose brightness at opposition is greater than their mean brightness, will constitute the principal part of the work with this instrument.

2. Observations of comets to determine position and physical peculiarities.

3. Occultation of the stars by the *Moon*

4. When arrangements shall have been made to photograph the *Sun*, to examine with the spectroscope any *Sun*-spots which show any decided peculiarities in the photographs.

The officer in charge of this instrument will furnish to the officers in charge of the transit circle and transit instrument, on application, corrections to the ephemerides of the minor planets.

Division E—The Prime Vertical Instrument. Observations of *a Lyræ* will be continued during the month of July, and the reduction of all observations will be proceeded with as rapidly as practicable. As suggested by Lieut. Bowman, equations of condition for a few of the stars which have been most frequently observed will be formed in order that the result from their solution may furnish a satisfactory test of the value of the work already done.

Division F—The Mural Circle. Observations will be made of stars down to the seventh magnitude, south of 10° north declination, the positions of which have not been recently determined at some northern observatory. The observing list to be formed of all stars from Gould's Uranometria Argentina visible here, and not contained in Yarnall's catalogue, the transit-circle list of B. A. C. stars, or the recent catalogue of the Glasgow observatory.

The right ascension of the stars observed with the mural circle will be observed with the transit instrument, and the observations furnished to the officer in charge of the former.

It is further ordered that observations with each instrument shall be continued uninteruptedly, notwithstanding some of the observers may be absent.

Division G—Time, Including Chronometers. The officer charged with the duty of sending out time signals will continue to do so, according to the system already adopted, and will also continue, as heretofore, the rating and care of the chronometers.

The Library. The librarian will attend to the destribution of the observatory publications as they may be received from the public printer. He will attend also to the arrangement and perservation of the books now on hand and those hereafter received, and will prepare for the bindery such publications as require binding. The catalogue which has been in course of preparation during the last two years of the publications contained in the library, will be made ready for sending to the printer as soon as the appropriation is available.

Books and publications will be purchased, as heretofore, according to selections made from lists to be submitted annually by the staff of the observatory, and such additional books as may be needed from time to time, will also be purchased, should the appropriation be sufficient.

COM. S. R. FRANKLIN, Superintendent,
Naval Observatory, July 1, 1884.

Observations of Meteors made at Vevay, Ind., by Chas. G. Bœrner, *August 10th, 11th and 12th, 1884. Lat. 38° 46′, Long. 84° 59′ 20″. 5; above sea level 525 feet.*

Date.	Time. h	Time. m	Number.	Duration of Flight. s	Magnitude.	Radiant. Path. Color. Train, etc.
Aug. 10th, p. m.	8	23	1	2	1	α Cygni, path, β Ophiuchi; white nebulous train.
		32	2	2	1	γ Urs. Maj., path, due northwest; train visible 3 seconds.
		37	3	2	1	β Urs. Maj., path, westward; nucleus intensely brilliant, movement slow, train visible 3 seconds.
		50	4	1	2	η Pegasi, path, δ Cephei; faint, flight rapid.
	9	01	5	1	2	β Cygni, path, γ Draconis; faint nebulous train.
		03	6	2	1	γ Andromedæ, path, α Aquilæ; bright train, visible 3 seconds.
		04	7	1	2	γ Andromedæ, path, α Aquilæ; faint short train.
		07	8	1	3	α Cassiopeæ, path, α Cephei; faint short train.
		08	9	2	1	β Pegasi, path, δ Cygni; bluish tint, short luminous trains.
		11	10	2	1	γ Cor. Bor., path, η Bootis; moderate brilliancy.
		11	11	1	2	δ Cassiopeæ, path, β Andromedæ; faint luminous train.
		12	12	2	1	γ Urs. Maj., path, α Lyræ; bright train, visible 4 seconds.
		14	13	1	3	β Cassiopeæ, path, δ Andromedæ; nucleus of feeble light.
		21	14	1	3	β Cephei, path, η Draconis; faint short train.

11th, p. m.		27	15	1	3	β Andromedæ, path, γ Pegasi; flight rapid without train.
		40	16	2	2	δ Cephei, path, β Lyræ; train of moderate brilliancy.*
	8	46	17	2	1	γ Cassiopeæ, path, α Andromedæ; color bluish white.
		47	18	2	1	β Cassiopeæ, path. γ Draconis; faint nebulous train.
		48	19	1	2	δ Cephei, path, δ Herculis; without train.
	9	02	20	2	3	γ Cassiopeæ, path, η Pegasi; short nebulous train.
		05	21	1	2	β Pegasi, path, β Delphini.
		15	22	2	1	α Perseus, path, δ Cephei; bright short train, motion slow.
12th, p. m.	8	03	23	2	1	α Lyræ, path, ε Bootis; bright luminous train.
		16	24	3	1	α Lyræ, path, α Urs. Maj., brilliant train about 3° long, visible 4 seconds, motion of train slightly wavy.
		39	25	2	1	α Aquilæ, path, α Ophiuchi; faint short train.
		45	26	2	1	α Cor. Bor. path α Cygni. Up to 9:30 p. m. no meteor appeared and watching was discontinued.

Of the total number 26 of meteors observed, eighteen (18) were conformable to the radiant in Perseus, and eight (8) noncomformable; of the above number there are 13 of the 1st magnitude with average duration of flight of 2.1 seconds. 8 of the 2d magnitude with average duration of flight of 1.3 seconds; 5 of 3d magnitude with average duration of flight of 1.2 seconds.

The maximum number fell on the night of the 10th, with a gradual decrease on the 11th and 12th two (2) only were followed by long luminous trains; of the remainder the train were short or ill defined. It may reasonably be supposed that a greater number would have been visible on a dark, night, unfortunately as it was, the interposing moon prevented the opportunity.

*At this time the bright full moon had attained an altitude to obscure all stars below the 1st magnitude; watching discontinued.

PENDING PROBLEMS OF ASTRONOMY.*

With your permission, I propose this evening to consider some of the pending problems of astronomy,—those which seem to be most pressing, and most urgently require solution as a condition of advance; and those which appear in themselves most interesting, or likely to be fruitful, from a philosophic point of view.

Taking first those that lie nearest, we have the questions which relate to the dimensions and figure of the Earth, the uniformity of its diurnal rotation, and the constancy of its poles and axis.

I think the impression prevails, that we already know the Earth's dimensions with an accuracy even greater than that required by any *astronomical* demands. I certainly had that impression myself not long ago, and was a little startled on being told by the superintendent of our Nautical Almanac that the remaining uncertainty was still sufficient to produce serious embarrassment in the reduction and comparison of certain lunar observations. The length of the line joining, say, the Naval observatory at Washington, with the Royal observatory at the Cape of Good Hope, is doubtful; not to the extent of only a few hundred feet, as commonly supposed, but the uncertainty amounts to some thousands of feet, and may possibly be a mile or more, and probably not less than a ten-thousandth of the whole distance; and the *direction* of the line is uncertain in about the same degree. Of course, on those portions of either continent which have been directly connected with each other by geodetic triangulations, no corresponding uncertainty obtains; and as time goes on, and these surveys are extended, the form and dimensions of each continuous land-surface will become more and more perfectly determined. But at present we have no satisfactory means of obtaining the desired accuracy in the relative position of places separated by oceans, so they can-

*From an address to the American association for the advancement of science at Philadelphia, Sept. 5, 1884, by Prof C. A YOUNG, at Princeton, retiring president of the association.—*Science.*

not be connected by chains of triangulation. Astronomical determinations of latitude and longitude do not meet the case; since, in the last analysis, they only give at any selected station the *direction of gravity* relative to the axis of the Earth, and some fixed meridian plane, and do not furnish any *linear* measurement of dimension.

Of course, if the surface of the Earth were an exact spheroid and if there were no irregular attractions due to mountains and valleys and the varying density of strata, the difficulty could be easily evaded; but, as the matter stands, it looks as if nothing short of a complete geodetic triangulation of the whole Earth would ever answer the purpose,—a triangulation covering Asia and Africa, as well as Europe, and brought into America by way of Siberia and Behring Strait.

It is indeed theoretically possible, and just conceivable, and the problem may some day be reversed, and that the geodesist may come to owe some of his most important data to the observers of the lunar motions. When the relative position of two or more remote observatories shall have been precisely determined by triangulation (for instance, Greenwich, Madras, and the Cape of Good Hope), and when, by improved methods and observations made at these fundamental stations, the *Moon's* position and motion relative to them shall have been determined with an accuracy much exceeding anything now attainable, then by similar observations, made simultaneously at any station in this hemisphere it will be theoretically possible to determine the position of this station, and so, by way of the *Moon*, to bridge the ocean, and ascertain how other stations are related to those which were taken as primary. I do not, of course, mean to imply, that in the *present state* of observational astronomy, any such procedure would lead to results of much value; but, before the Asiatic triangulation meets the American at Behring Strait, it is not unlikely that the accuracy of lunar observations will be greatly increased.

The present uncertainty as to the Earth's dimensions is not, however, a sensible embarrassment to astronomers, except in dealing with the *Moon*, especially in attempting to employ observations made at remote and ocean-separated stations for the determination of her parallax.

As to the form of the Earth, it seems pretty evident that before long it will be wise to give up further attempts to determine exactly what spheroid or ellipsoid *most nearly corresponds* to the actual figure of the Earth; since every new continental survey will require a modification of the elements of this spheroid in order to take account of the new data. It will be better to assume some closely approximate spheroid *as a finality*; its elements to be forever retained unchanged, while the deviations of the actual surface from this ideal standard will be the subject of continued investigation and measurement.

A more important and anxious question of the modern astronomer is: Is the Earth's rotation uniform, and, if not, in what way and to what extent does it vary? The importance, of course, lies in the fact that this rotation furnishes our fundamental measure and unit of time.

Up to a comparatively recent date, there has not been a reason to suspect by human observation. It has long been preceived, of course, that any changes in the Earth's form or dimensions must alter the length of the day. This displacement of the surface or strata by earthquakes or by more gradual elevation and subsidence, the transportation of matter towards or from the equator by river or ocean currents, the accumulation or removal of ice in the polar regions or on mountain-tops,—any such causes must necessarily produce a real effect. So, also, must the friction of tides and trade-winds. But it has been supposed that these effects were so minute, and to such an extent mutually compensatory, as to be quite beyond the reach of observation; nor is it yet certain that they are not. All that can be said is, that it is now beginning to be *questionable* whether they are, or are not.

The reason for suspecting preceptible variation in the Earth's revolution, lies mainly in certain unexplained irregularities in the apparent motions of the *Moon*. She alone, of all the heavenly bodies, changes her place in the sky so rapidly, that minute inaccuracies of a second or two in the time of observation would lead to sensible discrepancies in the observed position; an error of one second, in the time, corresponding to about half a second in her place,—a quantity minute, certainly, but perfectly observable. No other heavenly body has an apparent movement anywhere nearly as rapid, excepting only the inner satellite of *Mars*; and this body is so minute that its accurate observation is impracticable, except with the largest telescopes, and at the times when *Mars* is unusually near the Earth.

Now, of late, the motions of the *Moon* have been very carefully investigated, both theoretically and observationally; and, in spite of everything, there remain discrepancies which defy explanation. We are compelled to admit one of three things,—either the lunar theory is in some degree mathematically incomplete, and fails te represent accurately the gravitational action of the Earth and *Sun*, and other known heavenly bodies, upon her movements; or some unknown force other than the gravitational attractions of these bodies is operating in the case; or else, finally, the Earth's rotational motion is more or less irregular, and so affects the time reckoning, and confounds prediction.

If the last is really the case, it is in some sense a most discouraging fact, necessarily putting a limit to the accuracy of all prediction, unless some other unchanging and convenient measure of time shall be found to replace the "day" and "second."

The question at once presents itself: How can the constancy of the day be tested? The lunar motions furnish grounds of suspicion, but nothing more; since it is at least as likely that the mathematical theory is minutely incorrect or incomplete as that the day is sensibly variable.

Up to the present time, the most effective tests suggested are from the transits of *Mercury* and from the eclipses of *Jupiter's* satellites. On the whole, the result of Professor NEWCOMB's elaborate and exhaustive investigation of all the observed transits, together with all the available eclipses and occultations of stars, tends rather to establish the sensible constancy of the day, and to make it pretty certain (to use his own language) that "inequalities in the lunar motions, not accounted for by the theory of gravitation, really exist, and in such a way that the mean motion of the *Moon* between 1800 and 1875 was really less (*i. e.*, slower) than between 1720 and 1800." Until lately, the observations of *Jupiter's* satellites have not been made with sufficient accuracy to be of any use in settling so delicate a question; but at present the observation of their eclipses is being carried on at Cambridge, Mass., and elsewhere, by methods that promise a great increase of accuracy over anything preceding, Of course, no *speedy* solution of the problem is possible through such observations, and their rusult will not be so free from mathematical complications as desirable,—complications arising from the mutual action of the satellites, and the ellipsoidal form of the planet. On account of its freedom from all sensible disturbances, the remote and lonely satellite of *Neptune* may possibly some time contribute useful data to the problem.

We have not time, and it lies outside my present scope, to discuss whether, and, if so, how, it may be possible to find a unit of time (and length) which shall be independent of the Earth's conditions and dimensions (free from all *local considerations*), cosmical, and as applicable in the planetary system of the remotest star as in our own. At present we can postpone its consideration; but the time must unquestionably come, when the accuracy of scientific observation will be so far increased, that the irregularities of the Earth's rotation, produced by the causes alluded to a few minutes ago, will protrude, and become intolerable. Then a new unit of time will have to be found for scientific purposes, founded, perhaps, as has been already suggested by many physicists, upon the vibrations or motion of light, or upon some other physical action which pervades the universe.

Another problem of terrestrial astronomy relates to the constancy of the position of the Earth's axis in the globe. Just as displacements of matter upon the surface or in the interior of the Earth would produce changes in the time of rotation, so also would they cause corresponding alternations in the position of the axis and in the places of the poles,—changes certainly very minute. The only question is, whether they are so minute as to defy detection. It is easy to see that any such displacements of the Earth's axis will be indicated by changes in the *latitudes* of our observatories. If, for instance, the pole were moved a hundred feet from its present position, towards the continent of Europe, the latitudes of European observatories would be increased about one second, while in Asia and America the effects would be trifling.

The only observational evidence of such movements of the pole, which thus far amounts to any thing, is found in the results obtained by NYREN in reducing the determinations of the latitude of *Pulkowa*, made with the great vertical circle, during the last twenty-five years. They seem to show a slow, steady diminution of the latitude of this observatory, amounting to about a second in a century, as if the north pole were drifting away, and increasing its distance from *Pulkowa* at the rate of about one foot a year.

The Greenwich and Paris observations do not show any such results; but they are not conclusive, on account of the difference of longitude, to say nothing of their inferior precision. The question is certainly a doubtful one; but it is considered of so much importance, that, at the meeting of the International Geodetic association in Rome last year, a resolution was adopted recommending observations specially designed to settle it. The plan of Sig. FERGOLA, who introduced the resolution, is to select pairs of stations, having nearly the same latitude, but differing widely in longitude, and to determine the *difference* of their latitudes by observations of the same set of stars, observed with similar instruments, in the same manner, and reduced by the same methods and *formulæ*. So far as possible, the same observers are to be retained through a series of years, and are frequently to exchange stations when practicable, as to eliminate personal equations. The main difficulty of the problem lies, of course, in the minuteness of the effect to be detected; and the only hope of success lies in the most scrpulous care and precision in all the operations involved.

Other problems, relating to the rigidity of the Earth and its internal constitution and temperature, have, indeed, astronomical bearings, and may be reached to some extent by astronomical methods and considerations; but they lie on the border of our science, and time forbids anything more than their mere mention here.

If we consider, next, the problems set us by the *Moon*, we find them numerous, important, and difficult. A portion of them are purely mathematical, relating to her orbital motion; while others are physical, and have to do with her surface, atmosphere, heat, etc.

As has been already intimated, the lunar theory is not in a satisfactory state. I do not mean, of course, that the *Moon's* deviations from the predicted path are gross and palpable,—such, for instance, as could be preceived by the unaided eye (this I say for the benefit of those who otherwise might not understand how small a matter sets astronomers to grumbling); but they are large enough to be easily observable, and even obtrusive, amounting to several seconds of arc, or miles of space. As we have seen, the attempt to account for them by the irregularity of the Earth's rotation has apparently failed; and we are driven to the conclusion, either that other forces than gravitation are operative upon the lunar motions, or else (what is far more probable, considering the past history of theoretical astronomy) that the mathematical theory is somewhere at fault.

To look at the matter a little from the outside, it seems as if that which is most needed just now, in order to secure the advance of science in many directions, is a new, more comprehensive, and more manageable solution of the fundamental equations of motion under attraction. Far be it from me to cry out against those mathematicians who delight themselves in transcendental and *n*-dimensional space, and a revel in the theory of numbers,—we all know how unexpectedly discoveries and new ideas belonging to one field of science find use and application in widely different regions,

—but I own, I feel much more interest in the study of the theory of functions and differential equations, and expect more aid for astronomy from it.

The problem of any number of bodies, moving under their mutual attraction, according to the Newtonian laws, stands, from a physical point of view, on precisely the same footing as that of *two* bodies. Given the masses, and the positions and velocities corresponding to any moment of time, then the whole configuration of the system of all time, past and future (abstracting outside forces, of course), is absolutely determinate, and amenable to calculation. But while in the case of *two* bodies, the calculation is easy and feasible, by methods known for two hundred years, our analysis has not yet mastered the general problem for more than two. In special instances, by computations, tedious, indirect, and approximate, we can, indeed, carry our predictions forward over long periods, or indicate past conditions with any required degree of accuracy; but a general and universally practicable solution is yet wanting. The difficulties in the way are purely mathematical: a step needs to be taken, corresponding in importance to the introduction of the circular functions, into trigonometry, the invention of logarithms, or the discovery of the calculus. The problem confronts the astronomer on a hundred different roads; and, until it is overcome, progress in these directions must be slow and painful. One could not truly say, perhaps, that the lunar theory must, in the mean while, remain quite at a standstill: labor expended in the old ways, upon the extension and development of existing methods, may not be fruitless, and may, perhaps, after a while, effect the reconcilement of prediction and observation far beyond the present limits of accuracy. But if we only had the mathematical powers we long for, then progress would be as by wings: we should fly, where now we crawl.

As to the physical problems presented by the *Moon*, the questions relating to the light and heat—the radiant energy it sends us, and to its temperature, seem to be the most attractive at present, especially for the reason that the results of the most recent investigators seem partially to contradict those obtained by their predecessors some years ago. It now looks as if we should have to admit that nearly all we receive from the *Moon* is simply *reflected* Sun-light and Sun-heat, and that the temperature of the lunar surface nowhere rises as high as the freezing-point of water, or even of *Mercury*. At the same time, some astronomers of reputation are not disposed to admit such an upsetting of long-received ideas; and it is quite certain, that in the course of the next few years, the subject will be carefully and variously investigated.

Closely connected with this is the problem of a lunar atmosphere—if, indeed, she has any.

[*To be continued.*]

Note on the Comparison of the Coast Survey Catalogue of Latitude Stars, with the Fundamental Catalogues of Safford, Boss and Auwers.

BY JOHN TATLOCK, JR.

Having had occasion to examine the declination of certain stars used for the determination of a latitude, whose places were originally taken from the Catalogue of Latitude Stars published as Appendix No. 7, to the Coast Survey Report of 1876, I have been led to compare the declination of these stars, as given in that paper, with the places of the same stars as given in the so-called fundamental catalogues of Safford, Boss and Auwers. As the results of this comparison may not be uninteresting to some of the readers of the MESSENGER, I have given in the following table the discrepancies between the places, as given in the Coast Survey Catalogue, and those given in the other authorities. Of course it will be understood that this comparison is not considered as, in any sense, a comparison of the Coast Survey *Catalogue*, but simply pertains to the places of the stars here given.

In the following table $\Delta\delta$ denotes the *correction* to the C. S. Catalogue place, as given by the several authorities, and

$\Delta\mu'$ the *correction* to the proper motion as given in that catalogue to reduce it to the value given in the standard catalogues.

The corrections hold good for 1880.0.

B. A. C. No.	Name of Star.	$\Delta\delta$			$\Delta\mu'$		
		Safford.	Boss.	Auwers.	Safford.	Boss.	Auwers.
		″	″	″	″	″	″
6857	Cygni	−0.55					
6876	Cygni	−0.19					
6912	17 Vulpeculæ	−0.47			−0 005		
6932	66 Draconis	+0.03			0.000		
6970	68 Draconis	+0.25	+0.99		−0.01	+0.018	
6968	22 Vulpeculæ	−1.26			−0.038		
6986	Cygni	−0.10					
7067	41 Cygni	+0.16			−0.01		
7086	Cygni	+0.18					
7158	Cygni	+0.48					
7171	α Cygni	+0.33	−0.16	−0.08	+0.003	−0.008	+0.003
7204	ε Cygni	+0.20	−0.46	−0.22	+0.007	−0.014	+0.015
7301	*f* Cygni	−0.36			−0.008		
7320	Cygni	+0.62	+0.13		+0.05	+0.013	
7336	61 Cygni	+0.08	−0.27	−0.34	+0.011	+0.008	+0.010
7345	f^2 Cygni	−1.12	−1.40		−0.02	−0.025	
7368	ζ Cygni	−0.22	−0.39	−0.45	0.000	+0.003	+0.004
7401	D M 55° 2549	+2.26			+0.11		
7411	Cygni	+0.84					
7453	69 Cygni	−0.67	−0.58		−0.027	−0.035	
7503	ρ Cygni	−1.30			−0.046		
7521	74 Cygni	−0.37	−0.25	−0.91	0.000	−0.010	−0.001
7544	75 Cygni	−0.22			−0.023		
7571	χ Pegasi	−0.34	−0.57	−0.46	−0.020	−0.041	−0.017
7595	γ Cephei	+0.48	−0.09		+0.025	−0.082	
7607	14 Pegasi	−0.41			−0.013		
7631	Cygni	+0.54			+0.06		
7676	Cygni	+0.24					
7721	π Pegasi	−1.98		−1.61	−0.036		−0.031
7749	ζ Cephei	+0.60	+0.68	+0.68	+0.002	+0.014	+0.004
7798	32 Pegasi	−0.84			−0.01		
7850	6 Lacertæ	−0.54			−0.01		
7914	o Pegasi	−0.88			−0.022		
7932	13 Lacertæ	−0.89		−1.26	−0.006		−0.008
7948	Lacertæ	−0.60					
7972	15 Lacertæ	−0.11			+0.01		
7984	Lacertæ	−0.47			0.000		
8058	4 Andromedæ	−0.26			+0.045		
8125	11 Andromedæ	+1.11			+0.007		
8136	12 Andromedæ	−1.26			−0.026		
8229	2 Andromedæ	−0.49	−0.32	−0.71	−0.026	−0.025	−0.032
8256	78 Pegasi	−1.20			−0.048		
8310	ρ Cassiopeæ	−1.79		−1.83	+0.001		−0.002
8324	4 Pegasi	−1.16	−1.21		−0.023	−0.034	
8344	Cassiopeæ	−0.04	−0.22		−0.004	−0.010	

EDITORIAL NOTES.

The thirty-third meeting of the American Association for the Advancement of Science, which convened this year, in Philadelphia, Sept. 4–11, was in numbers and character, one of the great meetings in the history of the association. It was but natural to expect such a result in view of the fact that more than one-half of the entire membership of the association resides in New England and east of the Alleghenies, and also because Philadelphia was known to possess and generously to offer many other advantages for the meeting of such an association that could be scarcely equalled in any other locality in the United States. The membership of the association preceding the Philadelphia meeting was 2011. Attendance at Philadelphia was 1249, and the number of new members elected during the meeting was 491.

At the Philadelphia meeting there were sixty persons representing various foreign societies, which was an interesting feature, the large number being due to the fact that the meeting of the British association had taken place only a few days before at Montreal, Canada. Some of the more prominent persons who were present as delegates from the foreign societies were: Professor R. S. Ball, the Royal Astronomer of Ireland; Sir. Wm. Thompson, W. H. Preece, W. T. Blanford, Royal Society; E. B. Taylor, Author of the Early History of Mankind; Professor Adams, the Cambridge astronomer; Captain Pym, of the Royal Navy; Professors George Forbes and James Mactear, of Glasgow; Professor Struther and Dr. Robert Beveridge, of Aberdeen. There were also delegates from the Belfast Natural History Society, Geological Survey of India, Asiatic Society of Bengal, Asiatic Society of Japan, Natural History of Glasgow, Manchester Philosophical Society, Zoological Society of London, Botanical Society of Edinburgh, Royal Irish Academy, University of Japan, and many others quite as important to science as those already named. This indicates some of the interest that educated gentlemen of the foreign societies take in the character and progress of similar work on this side of the Atlantic. The chief address of the more elaborate ones at the Philadelphia meeting of the A. A. A. S., was delivered by the retiring President of the Association, Professor Charles A. Young, Princeton College, N. J., on the theme *Pending Problems in Astronomy*. Those who are acquainted with Professor Young's style know that it is always clear and apt; that he has remarkable insight in discussing theories, in balancing probabilities, and in stating the unsolved problems of astronomy as they lie in his own mind. The address successfully presents the knotty questions of astronomy in their latest phases, so that others less familiar with the intricate ways of the scholars, may yet get a definite knowledge of what is known to the science, and distinguish it from that which is not known. It is to be hoped that no one interested in astronomy will fail to read the address, because it is a complete unfolding of all its title implies that could well be given in a single paper. No abstract would do it justice; so we shall continue it in parts in following numbers.

DISCOVERY OF A SUSPECTED COMET.

On the evening of September 9th, about nine o'clock, while comet sweeping, I picked up a nebulous object in, approximately, right ascension 13^h 5^m; declination north 57°. It was faintish, but easily seen with the sky illuminated by the approaching moonlight. After the *Moon* rose, it was not visible in the 9-inch reflector, so that further observations that night was impossible. The next evening it rained. On the following evening, however, the sky was very clear, and the seeing far better than on the 9th, but the suspected object was missing, and a very careful search for several evenings following, failed to rediscover it. On the morning of the 12th, I telegraphed to Dr. SWIFT, and through him, Harvard College observatory, to assist in the search, but without success up to this writing.

Red House Observatory, September, 19th, 1884. WILLIAM R. BROOKS.

DRAWING OF SATURN.

February 11th, 1884.

Mr. Henry Pratt, F. R. A. S., has recently printed in the Monthly Notices, a beautiful Woodbury type of a drawing of *Saturn* by himsef.

As a scheme of the planet and rings, it is very satisfactory as it shows nearly every feature whose existence is undoubted, and none upon which much doubt is cast.

The refraction of the dusky ring in front of the planet by the planet's own atmosphere does not appear to the writer to be quite successfully portrayed, though it clearly is an attempt to depict the veritable phenomenon.

Whether in the printing of the especial copy of the Woodbury type, accessible to the writer, or by real design it is impossible to say, but the brightness of the brightest part of the whole system (ring B), is not uniform. In the writer's experience, the brightest part of ring B is equally bright all round the planet, east as well as west. In the picture it is noticeably not so.

A crucial test of the pictorial accuracy of a drawing of *Saturn* is to view it up-side down, and this picture, in spite of its real excellence, will not stand this test.

The ball appears to be unsymmetric in the rings. This lack of symmetry appears less strikingly in the proper view of the picture. The best view of the drawing is to be had by making the preceding ansa the top of the picture, and by allowing the light to be transmitted through the picture not reflected from it. Seen in this way it is of remarkable beauty. E. S. H.

The observers at Davidson observatory, San Francisco, California, under date Sept. 3, 1884, kindly favor the MESSENGER with the following notes and observations:

"The attention which has been called to the not instantaneous disappearance of the star B. A. C. 1992, the companion of *Beta Capricorni*, at its occultation last November, prompts me to send you the following table from my records to note another star that was not absolutely instantaneous.

"At the same time I made mention that on the 12th of September, 1883, I observed the occultations of *Beta Capricorni* and its companion, and I find no note made upon the appearance of the companion, to indicate any decrease of its light at the time of occultation.

"Last night I lost the occultations of *Beta Capricorni* and its companion, on account of fog which cleared away too late."

OCCULTATIONS.

Occultations of stars by the *Moon*, observed at the Davidson observatory, April 1st, 1884.

Disappearance of star.	Observer.	Teles'pe. Apert.	Teles'pe. Power	Observed Local Time. Mean.	Observed Local Time. Sidereal.	Remarks.
		In.	.	h m s	h m s	[instantaneous.
Arg. +18°:1178	D.	6.4	120	8 28 26.44	7 44 49.84	Not absolutely
7.9 mag.	H.	3.0	105	8 28 26.43	7 44 49.83	Good.
+18°:1179	D.			8 29 49.84	7 46 13.01	—— [doubtful.
8.5 mag.	H.			8 29 51.36	7 46 14.53	too faint, very
+17°:1214	D.			9 09 05 19	8 25 21.93	——
6.5 mag.	H.			9 09 05.13	8 25 21.87	Good.
						Ob'rs using dif. chronometers.

Prof. GEORGE DAVIDSON has published a Field Catalogue of 1278 Time and Circumpolar stars for 1885.0 The preface refers to the previous editions of the list, which was "an out-growth of the necessities of those parties of the U. S. Coast and Geodetic Survey, which were engaged in Geographical Reconnaissance, Telegraphic Longitude, Latitude and Azimuth work, and special investigations demanding the determination of exact local time."

The present list of 1278 stars is in continuation of the earlier ones. It contains 12 columns. Col. 1 and col. 10 give the current numbers;

Col. 2 gives the star's name; col. 3, its magnitude; col. 4, the R. A. to $0^s.1$; col. 5, its annual variation to $0^s.001$; col. 6, dec. to 1″; col. 7, the annual variation to 0″.01; col. 8, the sec. dec. to 0.01; col. 9, the authorities for the star's place (28 in number, of which all but 4 are in the English language); col. 11 notes on color, duplicity, etc. etc., and col. 12 is left blank for MS. notes—settings?

It would seem that the present list of the *Berliner Jahrbuch* (650 stars), should be large enough for all purposes. It has the further advantage of being, at least, approximately homogeneous. The present list contains, however, nearly twice as many stars, and may present advantages in rapid and hurried work. For the more elaborate operations of the survey, it would appear to be less important to provide a great number of stars, than to provide stars whose positions have been carefully reduced to one homogeneous system.

The narrow thin white cloud extending from a point about 30° above the horizon in the west, to 20° beyond the zenith in the east, seen by Philadelphia observers in the evening of July 30th, was also noticed by Professor SWIFT of Warner observatory. Speaking of the description of it given by a correspondent last month, he says the description was almost exactly as it appeared to him. He further adds: "I was greatly interested in the object at the time, and have reflected on it much since, but have not been able to find a satisfactory explanation as to what it was. I thought it a long narrow cloud at first, but its exceedingly slow motion soon convinced me that it was not a cloud. An auroral beam next suggested itself, of which I have seen several, but unlike them, it was not at right angles to the magnetic meridian as were the others. It was a conspicuous object visible for about forty-five minutes, and then disappearing in the eastern horizon."

The same phenomenon was seen at Carleton College observatory.

DESCRIPTION OF A METEOR.

About 9 o'clock on the evening of August 19th, being at North Wales, Pa., (22 miles northwest of Philadelphia), my attention was called by a companion to a bright meteor, which was visible for 3 or 4 seconds, and which left a luminous train, lasting ten seconds or longer. I saw the meteor in time to notice the greater portion of its flight. It first appeared, as my companion pointed out, near *Ursæ Majoris*, and passing between "the pointers" in that constellation, and a little below *Gamma*, rather less than 1°, estimating from memory, it vanished when about south of *Epsilon Ursæ Majoris*, or nearly in 13^h right ascension.

The train seemed to loose its brightness a little sooner than the meteor, so that when the latter disappeared, which it did quite suddenly, the train was but a feeble line of light for the first 4 or 5 degrees, then where it was more brilliant, it slowly broadened out to a degree or more in width, by the dispersion of the luminous matter, the whole extending about 25 degrees in length, and without the faint portion next to the meteor, presenting quite perfectly the form of a very elongated ellipse.

The meteor presented no percetible disc; but was five or six times brighter than *Venus* at her greatest brilliancy. It was undoubtedly one of the *Persids*, though considerably out of the beaten track. Another faint meteor apparently from the same source, was seen a few minutes later. GEO. P. MERRIMAN.

New Brunswick, N. J.
Aug. 25th, 1884.

ELEMENTS OF COMET (*b*), 1884, BARNARD.

$T=1884$, Aug. 17. 7202, Greenwich, M. T.
$\pi=303^\circ\ 4'\ 58''$
$\Omega=357^\circ\ 5'\ 22''$
$\omega=305^\circ\ 59'\ 36''$
$i=\ 6^\circ\ 52'\ 14''$
$\log q=0.1407591$
$d\lambda=-11''4.$
$d\beta=+76''.9$

Computed from observations at Nashville, July 16 and 22, and at Cambridge, July 28. GUSTAVE RAVENE.

Washington, D. C.,
Sept. 18, 1884.

The attention of observers is again called to the occultation of *Beta Capricorni* and its companion B. A. C. 1992, by the *Moon*, which takes place October 26th, $8^h\ 26^m.8$, Washington mean time. Three good observers claim that the companion is double. One predicted it several months ago from gradual disappearance when occulted by the *Moon*, the others have seen it double in a large telescope, and obtained the following measures, which were communicated directly to the MESSENGER:—Position angle 108°.6, Distance 0″.86. From recent private correspondence, it appears that some of the best observers in the country are not yet fully satisfied, and so we ask very general attention to the coming occultation, and indulge the hope that our readers may soon have the benefit of many observations.

Professor JOHN HEYWOOD of Otterbein College, Westerville, O., in a recent private letter, said that he had observed the *Moon* on the morning of September 16th, from $3^h\ 30^m$ to 4^h A. M., and found an unusually bright glow covering nearly uniformly the dark part of the *Moon's* disc. He thinks the phenomenon electric for two reasons: It was too bright for Earth-shine, and it obscured the features of the *Moon's* surface. This latter fact is puzzling and unsatisfactory. Professor HEYWOOD will give further attention to these interesting lunar phenomena, as he finds favorable opportunity for observation.

COMET BARNARD, 1884.

We received the following note from Mr. BARNARD too late for the September number of the MESSENGER:

"The comet reached its greatest southern declination July 28 or 29. Up to the last observations before the August *Moon* interfered, it had a tiny nucleus of about the eleventh magnitude. Since the *Moon* withdrew, it has not been possible to detect any evidence of a nucleus, although it is now very gradually a little brighter in the middle. On the 10th of August it was visible in the 1¾-inch finder. It has been observed on every favorable opportunity with the ring micrometer on the 6-inch equatorial. August 2nd it was seen in bright moonlight, but was exceedingly faint. August 6th I could barely see it in full moonlight. On the 11th it passed almost centrally over a 11th magnitude star which was considerably dimmed by the cometary light. Some twenty positions of this comet have been obtained here, every observation possible being secured."

The star near the comet July 18th was Lacaille 6637 of 7th magnitude. The light of the comet then was less than Lacaille 6607, which was the star referred to in the August MESSENGER, page 188.

SHORT FOCUS TELESCOPE.

Some time ago Professor HENRY HARRISON, of Jersey City, ordered of JOHN BYRNE, of New York City, a short focus telescope, and after testing it until he is satisfied, he claims that it is all that can be desired. He says: "The first object I viewed with the telescope was the planet *Saturn*, and the image surpassed anything I have heretofore seen; it was as sharp as if it had been cut out of a card board, and the rings and their divisions as well as the bands on the planet were clearly and well defined. *Saturn* was then in the zenith early in the evening, and five of its satellites were plainly visible. This planet was seen as well with a 0.2 eye-piece and an amplifier (giving a power of 380, its aperture being 4.25 inches and its focal length 39 inches), as I have seen it with Mr. RUTHERFORD's 12.5-inch refractor. The planet *Jupiter* gave still better results; its satellites appeared perfectly round and their shadows on the planet's disc were sharp and well defined. The light properties of this instrument are excellent. The so-called spurious disc of a first magnitude star, viewed with the highest power is exceedingly small, and the performance of the severest tests is easily accomplished; e. g. *Iota Cassiopeæ*, 36. *Andromedæ*, *Sigma of Corona Borealis* with Smyth's 11 magnitude following,—*Delta Cygni*, *Lambda Ophiuchi*, etc.

This telescope does admirable service as a comet seeker, for a two-inch eye-piece gives a power of 20 and a field of about two degrees which exhibits the two beautiful clusters of *Perseus* (512 and 521) at once. There is also the further advantage of handling it easily, as it does not require a large dome, a circumstance of importance to amateurs. I have possessed telescopes of normal length, but I have learned to prefer the 'Dumpy.'"

COMET WOLF, (1884).

Under date of Sept. 23, the following elements and ephemeris of the newly discovered comet, known as comet Wolf, were communicated by telegraph from Harvard College observatory as follows:

Two positions of this comet have been obtained at Harvard College observatory:

	d.	h.	m.	s.		App. α. h.	m.	s.	App. δ °	′	″
Sept.	21	9	51	59	Cambridge, M. T.	21	15	52.88	21	52	37.8
"	22	7	50	46	Cambridge, M. T.	21	16	19.22	21	28	17.6

From these observations, together with the announcement of discovery position, given in Circular No. 51, the following orbit has been computed by Messrs. CHANDLER and WENDELL.

ELEMENTS.

T=1884, November, 25.03

$$\left.\begin{array}{l}\pi = 20^\circ\ 30' \\ \Omega = 199\ \ 31 \\ i = 31\ \ 22\end{array}\right\} 1884.0 \qquad \begin{array}{l}(C-O) \\ \Delta\lambda \cos.\beta = +0'.1 \\ \Delta\beta \quad = 0'.0\end{array}$$

log q=0.2202.

EPHEMERIS.

Gr. M. T.		App. R. A. h.	m.	s.	App. Decl. °	′	Log. r.	Log. Δ.
Sept.	24.5	21	17	23	+20	35	0.2669	0.0033
	28.5		20	1	18	41	.2617	9.9980
Oct.	2.5		23	20	16	43	.2566	9.9940
	6.5		27	21	14	41	.2518	9.9913
	10.5		31	58	12	38	.2473	9.9903
	14.5		37	24	+10	31	.2430	9.9903

Light, September 17, unity. From September 24.5, to October 14.5, the computations show an increase of light from 1.11 to 1.32.

This comet was discovered by Dr. WOLF, of Zurich, September 17, 1884. It has a well-defined nucleus, and a faint short tail directed away from the *Sun.*

NEW NEBULA.

August 17th, Mr. E. E. BARNARD, of Nashville, Tenn., discovered an exceedingly faint nebula. It lies in low power field, with the small bright planetary nebula No. 4510 of the General Catalogue, and is south of that object.

$$\text{Its position is, R. A. } \left.\begin{array}{l}19^h\ 38^m\ 25^s \\ \text{Decl.} -15^\circ\ 2'\ 50''\end{array}\right\} 1884.0$$

This is the mean of two pointings with the 6-inch equatorial.

Quite a bright aurora was visible on the evening of the 13th inst. First noticed at $10^h\ 20^m$, at that time arch was about 10° above the horizon and nearly 4° in width. Very shortly, an appearance was presented resembling puffs of luminous smoke all along the arch, and at 10^h

30^m streamers began to shoot up towards the zenith, attaining an altitude of 20° or more. During the latter part of this time, the arch had risen somewhat, about 10^h 40^m, witnessing the last of the streamers. Five minutes later the coronal appearance only was seen nearly reaching to *Alpha Ursæ Majoris*. Nothing more noted after 10^h 45^m.

Hartford, Sept. 13th, 1884. W. C. P.

The following papers pertaining to Astronomy were read at the Philadelphia meeting of the A. A. A. S.:—

1. Results of Observations and Experiments with an "Almucantar" of four inches aperture at the Harvard College observatory, by S. C. Chandler, Jr.
2. On the Colors of Variable Stars, by S. C. Chandler, Jr.
3. Colors of the Stars. E. C. Pickering.
4. Temporary Stars. Daniel Kirkwood.
5. On the magnitude of the errors which may be introduced in the reduction of an observed system of stellar co-ordinates to an assumed normal system by graphic methods. Wm. A. Rogers.
6. Systematic Errors in Stellar Magnitudes. E. C. Pickering.
7. The Average Asteroid Orbit Ring and the Asteroid Ring. M. W. Harrington.
8. Micrometric Observations of *Jupiter's* third Satellite. David P. Todd.
9. On the Course of the Corrections to the Heliocentric Longitudes of Newcomb's tables of *Uranus* and *Neptune*. David P. Todd.
10. The Lunar Aurora. John Heywood.
11. Description of the Leander McCormick observatory of the University of Va. Ormond Stone.
12. On the Visibility of faint Objects under red Illumination. G. W. Hough.
13. The Nebulæ. Lewis Swift.
14. On the Constitution of the Earth and Planets. H. Hennessy.
15. Late Researches on the Solar Surface, with special reference to evanescent spots. S. I. Perry.
16. Harmonic Motion in Stellar Systems. P. E. Chase.
17. On the general expression for the value of the obliquity of the ecliptic at any given time, taking into account terms of the second order. J. C. Adams.
18. Note on Newton's Theory of Atmospheric Refraction, and on his method on finding the motion of the *Moon's* apogee. J. C. Adams.

All of these papers that can be secured, will be presented in the MESSENGER as early as practicable.

A new Minor Planet (239), was discovered by BORRELLY, at the observatory in Paris, August 27, 12^h 6^m.6. Marseilles mean time. Its magnitude is 12. September 13, the discovery of another Minor Planet was reported by telegraph from Europe. It was found by Dr. LUTHER, Sept. 12.379. Greenwich mean time. Its position was: R. A. 0^h 12^m 4^s; Decl. +10° 37′. Eleventh magnitude. If new, its number is (240).

We expected this month to present an illustration, and a detailed description of the great dome of the Leander McCormick observatory of the University of Virginia, built by Messrs. WARNER & SWASEY, of Cleveland, Ohio. As the drawings have not yet reached us, it must be deferred.

The new Meridian Circle for Carleton College observatory, by the REPSOLDS of Hamburg, Germany, is daily expected. Drawings for the piers and transit-room were received some weeks ago.

The DePauw University, of Greencastle, Indiana, has just ordered a 9.5-inch equatorial, and a 17-foot iron Dome from Messrs. WARNER & SWAZEY, of Cleveland, Ohio.

Erratum. MESSENGER No. 26, page 184, line 23 from the top, for 3°.9, read 3.′9.

Subscriptions and orders not previously acknowledged:—Chas. G. Boerner, Vevay, Indiana; Frank Drummond, Lamoni, Ia.; George H. Peters, care of Western Insurance Company, Chicago, Ill.; Wm. H. Barton, Cambridge, Maryland; Professor John P. D. John, De Pauw University, Greencastle, Indiana; M. Payet, Director of the Observatory, Bordeaux, France, (Volumes II. and III.); Alfred Bicknell, 82 Water St. Boston; Mrs. E. J. Dole, Melrose, Mass.; Abraham Cooper, Zanesville, Ohio; A. H. Tomlinson, Locust Valley, Queens County, N. Y.

BOOK NOTICE.

Elements of Analytic Geometry: by Simon Newcomb: pp. 356. Henry Holt & Co.

This work is an excellent text-book; it is written with simplicity and clearness, and contains the subjects usually studied in a college course, excepting Higher Plane Curves. Eighty pages are devoted to Geometry of Three Dimensions, treating of the Straight Line, the Plane and Quadric Surfaces. The properties of Quadrics are deduced from the general equation, slight attention being paid to the ordinary method of obtaining the equations of surfaces of revolution from those of their generating curves. The number of exercises is more than sufficient for the wants of the ordinary student, and some of them will tax his best endeavors. Realizing the fact that there are always some students who delight in mathematical study, Prof. NEWCOMB has introduced some additional matter. In the body of the work are a few pages on the Synthetic Geometry of the Circle, and the last fifty pages of the book give an introduction to Modern Geometry. Teachers who devote a term to Analytic Geometry will do well to examine this work thoroughly. H. A. H.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

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PENDING PROBLEMS OF ASTRONOMY.*

[*Continued from page 245.*]

Then there is the very interesting discussion concerning changes upon the *Moon's* surface. Considering the difference between our modern telescopes and those employed fifty or a hundred years ago, I think it still far from certain that the differences between the representations of earlier and later observers necessarily imply any real alterations. But they, no doubt, render it considerably *probable* that such alterations have occurred, and are still in progress; and they justify a persistent, careful, minute and thorough study of the details of the lunar surface with powerful instruments: especially do they inculcate the value of large-scale photographs, which can be preserved for future comparison as unimpeachable witnesses.

I will not leave the *Moon* without a word in respect to the remarkable speculations of Professor GEORGE DARWIN concerning the tidal evolution of our satellite. Without necessarily admitting all the numerical results as to her age and her past and future history, one may certainly say that he has given a most plausible and satisfactory explanation of

*From an address to the American association for the advancement of science at Philadelphia, Sept, 5, 1884, by Prof. C. A. YOUNG, at Princeton, retiring president of the association.—*Science.*

the manner in which the present state of things might have come about through the operation of causes known and recognized, has opened a new field of research, and shown the way to new dominions. The introduction of the doctrine of the conservation of energy, as a means of establishing the conditions of motion and configuration in an astronomical system, is a very important step.

In the planetary system we meet, in the main, the same problems as those that relate to the *Moon*, with a few cases of special interest.

For the most part, the accordance between theory and observation of the motions of the larger planets is as close as could be expected. The labors of LEVERRIER, HILL, NEWCOMB, and others, have so nearly cleared the field, that it seems likely that several decades will be needed to develop discrepancies sufficient to furnish any important corrections to our present tables. LEVERRIER himself, however, indicated one striking and significant exception to the general tractableness of the planets. *Mercury* the nearest to the *Sun*, and the one, therefore, which ought to be the best behaved of all, is rebellious to a certain extent: the perihelion of its orbit moves around the *Sun* more rapidly than can be explained by the action of the other known planets. The evidence to this effect has been continually accumulating ever since LEVERRIER first announced the fact, some thirty years ago; and the recent investigation by Professor NEWCOMB, of the whole series of observed transits, puts the thing beyond question. LEVERRIER'S own belief (in which he died) was, that the effect is due to an unknown planet or planets between *Mercury* and the *Sun*; but, as things now stand, we think that any candid investigator must admit that the probability of the existence of any such body or bodies of considerable dimensions is vanishingly small. We do not forget the numerous instances of round spots seen on the solar disk, nor the eclipse-stars of WATSON, SWIFT, TROUVELOT, and others; but the demonstrated possibility of error or mistake in all these cases, and the tremendous array of negative evidence from the most trustworthy observers, with the best equipment and opportunity, makes it little short of certain that there is no *Vulcan* in the planetary system.

A ring of meteoric matter between the planet and the *Sun* might account for the motion of the perihelion; but, as NEWCOMB has suggested, such a ring would also disturb the *nodes* of *Mercury's* orbit.

It has been surmised that the cause may be something in the distribution of matter within the solar globe, or some variation in gravitation from the exact law of the inverse square, or some supplementary electric or magnetic action of the *Sun*, or some special effect of the solar radiation, sensible on account of the planet's proximity, or something peculiar to the region in which the planet moves; but as yet no satisfactory explanation has been established.

Speaking of unknown planets, we are rather reluctantly obliged to admit that it is a part of our scientific duty as astronomers to continue to search for the remaining asteroids; at least, I suppose so, although the family has already become embarrassingly large. Still I think we are as likely to learn as much about the constitution, genesis, and history of the solar system from these little flying rocks as from their larger relatives; and the theory of perturbations will be forced to rapid growth in dealing with the effects of *Jupiter* and *Saturn* upon their motions.

Nor is it unlikely that some day the searcher for these insignificant little vagabonds may be rewarded by the discovery of some great world, as yet unknown, slow moving in the outer desolation beyond the remotest of the present planetary family. Some configurations in certain cometary orbits,and some almost evanescent peculiarities in *Neptune's* motions, have been thought to point to the existence of such a world; and there is no evidence, nor even a presumption against it.

Mercury, as yet, defies all our attempts to ascertain the length of its day, and the character and condition of its surface. Apparently the instruments and methods now at command are insufficient to cope with the difficulties of the problem; and it is not easy to say how it can be successfully attacked.

With *Venus*, the *Earth's* twin-sister, the state of things is a little better: we do already know, with some degree of approximation, her period of rotation; and the observations of the last few months bid fair, if followed up, to determine the position of her poles, and possibly to give us some knowledge of her mountains, continents, and seas.

It would be rash to say of *Mars* that we have reached the limit of possible knowledge as regards a planet's surface; but the main facts are now determined, and we have a rather surprising amount of supposed knowledge regarding his geography. By "supposed," I mean merely to insinuate a modest doubt whether some of the map-makers have not gone into a little more elaborate detail than the circumstances warrant. At any rate, while the "areographies" agree very well with each other in respect to the planet's more important features, they differ widely and irreconcilably in minor points.

As regards the physical features of the asteroids, we at present know practically nothing: the field is absolutely open. Whether it is worth anything, may be a question; and yet, if one *could* reach it, I am persuaded that a knowledge of the substance, form, density, rotation, temperature, and other physical characteristics, of one of these little orphans, would throw vivid light on the nature and behavior of interplanetary space, and would be of great use in establishing the physical theory of the solar system.

The planet *Jupiter*, lordliest of them all, still, as from the first, presents problems of the highest importance and interest. A sort of connecting-link between *Suns* and planets, it seems as if, perhaps, we might find, in the beautiful and varied phenomena he exhibits, a kind of halfway house between familiar terrestrial facts and solar mysteries. It seems quite certain that no analogies drawn from the *Earth* and the *Earth's* atmosphere alone, will explain the strange things seen upon his disk, some of which, especially the anomalous differences observed between the rotation periods derived from the observation of markings in different latitudes, are very similar to what we find upon the *Sun*. "The great red spot" which has just disappeared, after challenging for several years our best endeavors to understand and explain it, still, I think, remains as much a mystery as ever,—a mystery probably hiding within itself the master-key to the constitution of the great orb of whose inmost nature it was an outward and most characteristic expression. The same characteristics are also probably manifested in other less conspicuous but equally curious and interesting markings on the varied and ever-changing countenance of this planet; so that, like the *Moon*, it will well repay the most minute and assiduous study.

Its satellite system also deserves careful observation, especially in respect to the eclipses which occur; since we find in them a measure of the time required for light to cross the orbit of the *Earth*, and so of the solar parallax, and also because, as has been already mentioned, they furnish a test of the constancy of the *Earth's* rotation. The photometric method of observing these eclipses, first instituted by Professor PICKERING at Cambridge in 1878, and since re-invented by CORNU in Paris, has already much increased the precision of the results.

With reference to the mathematical theory of the motion of these satellites, the same remarks apply as to the planetary theory. As yet, nothing appears in the problem to be beyond the power and scope of existing methods, when carried out with the necessary care and prolixity; but a new and more compendious method is most desirable.

The problems of *Saturn* are much the same as those of *Jupiter*, excepting that the surface and atmospheric phenomena are less striking, and more difficult of observation. But we have, in addition, the wonderful rings, unique in the heavens, the loveliest of all telescopic objects, the type and pattern, I suppose, of world-making, in actual progress before our eyes. There seems to be continually accumulating evidence from the observations of STRUVE, DAWS, HENRY, and others, that these whirling clouds are changing in their dimensions and in the density of their different parts; and it is certainly the duty of everyone who has a good telescope, a sharp eye, and a chastened imagination, to watch them carefully, and set down exactly what he sees. It may well be that even a few decades will develop most important and instructive phenomena in this gauzy girdle of old *Chronos*. Great care, however, is needed in order not to mistake fancies and illusions for solid facts. Not a few anomalous appearances have been described and commented on, which failed to be recognized by more cautious observers with less vivid imaginations, more trustworthy eyes, and better telescopes.

The outer planets, *Uranus* and *Neptune*, until recently, have defied all attempts to study their surface and physical characteristics. Their own motions and those of their satellites, have been well worked out; but it remains to discuss their rotation, topography, and atmospheric peculiarities. So remote are they, and so faintly illuminated, that the task seems almost hopeless; and yet, within the last year or two, some of our great telescopes have revealed faint and evanescent markings upon *Uranus*, which may in time lead to some further knowledge of that far-off relative. It may, perhaps, be that some great telescope of the future will give us some such views of *Neptune* as we now get of *Jupiter*.

There is a special reason for attempts to determine the rotation periods of the planets, in the fact that there is very possibly some connection between these periods, on the one hand, and, on the other, the planets' distances from the *Sun*, their diameters and masses. More than thirty years ago, Professor KIRKWOOD supposed that he had discovered the relation in the analogy which bears his name. The materials for testing and establishing it were then, however, insufficient, and still remain so, leaving far too many of the data uncertain and arbitrary. Could such a relation be discovered, it could hardly fail to have a most important significance with respect to theories of the origin and development of the planetary system.

The great problem of the absolute dimensions of our system is, of course, commanded by the special problem of the solar parallax; and this remains a problem still. Constant errors of one kind or another, the origin of which is still obscure, seem to affect the different methods of solution. Thus, while experiments upon the velocity of light and heliometric measurements of the displacements of *Mars* among the stars agree remarkably in assigning a smaller parallax (and greater distance of the *Sun*) than seems to be indicated by the observations of the late transits of *Venus*, and by methods founded in the lunar motions, on the other hand, the meridian observations of *Mars* all point to a larger parallax and smaller distance. While still disposed to put more confidence in the methods first named, I, for one, must admit that the margin of probable error seems to me to have been rather increased than diminished by the latest published results deduced from the transits. I do not feel so confident of the correctness of the value 8″.80 for the solar parallax as I did three years ago. In its very nature, this problem is one, however, that astronomers can never have done with. So fundamental is it, that the time will never come when they can properly give up the attempt to increase the precision of their determination, and to test the received value by every new method that may be found.

The problems presented by the *Sun* alone might themselves well occupy more than the time at our disposal this evening. Its mass, dimensions, and motions, as a whole, are, indeed, pretty well determined and understood; but when we come to questions relating to its constitution, the cause and nature of the appearances presented upon its surface, the periodicity of its spots, its temperature, and the maintenance of its heat, the extent of its atmosphere, and the nature of the corona, we find the most radical differences of opinion.

The difficulties of all solar problems are, of course, greatly enhanced by the enormous difference between solar conditions and the conditions attainable in our laboratories. We often reach, indeed, similarity sufficient to establish a bond of connection, and to afford a basis for speculation; but the dissimilarity remains so great as to render quantitative calculations unsafe, and make positive conclusions more or less insecure. We can pretty confidently infer the presence of iron and hydrogen and other elements in the *Sun* by appearances which we can reproduce upon the *Earth*; but we cannot safely apply empirical formulæ (like that of DULONG and PETIT, for instance), deduced from terrestrial experiments, to determine solar temperatures; such a proceeding is an unsound and unwarrantable extrapolation, likely to lead to widely erroneous conclusions.

For my own part, I feel satisfied as to the substantial correctness of the generally received theory of the *Sun's* constitution, which regards this body as a great ball of intensely heated vapors and gases, clothed outwardly with a coat of dazzling clouds formed by the condensation of the less volatile substances into drops and crystals like rain and snow. Yet it must be acknowledged that this hypothesis is called in question by high authorities, who maintain with KIRCHOFF and ZOLLNER, that the visible photosphere is no mere layer of clouds, but either a solid crust, or a liquid ocean of molten metals; and there may be some who continue to hold the view of the elder *Herschel* (still quoted as authoritative in numerous school-books), that the central core of the *Sun* is a solid and even habitable globe, having the outer surface of its atmosphere covered with a sheet of flame maintained by some action of the matter diffused in the space through which the system is rushing. We must admit that the question of the *Sun's* constitution is not yet beyond debate.

And not only the constitution of the *Sun* itself, but the nature and the condition of the matter composing it, is open to question. Have we to do with iron and sodium and hydrogen as we know them on the *Earth*, or are the solar substances in some different and more elemental state?

However, confident many of us may be as to the general theory of the constitution of the *Sun*, very few, I imagine, would maintain that the full explanation of the Sun-spots and their behavior has yet been reached. We meet continually with phenomena, which, if not really contradictory to prevalent ideas, at least do not find in them an easy explanation.

So far as mere visual appearances are concerned, I think it must be conceded, that the most natural conception is that of a dark chip or scale thrown up from beneath, like scum in a caldron, and floating, partly submerged, in the blazing flames of the photosphere which overhang its edges, and bridge across it, and cover it with filmy veils, until at last it settles down again and disappears. It hardly *looks* like a mere hollow filled with cooler vapor, nor is its appearance that of a cyclone seen from above. But then, on the other hand, its spectrum under high dispersion is very peculiar; not at all that of a solid, heated slag, but it is made up of countless fine dark lines, packed almost in contact, showing, however, here and there a bright line, or at least an interspace where the rank is broken by an interval wider than that which elsewhere separates the elementary lines,—a spectrum, which, so far as I know, has not yet found an analogue in any laboratory experiment. It seems, however, to belong to the type of absorption spectra, and to indicate, as the accepted theory requires, that the spot is dark in consequence of *loss* of light, and not from any original defect of luminosity. Here, certainly, are problems that require solution.

The problen of the *Sun's* peculiar rotation and equatorial acceleration is a most important one and still unsolved. Probably its solution depends in some way upon a correct understanding of the exchanges of the matter going on between the interior and the surface of the fluid, cooling globe. It is a significant fact (already alluded to), that a similar relation appears to hold upon the disk of *Jupiter*; the bright spots near the equator of the planet completing their rotation about five minutes more quickly than the great red spot which was forty degrees from the equator. It is hardly necessary to say that an astronomer, watching our terrestrial clouds from some external station (on the *Moon*, for instance), would observe just the reverse. Equatorial clouds would complete their revolution more slowly than those in our own latitude. *Our* storms travel toward the east, while the volcanic dust from Krakatoa moved swiftly west. We may at least conjecture that the difference between different planets somehow turns upon the question, whether the body whose atmospheric currents we observe is receiving more heat from without than it is throwing off itself. Whatever may be the true explanation of this peculiarity in the motion of sun-spots, it will, when reached, probably carry with it the solution of many other mysteries, and will arbitrate conclusively between rival hypotheses.

The periodicity of the sun-spots suggests a number of important and interesting problems; relating, on the one hand, to its mysterious cause, and, on the other, to the possible effects of this periodicity upon the earth and its inhabitants. I am no 'sun-spottist' myself, and am more than sceptical whether the terrestrial influence of sun-spots amounts to anything worth speaking of, except in the direction of magnetism. But all must concede that this is by no means yet demonstrated (it is not easy to prove a negative); and there certainly are facts and presumptions enough tending the other way to warrant more extended investigation of the subject. The investigation is embarrassed by the circumstance, pointed out by DR. GOULD, that the effects of sun-spot periodicity, if they exist at all (as he maintains they do), are likely to be quite different in different portions of the earth. The influence of changes in the amount of the solar radiation will, he says, be first and chiefly felt in alterations and deflections of the prevailing winds, thus varying the *distribution* of heat and rain upon the surface of the earth without necessarily much changing its absolute amount. In some regions it may, therefore. be warmer and drier during a sun-spot maximum, while in adjoining countries it is the reverse.

[*To be continued.*]

AMOUNT OF ATMOSPHERIC ABSORPTION.*

The earth is surrounded by an absorbing atmoshpere, and we never see the *Sun* or stars except through it. To determine the absolute brightness of these bodies, we must first know the degree and kind of this absorption, and add the amount of it to the observed quantities of light at the surface of the *Earth*.

The earliest observations of the last century gave the light absorption as 19 per cent. of the whole (at sea level). The elaborate ones by SEIDEL, of Munich, 21 per cent.; PRITCHARD, of Oxford, 21 per cent., the most recent by MUELLER, of Potsdam, 17, and those of POUILLET on the *Sun's* heat gave 18 to 24 per cent. Almost all of a great number of observations of 'light' or 'heat' that might be cited, give about 20 per cent. Late observations show, on the whole, that 'light' rays are more absorbable than those of 'heat,' and that in particular, blue light is much more so; the difference between the two mean co-efficients being small. The careful series of observations by ERICSSON on the *Sun's* heat gives about 21 per cent. After citing all these authorities and noticing the close agreement of their results, Professor LANGLEY says, "I have arrived at a result so wholly different, that in the face of such authority, I almost hesitate to announce it; for I have been forced to the conclusion, that all these determinations are in error; and not in some small degree, but by a quantity at least equal to the total amount in question."

He does not question the general accuracy of the above-named skillful investigators and others, but he does claim that the common method of reducing their observations is erroneous, and singularly, too, this error is always in one direction.

Professor LANGLEY reaches his conclusions from both theoretical and experimental investigation. It is well

*Abstract of a communication made to the National Academy of Sciences, April, 1884, by Professor S. P. Langley, Allegheny Observatory.

known to the readers of the MESSENGER, that he has been engaged for years in observations of this kind at home and abroad, at sea level and at great altitudes, and that he has established the fact that the laws under which solar and stellar light and heat are absorbed by the atmosphere are so complex that their complete comprehension is still beyond our power, and that we may improve our ways of studying them, because certain facts pertaining to atmospheric absorption are now better understood, than they were formerly.

In methods of study heretofore the atmosphere was thought of as a homogeneous absorbing medium, divided in imagination, into successive strata of identical thickness and chemical constitution. Then, suppose A to be a source of radiant heat or light whose intensity is reduced in passing through the first stratum to a fraction of the original quantity represented by p, so that what was A becomse Ap. Then, since the second stratum is identical with the first in constitution and amount, it is assumed that a like effect will be produced on the quantity Ap which will result in Ap^2; after the third stratum the result will be Ap^3 etc., until e strata would give a result of Ap^e. But these expressions indicate that the amount transmitted at any point will be proportional to the ordinate of a logarithmic curve, a law, if true, easily understood and simple in application. Then by observation two equations may be obtained in the form of $Ap^2 = m$, $Ap^3 = n$, from which both A and p become known. Now if we designate the number of strata e, then $Ap^e = t$; the exponential formula of POUILLET and later investigators. Its fundamental (and erroneous) assumption is that the co-efficient of transmission (p) is a constant.

It is doubtless true that radiation is not simple but complex. Heat, like light, is of different kinds. Could we see it, it would appear of totally different colors, and we ought no more attribute to it a single rate of absorption in any medium than to assume that a blue and a red ray would pass through a red glass with equal facility. The bearing of this fact on the question in hand is plain. Solar energy, whether regarded in whole as 'heat' or 'chemical action,' or in part as 'light' is the sum of an infinite number of radiations conceivably influenced in an infinite number of ways by varying atmospheric conditions. The larger particles reflect the light and heat treating all wave-lengths alike, or diminish the direct radiation by nearly general absorption; minuter ones begin to act selectively, or on the whole, more at one end of the spectrum than the other; smaller particles of dust or faintest mist, and smaller ones still form probably a continuous sequence of more and more selective action, down almost to the actual molecule whose vibration is felt in the finely selective absorption of some single ray. The effect of the action of the grosser dust particles is to produce absorption of all rays, and the spectrum is equally less bright and less hot. The effect of the molecular absorption is selective action, in the form of dark telluric lines, taking out some kinds of light and heat, and not others, so that after absorption what remains is not only less in amount but altered in kind.

From this it must appear that the co-efficient of transmission is truly constant only in the case of the absolutely homogeneous ray; and hence the great difficulty of determining the or iginal lightfrom a star, or heat of the *Sun*; by any known methods. If a certain narrow space of the spectrum is measured and its co-efficient of transmission determined in the function of wave-lengths, we can not take the integral of that function because the unit is really discontinuous. Professor LANGLEY then treats this most interesting problem by ordinary algebraic processes and deduces four important results, as follows:

When the separate co-efficients of transmission are positive and less than unity (as is the case in Nature) the general co-efficient of transmission in the customary experimental formula is:

1. Never a constant (as determined from the customary formula).
2. Always too large.
3. Always larger and larger as we approach the horizon.

4. The original light or heat of the heavenly body determined by common methods is always too small, a conclusion which is reached in two different ways.

[*To be continued.*]

NAVAL OBSERVATORY AT WASHINGTON,

PROFESSOR RALPH COPELAND.

The distinguished astronomer, Professor RALPH COPELAND. of Dun Echt observatory, Scotland, recently visited the principal observatories of the United States, and his remarks concerning the Naval Observatory at Washington appear in the last issue of the *Astronomical Register* as follows:

The great 26-inch equatorial differs only in size from the rest of the telescopes made by Messrs. ALVAN CLARK& Sons. It has the same somewhat light mounting and axes, the same plain well-proportioned tube of riveted steel plates and the same absence of nearly all the outer fittings and adjuncts that are considered desirable about large instruments in Europe. It is indirectly driven by water which continually winds up the clock-weight. The clamping in declination is done in the usual way with a long rod, but both the slow motions, the clamping in right ascension and a special quick motion in hour angle are effected by cords. The white setting-circles are lit up when required by gas-light reflected from the wall by concave glass mirrors. The setting is done by the attendant who manages the dome and also throws light from a bull's-eye lantern into the end of the micrometer when bright-wire illumination is desired. The parallel wire micrometer has but one measuring screw, as with the considerable focal lengths of our large instruments it is quite possible to construct micrometer screws that are practically perfect, and thus do away with the necessity of changing the zero-point to eliminate periodic error. The sidereal clock is let into the wall of the dome so as to be out of the way. In short, everything is done to give free scope to the observer and to simplify the instrument, trusting to skill on the astronomer's part and considerable zeal on that of the attendant to meet the ever-varying demands of the work in progress.

On the evening of August 18, 1883, Professor Hall had the great kindness to show the writer a number of objects through telescope. α Lyræ with powers of 400 and 600 exhibited a sharp central disk with fine brilliant uniformly distributed rays on a moderate ground of outstanding palish blue; of course, the well-known companions were egregiously conspicuous. The action of the lens did not strike me as being different from that of the best telescopes with which I was acquainted. ε Lyræ was looked at chiefly as being a familiar object and one that the writer had just seen through a 12-inch Alvan Clark glass. The moonlight and some hazy cloud doubtless prevented the gain in light from being specially evident. Σ 2422 with a central distance of about $0''.8$ gave an opportunity of making a demand on a power of 900. A sketch repeatedly compared with the object shows the disks to have been about $0''.4$ in diameter and consequently separated by that interval. *O*Σ 387 with a distance of about half a second of arc was so distinctly separated as to give the assurance that under very favorable circumstances the glass might be trusted to work down to the closest theoretical limits of rather less than two-tenths of a second of arc provided the component stars were fairly equal and not too brilliant. Mr. Burnham's companion to β Aquilæ was so obvious that it could not be considered a test object. The instrument was very steady, but yielded in an elastic manner to the extent of one minute or so of arc when lightly pressed at right angles to the meridian, thus indicating a want of transverse stiffness in the mounting. The attendant did the setting quickly by the aid of the coarsely-divided painted circles, Professor HALL dictating the hour angles and the polar distances. The equatorial stands on the main floor of the observatory in a comparatively lightly-constructed building with the usual hemispherical dome moved on a plan little differing from that of the Dublin dome. The opening is 6½ feet wide and is covered by a sheet of oiled canvas running in guides and let down in a nautical fashion when the telescope is in use. The special computing room for the equtoreal work adjoins the dome. The cost of the instrument was £9,000, of which about £1,200 were paid to Messrs. CHANCE BROTHERS & Co., of Birmingham, for the glass disks.

Mounted in a dome surmounting the whole observatory is a 9·6-inch Munich equatorial of the usual construction. This, the fine Mural circle by TROUGHTON & SIMMS, as well as the 7-foot transit by ERTEL, do not call for special remark. The great transit-circle by PISTOR & MARTINS has a telescope of 12 feet focal length and $8\frac{1}{2}$ inches aperture with interchangeable ends. The collimators are of the usual small German type, having only $2\frac{1}{8}$ inches aperture, so that it may well be doubted whether the results they give fairly represent the collimation of the main telescope. The two movable circles have an effective diameter of 43·4 inches, and are divided to every 2′, each being read by four microscopes. The instrument is arched over with ladders, much on the Greenwich plan, so as to afford every facility for reflex and nadir observations. Professor NEWCOMB'S researches show that the graduations of the circles are remarkably free from systematic errors and that greater final accuracy is to be expected from occasionally changing their positions so as to use fresh divisions, than by the most elaborate determination and application of division corrections. The walls of the building are of thin sheet iron shaded by louvre-work on the outside. The inside temperature is found to differ very little from that of the external air. In a small detached building is a new reversible transit-instrument made by Messrs. STACKPOOLE Bros., of New York, from designs by Professor HARKNESS. In it the bearings are segments of cylinders—a detail of construction worthy of more general imitation.

All the photographs of the recent transit of *Venus* taken by the American parties are now being measured at the the Naval Observatory under the supervision of Professor HARKNESS, who has devised most ingenious apparatus for the purpose. Polar co-ordinates are measured and referred to the photographed image of a plumb-line, whose support was regularly varied to eliminate *kink*. Between 1,300 and 1,400 pictures are available. Tney were taken with long-focus lenses, through which the light was thrown by unsilvered mirrors, both being made by the CLARKS. The writer saw some spirit levels of a novel construction in which the tube was enclosed in close proximity to the glass lid of a box; the divisions being on the underside of the covering and not on the lube, Professor HARKNESS being of the opinion that the figure and elasticity of the tube are injured by the ordinary divisions.

A new 7-inch heliometer is to be made for the Cape observatory, for work in charge of Dr. GILL. It will cost £2700, and is being constructed by Messrs. REPSOLD, of Hamburg.

GREENWICH, THE WORLD'S MERIDIAN.

According to announcement, the International Conference to fix a prime meridian for the world, assembled at Washington, Oct. 1. Forty delegates, representing twenty-five nations, were present. This country was represented by Admiral C. R. P. Rogers, L. M. Rutherford, W. F. Allen, Commander W. T. Sampson and Professor C. Abbey. By vote of the conference, Professor Newcomb, Dr. Hilgard Professor Hall, Dr. Valentiner (Karlsruhe observatory) and Sir William Thompson were invited to the meetings of the conference, and to participate in the discussion of questions under consideration. After considerable discussion as to the details of work, Mr. Rutherford, of the United States, offered the following resolution:

"That the conference proposes to the governments here represented the adoption of the meridian passing through the center of the transit instrument at the Observatory of Greenwich, as the initial meridian for longitude."

"Mr. Fleming, of Canada, moved as an amendment, that the conference adopt the 180th degree of longitude, east or west from Greenwich as the prime meridian, but the other delegates from Great Britain opposed this amendment and it was lost.

"Mr. Valera, the Spanish minister, stated that he had been instructed by his government, in voting for the meridian of Greenwich, to say that he hoped the Metric System of weights and measures would be adopted by England, the United States and the other nations here represented, as recommended by the conference at Rome.

"Gen. Strachey, of Great Britain, said that he was authorized to state that his country had asked to be allowed to join the Metric convention, and that the Metric System was already recognized by the laws of Great Britain, and was in use for scientific purposes. He could not, however, say that it would be adopted under any circumstances as the popular system of weights and measures throughout the kingdom.

"Mr. W. F. Allen, of the United States, made an argument in behalf of the meridian of Greenwich, and presented the resolutions adopted by the railroad convention in Philadelphia, protesting against a change of meridian.

"Mr. Lefaivre, of France, said that the meridian of Greenwich was not the scientific meridian; that it implied no progress in any of the sciences, but was merely a commercial standard. Since, therefore, nothing would be gained to science by adopting Greenwich, France could not make a sacrifice of her own meridian, and incur the vast expense consequent upon the adoption of a new one, because she would thereby gain no advantage whatever."

"Mr. Janssen, of France, was in favor of a neutral meridian, and was not interested in the discussion, if that principle were rejected. He maintained that the 'need of a common prime meridian was limited to Geography and Hydrography alone, and were wholly independent of Astronomy and Geodesy.

"Professor Adams, of England, spoke of the dependence of all meridians on astronomical observations, and the difficulty of getting any of high accuracy on account of the irregular figure of the *Earth*; that there could not be any important distinction between geographical and astronomical longitudes as such, although so claimed by some delegates of the conference.

"Sir William Thompson, who is delivering lectures in Baltimore, was present then as a guest, and by invitation of the conference spoke at some length in favor of the adoption of Greenwich. He held that it was purely a matter of convenience, and that Greenwich answered the convenience of the world better than any other standard meridian.

"There was an effort made to discuss the subject of the Metric System of weights and measures, but the president stated that, as that subject was not referred to in the acts of Congress relating to the conference, or in the official circulars issued by the president of the United States, it was not a proper subject for present discussion.

"Sir Frederick Evans, of Great Britain, then presented a comparative statement, showing that the tonnage of shipping controlled by the Greenwich standard of longitude was, in round numbers, 14,000,000 tons, while that controlled by the Paris standard was only 1,735,000 tons. He also submitted a statement of the number of charts, etc., purchased by nations outside of Great Britain for scientific and commercial purposes, in order to show how largely that meridian is now being used.

"Mr. Rutherford's resolution in favor of Greenwich, as the prime meridian was then adopted, twenty-one nations voting in favor of it, one (San Domingo) against it, and France and Brazil abstaining from voting.

"Mr. Rutherford then moved the adoption of the following resolution: 'From this meridian (Greenwich) longitude will be counted in two directions up to 180 degrees, east longitude being plus and west longitude minus.' The Russian minister spoke in favor of this resolution."

After extended discussion, Mr. Rutherford's second resolution was adopted by a small majority.

The very general agreement of this conference, in selecting the meridian of Greenwich, as the zero for longitude for the world, is a step in advance for science. On the other hand, it is a matter of wonder and regret that the apparently strong reasons in favor of reckoning longitude one way to 360° only, should not have carried with equal unanimity.

It can scarcely be supposed that any scientist of national reputation, judging of that which is best for the common cause, would prefer two systems of equal longitudes on the *Earth's* surface, having the importance difference only of an algebraic sign. If dipolmatic relations were to be regarded as the chief factor in the problem, it is then easy to see why two or a dozen different systems should be maintained.—*Editor.*

NOTES RELATING TO MERIDIAN CIRCLES.

BY JOHN TATLOCK, JR.

During the past year, while engaged in meridian work, I have made, from time to time, notes on the values of the constants pertaining to different instruments, for comparison with the values which were found to belong to the instrument with which I was working. More especially I have searched for the value of the probable errors which different observers have ascribed to their results. In what follows I have given a part of these notes which I have collected, as they may be of interest to some of the readers of the MESSENGER. I have made no attempt to make a full and complete collection of existing data on the various subjects, but have simply put down those which have casually come under my notice.

In most cases I have given the authority, where none is given, it is to be understood that the information was derived from private sources.

Prof. HOLDEN wishes me to state that everything which pertains to the Madison meridian circle is to be regarded as merely approximate and preliminary.

VALUE OF THE FLEXURE CONSTANT OF VARIOUS INSTRUMENTS.

Dr. GOULD, at Cordoba, with the Repsold meridian circle, finds 0.″7.

(Annals, vol. II).

Prof. ROGERS, at Cambridge, Mass., with the Troughton & Simms meridian circle, found, by using collimators, in May 1876, a constant of 2.″03. Another series, in the same month by another observer, gave 1.″83. In December 1876, he found 1.″77, and in January 1877, after the reversal of the instrument, he found a constant of 0.″94.

The value that has been used at Cambridge is 2.″37, which is derived from the observation of the fundamental stars.

(Annals H. C. O., vol. X).

At Greenwich, Eng., Mr. AIRY found 0.″41 as the flexure constant of the large transit circle, (Chauvenet's Astronomy, vol. II). In May 1881, the constant was determined to be 0.″15. (Introd. to Gr. obs. 1881). The value used in 1883 was −0.″49.

(Introd. to Gr. obs. 1883).

Prof. BOSS, at Albany. with the P. & M. circle, used for the zone observations, a constant of 0.″47.

(V. J. S., 1880).

BESSEL, with the Reichenbach circle, in 1820-21, found 0.″56.

(Boss' Report on the declination of the fixed stars).

DUNER, at Lund, uses for the zone, 0.″57. P. &. M circle.

(Perrotin, *Visite de l' observatoires d' Europe*).

At Paris, Lowy's apparatus gave a constant of 1″.03 and the collimators 1.″15.

(Copernicus, vol. I, p. 90).

For the Dunsink meridian circle, P. & M.—the constant is—0."53 for circle east, and —0".05 for circle west.

(Ast. Researches, made at Dunsink, vol. IV.)

On the Leyden meridian circle—P. &. M.—both circles are divided. One gives a flexure constant of 0."23 and the otber 0."09.

(Annalen, B and II).

CARRINGTON, with the Troughton & Simms circle, found 0."60.

(Redhill Catalogue).

For the Pulcova meridian circle the flexure of the telescope + the flexure of one circle was found to be + 1."68. With the other circle this became + 2."41.

(*Struve's Description de 'l observatoire central*).

Dr. SCHUR, at Strassburg, with the Repsold circle finds 0."13.

RESPIGHI, at Rome, in his latitude determination, used 0."94.

(Declinazioni medie pel. 1875.0 di 285 stelle.)

For the Washington transit circle—P. & M.—the constant is about — 0."9.

(Washington Obs. 1872).

At Madison, in 1883-84, with the Repsold meridian circle, one observer found the constant to be — 0."13, and another — 0."17.

PROBABLE ERROR OF A SINGLE POINTING OF ONE MICROSCOPE OF A MERIDIAN CIRCLE.

PETERS, with the Pulcova Vertical circle, found ± 0."090 at night and ± 0."098 by day.

(Struve, *Description de l' observatoire central*).

Dr. GOULD, at Cordoba, with the Repsold circle, thinks that it cannot be less than ± 0."2.

Prof. NEWCOMB, at Washington, with the P. & M. circle, found ± 0."10.

(Wash. Obs. 1865. Description of transit circle).

STRUVE, at Berlin, in 1820, with a Pistor circle, found ± 0."16.

(Description de l' observatoire central).

Dr. SCHUR, at Strassburg in 1883, with the Repsold circle, finds ± 0.″3.

Prof. BOSS, at Albany, thinks that, with his circle he cannot reduce the p. e. of a single pointing below ± 0.″2.

(V. J. S., 1880).

At Madison, with the Repsold circle, Prof. HOLDEN found in 1882, for this quantity ± 0.″15, and Mr. COMSTOCK found ± 0.18. In September 1883, from a special series of observations for the purpose of determining this quantity, I found ± 0.″11. In October 1883, I found, from a number of observations to determine error of runs, ± 0.″16 In June 1884, from an extended series of readings, for the purpose of determining division error, I found ± 0.″14.

PROBABLE ERROR OF A SINGLE OBSERVATION IN RIGHT ASCENSION AND DECLINATION.

Dr. ROBINSON, at Armagh, finds ± $0^s.080$ sec. δ and ±0.″816.

(Places of 1000 stars).

Prof. ROGERS, at Cambridge, finds ± $0.^s024$ sec. δ and ± 0.″66 from two microscopes, and ± 0.′39 when four are read.

(Annals, H. C. O. vol. X).

M. SCHÆBERLE, at Ann Arbor, found ± $0.^s040$ sec δ and ± 0.″55.

(Publications of the Washburn Observatory, vol. I).

Prof. SAFFORD, at Williamstown, in 1882, in his circumpolar work, found ± $0.^s0264$ sec. δ.

(SIDEREAL MESSENGER, May, 1883.

Mr. DUNKIN, from a discussion of the Greenwich observations, found ± $0.^s017$ by the chronographic method. For a transit over a single wire he found ± $0.^s078$ eye-and-ear, and ± $0.^s051$ chronographic.

(Monthly Notices, R. A. S. 1863).

Dr. DREYER, at Dunsink, found in dec. ± 0.″63, for stars north of—10°, and ±0.″73 for stars between—10° and—26°. He also found the p. e. of a clock correction from a *single* star to be ± 0.ˢ 052. and the p. e. of an equator-point from a single star to be ± 0.″55.

(Ast. Researches, made at Dunsink, part IV).

SCHELLERUP, at Copenhagen, P. & M. circle, gives the p. e. of a single polar point as ± 0.″53. The p. e. of a clock correction from a *single* star is ± 0.ˢ 056. and the p. e. of a single complete observation in R. A. in ± 0.ˢ 036.

(Catalogue of 10,000 stars).

Prof. COFFIN, with the Mural circle. at Washington, found ± 0.″55.

(Washington Obs. 1846).

With the Pulcova Vertical circle, the p. e. of one obs. in δ is ± 0.″17. This is from the observations for the determination of the atitude.

(*Description de l' observatoire central*).

Dr. COPELAND, at Dunsink in 1875-76, found ± 0ˢ.049 and ± 0.″44.

(Dun Echt Obs. Pub. vol. II).

At Washington in 1877, from the observation of the *Mars* comparison stars, the p. e. of one observation is found to be ± 0.″30 from the work of all the observers, and ±0.″23 from the work of three.

(Washington Obs. 1877. Appendix III).

At Leyden. for these same stars the p. e. of one observation was ± 0.″26.

(Same reference as above).

At Melbourne, from the observations of the same stars, this quantity is found to be ± 0.″35.

(Same reference as above).

Dr. HILFIKER, at Neuenberg in 1883, found for one observation in δ ± 0.″67.

(Ast. Nach. No. 2541).

At Madison, from a preliminary discussion of the observations of the Southern fundamental stars, there have been found the following:

p. e. of a transit over one wire, ± 0.ˢ 058.

p. e. of a clock correction from a single star, ± 0.″028.

p. e. of an equator point from a single star, ± 0.″4.

EDITORIAL NOTES.

A very suggestive and thoughtful paper by M. THOLLON, has appeared in the *Bulletin Astronomique*, (French), on the *Constitution and Origin of the group* B *of the Solar Spectrum.* It will be read with profit, in connection with a late paper elsewhere, noticed from the pen of Professor LANGLEY. The study of the metallic and the telluric lines in this region of the solar spectrum indicates surprising results, if the writer is correct in his theory. The closing paragraphs of the paper will indicate something of its drift, especially regarding Captain ABNEY'S views, which were set forth in *Nature* (Oct. 12, 1882, p. 585). The position then taken, was that the groups A and B can not be regarded as telluric, but as proceeding from a medium lying some where between the *Sun* and *Earth*. PIAZZI SMYTH adopted the same views, and the later work of Mr. SIEMENS seemed to be confirmatory. Most of our readers perhaps may already know that a telluric line in the spectrum is a "very narrow, black and cold region, where the absorption has already done its full work, or which is at any rate so black and so cold, that it can grow very little blacker or colder." On this point Mr. THOLLON says:

"During the total eclipse of 1882, both M. TREPIED and myself, fancied we observed on the edge of the lunar disk, a notable strengthening of the rays of the B group.

"If Captain ABNEY'S theory could have been confirmed, it would have certainly added great weight to our observations, and for my own part, I should have felt highly satisfied at the result. Unfortunately, the atmosphere of oxygen, which should now be attributed to the *Moon*, in order to produce the observed effects, seems scarcely reconcilable with the absence of refraction in the luminous rays striking the edge of our satellite. I greatly fear the results obtained in Egypt, are one of those illusions, of which nearly all spectroscopists have been more or less victims.

"It would now be important to ascertain whether the nitrogen and carbonic acid of the air may not be represented by any line or any group of the solar spectrum. The study I am at present engaged in, according to the above described method, will not fail, I trust, to yield precise results on this important point. Hitherto, apart from the oxygen groups, I have discovered no line that may be confidently attributed to the constant elements of the atmosphere. Hence, it is desirable to await the result of my researches, before giving effect to the project adopted by M. BISCHOFFSHEIM to establish Mont Gross metallic tubes of considerable length, in which the spectra of absorption gases may be studied on a grand scale.

Professor SIMON NEWCOMB'S paper in A. N. No. 2617, entitled, *Remarks on the theory of relations among the mean motions of the planets*, has several points of interest to those familiar with the principles of perturbations and the theories of related mean motions of the planets. Professor BRUNS, of Leipsic, has recently called attention to such a relation between the mean motions of *Pallas* and *Jupiter*. From Professor HALL's discussion of his observations of *Hyperion*, Professor NEWCOMB has discovered a new relation between the motions of that satellite and *Titan*.

That relation is

$$4l'-3l-\pi'=180^\circ+H,\ H=-18^\circ \sin(\pi-\pi')$$

The accented quantities refer to the outer satellite *Titan*. The consequences are best stated in his own words:

"This remarkable relation results in the motion of the perisaturnium of *Hyperion* being totally different from what it should be by the ordinary theory of secular variations. This theory would give a direct motion not differing much from 3° or 4° per annum. The result of the above relation is that the theory of secular variations does not apply at all, since the two satellites never came into conjunction except near the aposaturnium of *Hyperion*.

Following this, Professor NEWCOMB discusses the mean motions of *Pallas* and *Jupiter*, in respect to the long period of 800 years computed by LEVERRIER. The method of work indicated for this difficult task seems ingeniously direct, but it is too abstruse for a popular summarizing at this time. He closes the paper by pointing out the fallacy frequently made by writers on the relations of mean motions, in supposing that if such a relation were almost exactly fulfilled, the stability of the system would be disturbed in consequence of the increase of perturbations without limit. While this might be so it does not necessarily follow from the circumstance supposed. He says: "The reason is, that as soon as the perturbations begin to develop themselves, the change in the longitude and other elements which they produce will speedily cause them to change their sign, and the only result will be a series of oscillations which may indeed be extremely irregular, but could only under exceptional circumstances destroy the stability."

The red skies are still attracting attention in all parts of the world. Full observations are reported in the foreign scientific papers, that seem to describe very well what is seen daily in America. At Northfield particular attention has been given to this phenomenon by naked eye observation for the last two months. Every clear day without exception the solar appendage appears which has often been described in these pages. It varies somewhat from day to day, to be sure, but this might be due to varying conditions of the atmosphere. The noteworthy feature, at the present time is the constancy of these sky-glows. One year ago they would appear, at times, with excessive brightness and remain in an after-glow for a surprisingly long time after sunset. Then several days might follow in which no marked display would appear. The phenomenon then was a variable one decidedly. It is now essentially different in this particular. It is steady and strangely uniform in this latitude. If the cause of it be the great dust envelope of Krakatoa, as is still maintained by most astronomers and physicists, we ought to expect diminution and probably greater uniformity from day to day, especially if the volume of the eruption were sufficient to fill the whole upper atmosphere to so great a height as that indicated by the evening after-glows. Such a dust or gas mantle for the whole *Earth*, or a considerable zone of it, at such an altitude and continuing persistently for more than a year, seems indeed very incredible; yet it is the best explanation that science can now offer after a year of diligent study.

By kindness of a friend in California, we have the following account from an unknown local paper of the progress of work on the great telescope of the Lick Observatory:

The Lick Trustees have just received through the kindness of Captain GOODALL, of the firm of GOODALL, PERKINS & Co., important advices from Paris in regard to the glass disk which is needed to complete the thirty-six inch equatorial for the Lick Observatory. It will be remembered that the contract for two disks—one of flint and one of crown glass—which are needed for the construction of an achromatic objective, was let to the firm of ALVAN CLARK & SONS in 1881. There were only two firms in the world capable of making glass disks of such size. The CLARKS employed one of these, Messrs. E. FEIL & Co., of Paris, to cast the rough disks for them. The flint disk was cast in an unexpected short time, but the making of the crown disk has proved to be a matter of great difficulty, and this alone will have delayed the making of the large objective, and thus the completion of the Lick Observatory by several years. The Lick Trustees will have all the observatory, excepting the large telescope and the dome to contain it, finished and ready for work during 1885. As soon as two perfect disks of crown and flint glass are on hand the focal length of the telescope can be calculated and the size of the great dome be determined upon; and nothing can be done until this focal length is known. Nineteen trials have been made by the Messrs. FEIL to cast a perfect crown disk and a delay of more than two years has been incurred through the difficulties and risks of the operation. It appears through the letter of Captain GOODALL to Captain FLOYD, which has been referred to, that Messrs. FEIL have cast two disks which they expect to be suitable for the purpose. The Captain visited their works early in September, and they were expected to ship one of the disks to CLARK & SONS early in October. There is, then, reason to believe that the rough disks for the large telescope will soon be in the hands of the optician. The successful working of these disks into the proper curve for a perfect object-glass is a matter of great difficulty, but the skill which the CLARKS have acquired in making the objectives for the National Observatory (26 inches), the Observatory of the University of Virginia (26 inches), the Princeton College Observatory (23 inches), the Imperial Observatory of St. Petersburg (30 inches), leave no doubt that within two or three years after receipt of a perfect disk the whole 36 inch objective will be finished. While the objective is making, the dome and the mounting can be constructed so that the whole delay is and has been due to the difficulties incident to the optician's work. The work on Mount Hamilton has progressed as far as possible under the present conditions, and it will not be long before California will possess the greatest observatory in the world, placed in the most favorable situation which can be found.

WOLF'S COMET.

The foreign observers speak of comet *c*, 1884, as a vague, nebulous mass, with central condensation, and without a tail. During the month of October it has been moving rapidly to the southeast. Elements of its orbit have been computed by CHANDLER, Dr. SCHUR and H. OPPENHEIM, all of which agree closely. Its brightness at Sept. 20 was taken as unity, and at the present writing (Oct. 24) it is 1.27. It is reported that it has already been seen by the naked eye in Alexandria, Egypt, which is probable. Nov. 1 this comet will be near the star *Theta* of *Pegasus*, a little to the south and west. It increases in right ascension daily about one-half degree and diminishes in declination about the same amount. With a small telescope or a good opera-glass, any person who knows its place ought to see it easily.

On the evening of October 24 this comet was seen near *Nu Pegasi*, that star being about eight minutes of arc east, and nearly on the same parallel of declination. The comet has a diameter of about three minutes of arc with ill-defined edges and a strong central condensation. It is not yet visible to the naked eye although its brightness is slowly increasing.

BRORSON'S COMET.

In the search for comets, new and old, Brorson's must not be forgotten. The time announced for its perihelion passage was Sept. 14. The time of previous returns, as given by computers, was as follows:

1846, February 25.
1857, March 27.
1868, April 17.
1873, October 10.
1879, March 30.

It will be remembered that this comet was captured by *Jupiter*, which made it, in fact, a citizen of the solar system. Its present orbit is due to a disturbance in 1842. As given by *L'Astronomie* (Vol. 3, No. 10) the date of near approach was May 27. By the disturbing effects of the planets its period has gradually diminished since 1846, the year of its discovery by Brorson, an amateur astronomer at Kiel.

OLBER'S COMET OF 1815.

Another interesting comet is expected soon to return, and it may already be within reach of the telescope, though not very probable. In *Astronomische Nachrichten* (Nos. 2613–14) von F. K. GINZEL has published a sweeping ephemeris extending from Oct. 1 to Jan. 1,

1885. Its perihelion passage for the present revolution should take place in December, 1886, but the discussions of observations during 1815 left an uncertainty in its period of 1.6 years, and on this account early preparations for a systematic search have been made. At the time of discovery by OLBERS it had the appearance of ENCKE'S comet and was just visible to the naked eye. It was observed for six months. Its orbit was computed by BESSEL.

BARNARD'S COMET.

The foreign papers have some interesting notes on BARNARD'S comet. M. GINIEIS, at Saint-Pons, on Sept. 11, made two observations of this comet. By a remarkable coincidence, the comet was just passing a star which gave it a brilliant central nucleus. Two hours later its motion showed it to be simply a diffused circular nebulous mass. According to the circulations of M. BERBERICH, this comet has an elliptic orbit, and a period of 2008 days, or 5½ years. The elements of its orbit are:

Perihelion passage 1884, Aug. 16, 48346, G. M. T.

Longitude of perihelion,	306°	7′	31.″1	Mean Equinox 1884.
" " ascending node,	5	3	50. 2	
Inclination,	5	28	49. 6	
Angle of eccentricity,	36	3	43. 8	
Log. semi axis major,	0.493392			
Period of resolution,	5.4955	7ˢ		

This comet at aphelion, will be distant from *Jupiter* 0.503. When, at a true anomoly of 37° 13′, it will make a very close approach to the orbit of *Mars*, the distance being only 0.0088. One remarkable fact appears in the study of Dr. BERBERICH'S orbit; that between April 5 and 10, 1868, both *Mars* and this comet would pass very nearly the same point. In the first of this month its position is about 12° south of the star *Alpha* of *Aquarius*, among the small stars of that constellation and too distant to be seen by the telescope.

In a private letter under date Oct. 22, Mr. E. E. BARNARD says: "My comet has been observed regularly when the sky was sufficiently clear to see it. It has become very faint, and I suppose will not be visible after the present *Moon* disappears. I saw it last night (Oct. 21). It was exceedingly faint and difficult to observe, though two comparisons for position were obtained through clouds. October 20th it passed centrally over an 8th or 9th magnitude star. During the progress of transit, though the star shone through the comet's very center, I was surprised at the star's continuous flickering and occasionally almost total disappearance, at the same time an 8th magnitude star in the same field was steady."

"Over thirty positions of the comet have been obtained here."

By kindness of Director TATLOCK, Smith Observatory, Beloit, Wis., we have the following notes respecting the curious phenomenon (a narrow white cloud stretching across the sky) referred to in last MESSENGER. He says: "I saw a similar appearance on the 17th of September, and by referring to my observing book I find the following:

1884, Sept. 17, $7^h\ 30^m$—Brilliant aurora. Arch about 12° in altitude. Dark cloud beneath.

$10^h\ 5^m$—The arch is lower, more brilliant, and at the western extremity streamers are flashing up toward the zenith to an altitude of about 40°.

$10^h\ 10^m$—The streamers have disappeared and the arch is fainter.

$11^h\ 20^m$—Streamers have reappeared in the north, and there is a belt of auroral light extending over the sky, meeting the Prime Vertical in the east and west points, and inclined to it about 5° to the south. The belt is about one degree wide.

$12^h\ 40^m$—The belt has disappeared and the arch is much fainter.

Mr. TATLOCK adds that he remembers seeing a similar appearance at Williamstown, Mass., in the spring of 1881. The belt then appeared in conjunction with a brilliant aurora in the north.

REMARKABLE RED STARS.

In comet sweeping I have noticed three remarkable red stars. They are all 7th magnitude nearly, and strikingly resemble each other. One is in,

$$\left.\begin{array}{l} \text{R. A.}\ \ 5^h\ 38^m\ 43^s.4 \\ \text{Decl.} +30^\circ\ 39'.1 \end{array}\right\}\ 1884.4$$

Another in,

$$\left.\begin{array}{l} \text{R. A.}\ \ 18^h\ 58^m\ 12^s.2 \\ \text{Decl.} -5^\circ\ 59' \end{array}\right\}\ 1884.0$$

The third is somewhere in the drapery of *Saggittarius* although I have not found it again. With the 5-inch telescope and a power of thirty diameters (field 1¼°), these objects resemble a drop of blood, they are so intensely red. They are more remarkable in this particular than any I know of. If not there already they should be entered in the catalogues of red stars. E. E. BARNARD.

THE "ALMUCANTAR."

The new astronomical instrument known as the "Almucantar," not long ago invented by C. S. CHANDLER, Harvard College Observatory, is apparently fulfilling the predictions claimed for it. C. H. ROCKWELL, of Tarrytown Observatory, New York, has a 3-inch aperture instrument (if memory serves us rightly), and under date of October 7 he gives a copy of four consecutive days' work for clock correction as follows:

Beta Pegasi / Alpha Cor. Borealis	$+9^s.225$	+9.237
Beta Herculis / Alpha Andromedæ	+9.248	

Tau Pegasi / Epsilon Cor. Borealis	+7 .571	+7.590
Beta Herculis / Alpha Andromedæ	+7 .609	
Tau Pegasi / Epsilon Cor. Borealis	+6 .355	+6.381
Beta Herculis / Alpha Andromedæ	+6 .444	
Delta Herculis / Delta Andromedæ	+6 .343	
Epsilon Cor. Borealis / Pi Andromedæ	+5 .009	+4.963
Delta Herculis / Delta Andromedæ	+4 .917	

Professor C. L. DOOLITTLE, Lehigh University, South Bethlehem Pa., favors the MESSENGER with the following ring micrometer observations of comet Wolf:

1884	Beth. s. T.	Comet, App. α	Comet, App. δ
Sept. 25,	21^h 34^m $46^s.4$	21^h 18^m $6^s.39$	20° 4′ 38″.2
" 26.	22 59 40 .3	21 18 47 .83	19 35 1 .8

1884	$\Delta\alpha$	$\Delta\delta$	Comp. Star.	No. of Comp.
Sept. 25	-3^m1 $5^s.03$	— 8′ 37″.6	W. Bessell, XXI 473	7
" 26	+2 1 .21	+16 0 .4	American Ephemeris	7

ORBIT OF COMET WOLF (1884).

ELEMENTS.

T=1884, November 17.71070, Greenwich M. T.

$$\left.\begin{aligned}\pi-\Omega&=172^\circ\ 36'\ 40''.5\\ \Omega&=206\ \ 27\ \ 36.5\\ i&=\ 25\ \ 10\ \ 54.3\end{aligned}\right\}1884.0$$

log. q=0.196049

a=3.53638

e=0.556885

Period=2429 days=6.65 years.

The above were computed by Messrs. CHANDLER and WENDELL, from the following places, which have been corrected for parallax and aberration and referred to equinox 1884.0

A parabolic orbit had previously been computed from the same, observations as follows:—

T=1884, November 14.23309, Greenwich M. T.

$$\left.\begin{aligned}\pi-\Omega&=170^\circ\ 40'\ 36''.0\\ \Omega&=197\ \ 16\ \ 24.3\\ i&=\ 34\ \ \ 0\ \ 46.8\end{aligned}\right\}1884.0$$

log. q=0.273507.

but the residuals of the Middle Place: $(C-O)$

$$\Delta\lambda \cos. \beta = +7' \; 35''.8$$
$$\Delta\beta = -4' \; 40''.5$$

which could not be sensibly reduced, showed clearly the elliptical character of the orbit, and the above ellipse was accordingly computed.—*Science Observer Circular.*

The following orders and subscriptions have not been previously acknowledged: S. J. Corrigan, Nautical Office, Washington, D. C.; Professor C. L. Doolittle, Lehigh University, Bethlehem, Pa.; Professor Joseph Hall, Principal High School, Hartford, Conn.; Library State Normal School, Ypsilanti, Mich.; William Dawson, Spiceland, Indiana; Charles Schofield, Cannon Falls, Minn.

October 11 at 9 o'clock (Eastern Time) Mr. JOHN R. HOOPER, of Baltimore, reports that the Wolf comet was three times as bright as it was on the previous night. Mr. GILDERSLEVE, of the same place, observed the comet on the same night at 7 o'clock, and reports its appearance as on the previous night. It is possible that a great change in brightness took place between those two hours.

Three minor planets have been discovered recently. We omitted to notice No. (241) last month, which was discovered by Dr. LUTHER Sept. 12, 9^h 33^m, in R. A., 0^h 45^m; Decl. $+10°$ 35′ 45″9. Magnitude 11.

Planet No. (242) whose name is *Germania*, was discovered by PALISA at Vienna, Sept. 22, 537.9. Its position in G. M. T. then was, R. A. 2^h 19^m $3^s.3$; Decl. $+14°$ 42′ 33″. Daily motion in R. A., -24^s; in Decl. $-5'$. Thirteenth magnitude.

Planet No. (243) was also discovered by PALISA, Sept. 29, 11^h $46^m.3$. Wien M. T. Right Ascension was, 2^h 18^m $26^s.3$; Decl. $+13°$ 47 7″. Magnitude 13; daily motion in R. A. -32^s. in Decl. $-1'$.

The October number of *L'Astronomie* contains a notice of a proposed astronomical station in the south of Algeria. M. ALEXANDER BELLETETE points out the scientific advantages that would result from establishing an astronomical station in M'zab. The atmosphere is free from moisture and of great purity. The writer thinks that if the government would send an officer who was devoted to astronomy with a good telescope that would cost about as much as one of those mischievous cannon it would please peaceable people quite as well.

Mr. JOHN M. LEWIS, of Mount Vernon, Ohio, has a transit instrument for sale. Description as follows:

A superior portable astronomical transit, aperture three (3) inches; focus 33½; 5 vertical wires, two horizontal; total reflecting prism for high altitudes; sun-shade; lamp; setting circle; axis level; cast iron stand with brass mountings; horizontal and vertical adjustments to axis; foot pieces, etc. The object glass is by ALVAN CLARK and is a very fine one, showing stars of the third magnitude by daylight. The instument is as good as new; bright and not marred. Price $325.00. Buff & Berger, of Boston, ask $480 for a similar instrument.

The eclipses of the *Moon* and *Sun* on October 4 and 18, respectively were of little interest to observers in America because invisible, and hence reports concerning them have been omitted.

On the 11th of November, *Saturn* is in conjunction with *Zeta Tauri*, a 3.5 magnitude star, the planet being 41 north of the star at time of conjunction.

Special attention is called to the new advertisements of Harvard Photometers, and telescope for sale.

Minima of *Algol. Beta Persei* occurs Nov. 9, 12^h 17^m in the evening, and Nov. 12, 9^h 6^m in the evening.

BOOK NOTICE.

COMPREHENSIVE PHYSIOLOGY. Messrs. J. B. Lippencott & Co., publishers, Philadelphia: 1884,

To one whose studies in anatomy began at a time when the works of Calvin Cutter were in extensive use, there comes a thrill of reminiscence at sight of the familiar name.

But the new work has other things of interest attaching to it beside the ancestral name.

The growth of practical teaching in the natural sciences is one of the features of modern education. This book is the first effort to render possible experimental instruction in common schools on the important topic of anatomy. Starting with some valuable suggestions to teachers upon instruments, etc., at the beginning of each chapter, are admirably clear directions for dissection upon the lower animals These, when practicable, are performed by students, otherwise by the teacher in the presence of the class.

Another point worthy of attention is the combination of a brief with a more extended course. For teachers who have no access to larger works this will be a great boon. Many pupils will be able to do no more than the brief outline, but for the successful teaching of that a broader knowledge is needful. This book supplies it.

It may seem hypocritical to say in presence of so many excellent features that the plates are not in all cases up to the highest standard of such publications. Many of the old ones from the original Cutter's physiology seem to have been used. Some representing the anatomy of the skin are especially noticeable as being positively misleading. The work of the publishers in getting up the book is of course good.

L. W. C., JR.

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. No. 10. DECEMBER, 1884. WHOLE No. 30.

PENDING PROBLEMS OF ASTRONOMY.*

[*Continued from page 266.*]

There can be no question, that it is now one of the most important and pressing problems of observational astronomy to devise apparatus and methods delicate enough to enable the student to follow promptly and accurately the presumable changes in the daily, even the hourly, amounts of the solar radiation. It might, perhaps, be possible with existing instruments to obtain results of extreme value from observations kept up with persistence and scrupulous care for several years at the top of some rainless mountain, if such can be found; but the undertaking would be a difficult and serious affair, quite beyond any private means.

Related to this subject is the problem of the connection between the activity of the solar surface and magnetic disturbances on the earth,—a connection unquestionable as matter of fact, but at present unexplained as matter of theory. It may have something to do with the remarkable prominence of iron in the list of solar materials; or the explanation may, perhaps, be found in the mechanism by

*From an address to the American association for the advancement of science at Philadelphia, Sept. 5, 1884, by Prof. C. A. YOUNG, of Princeton, retiring president of the association.

means of which the radiations of light and heatr traverse interplanetary space, presenting itself ultimately as a corollary of the perfected electro-magnetic theory of light.

The chromosphere and prominences present several problems of interest. One of the most fruitful of them relates to the spectroscopic phenomena at the base of the chromosphere, and especially to the strange differences in the behavior of different spectrum-lines, which, according to terrestrial observations, are due to the same material. Of two lines (of iron, for instance) side by side in the spectrum, one will glow and blaze, while the other will sulk in imperturbable darkness; one will be distorted and shattered, presumably by the swift motion of the iron vapor to which it is due, while the other stands stiff and straight.

Evidently there is some deep-lying cause for such differences; and as yet no satisfactory explanation appears to me to have been reached, though much ingenious speculation has been expended upon it. Mr. LOCKYER's bold and fertile hypothesis, already alluded to, that at solar and stellar temperatures our elements are decomposed into others more elemental yet, seems to have failed of demonstration thus far, and rather to have lost ground of late; and yet one is almost tempted to say, "It *ought* to be true," and to add that there is more than a possibility that its essential truth will be established some time in the future.

Pobably all that can be safely said at present is, that the spectrum of a metallic vapor (iron, for instance, as before) depends not only upon the chemical element concerned, but also upon its physical conditions; so that, at different levels in the solar atmosphere, the spectrum of the iron will differ greatly as regards the relative conspicuousness of different lines; and so it will happen, that, whenever any mass of iron vapor is suffering disturbance, those lines only which particularly characterize the spectrum of iron in that special statss will be distorted or reversed, while all their sisters will remain serene.

The problem of the solar corona is at present receiving much attention. The most recent investigations respecting it—those of Dr. HUGGINS and Professor HASTINGS—tend in directions which appear to be diametrically opposite. Dr. HUGGINS considers that he has succeeded in photographing the corna inn full sunshine, and so in establishing its objective reality as an immense solar appendage, sub-permanent in form, and rotating with the globe to which it is attached. One may call it 'an atmosphere,' if the word is not to be too rigidly interpreted. I am bound to say that plates which he has obtained do really show just such appearances as would be produced by such a solar appendage, though they are very faint and ghost-like. I may add further, that, from a letter from Dr. HUGGINS, recently received, I learn that he has been prevented from obtaining any similar plates in England this summer by the atmospheric haze, but that Dr. WOODS, who has been provided with a similar apparatus, and sent to the Riffelberg in Switzerland, writes that he has 'an assured success.'

Our American astronomer, on the other hand, at the last eclipse (in the Pacific Ocean), observed certain phenomena which seem to confirm a theory he had formulated some time ago, and to indicate that the lovely apparition is an apparition only, a purely optical effect due to the *diffraction* (not refraction, nor reflection either) of light at the edge of the *Moon*—no more a solar appendage than a rainbow or a mock sun. There are mathematical considerations connected with the theory which may prove decisive when the paper of its ingenious and able proposer comes to be published in full. In the mean time it must be frankly conceded that the observations made by him are very awkward to explain on any other hypothesis.

Whatever may be the result, the investigation of the status and possible extent of a nebulous envelope around a sun or a star is unquestionably a problem of very great interest and importance. We shall be compelled, I believe, as in the case of comets, to recognize other forces than gravity, heat, and ordinary gaseous elasticity, as concerned in the phenomena. As regards the actual existence of an extensive gaseous envelope around the *Sun*, I may add that other appearances than those seen at an eclipse seem to demonstrate it beyond question,—phenomena such as the original formation of clouds of incandescent hydrogen at high elevations, and the forms and motions of the loftiest prominences.

But of all solar problems, the one which excites the deepest and most general interest is that relating to the solar heat, its maintenance and its duration. For my own part, I find no fault with the solution proposed by HELMHOLTZ, who accounts for it mainly by the slow contraction of the solar sphere. The only objection of much force is, that it apparently limits the past duration of the solar system to a period not much exceeding some twenty millions of years; and many of our geological friends protest against so scanty an allowance. The same theory would give us, perhaps, half as much time for our remaining lifetime; but this is no objection, since I perceive no reason to doubt the final cessation of the *Sun's* activity, and the consequent death of the system. But while this hypothesis seems fairly to meet the requirements of the case, and to be a necessary consequence of the best knowledge we can obtain as to the genesis of our system and the constitution of the *Sun* itself, it must, of course, be conceded that it does not yet admit of any observational verification. No measurements within our power can test it, so far as we can see at present.

It may be admitted, too, that much can be said in favor of other theories; such as the one which attributes the solar heat to the impact of meteoric matter, and that other most interesting and most ingenious theory of the late Sir WILLIAM SIEMENS.

As regards the former, however, I see no escape from the conclusion, that, if it were exclusively true, the earth ought to be receiving, as was pointed out by the late Professor PEIRCE, as much heat from meteors as from the *Sun*. This would require the fall of a quantity of meteoric matter,—more than sixty million times as much as the best estimates make our present supply, and such as could not escape the most casual observation, since it would amount to more than one hundred and fifty* tons a day on every square mile.

As regards the theory of SIEMENS, the matter has been, of late, so thoroughly discussed, that we probably need spend no time upon it here. To say nothing as to the difficulties connected with the establishment of such a far-reaching vortex as it demands, nor of the fact that the temperature of the *Sun's* surface appears to be above that of the dissociation point of carbon compounds, and hence above the highest heat of their combustion, it seems certainly demonstrated, that matter of the necessary density could not exist in interplanetary space without seriously affecting the planetary motions by its gravitating action as well as by its direct resistance; nor could the stellar radiations reach us, as they do, through a medium capable of taking up and utilizing the rays of the *Sun* in the way this theory supposes.

And yet I imagine that there is a very general sympathy with the feeling that led to the proposal of the theory,—an uncomfortable dissatisfaction with received theories, because they admit that the greater part of the *Sun's* radiant energy is, speaking from a scientific point of view, simply wasted. Nothing like a millionth part of the sky, as seen from the sun, is occupied, so far as we can make out, by objects upon which its rays can fall; the rest is vacancy. If the *Sun* sends out rays in all directions alike, not one of them in a million finds a target, or accomplishes any useful work, unless there is in space some medium to utilize the

* In an article on astronomical collisions, published in the *North American Review* about a year ago, I wrongly stated the amount at fifty tons. There was some fatality connected with my calculations for that article. I gave the amount of heat due to the five hundred tons of meteoric matter which is supposed to fall daily on the earth with an average velocity of fifteen miles per second as fifty-three calories annually per square metre,—a quantity two thousand times too great. Probably the error would have been noticed if even the number given had not been so small, compared with the solar heat, as fully to justify my argument, which is only strengthened by the correction. I owe the correction to Professor LeConte of California, who called my attention to the errors.

rays, or unknown worlds of which we have no cognizance beyond the stars.

Now, for my own part, I am very little troubled by accusations of wastefulness against nature, or by demands for theories which will show what the human mind can recognize as "use" for all energy expended. Where I can perceive such use, I recognize it with reverence and gratitude, I hope; but the failure to recognize it in other cases creates in my mind no presumption against the wisdom of nature, or against the correctness of an hypothesis otherwise satisfactory. It merely suggests human limitations and ignorance. How can one without sight understand what a telescope is good for?

At the same time, perhaps we assume with a little too much confidence, that, in free space, radiation does take place equally in all directions. Of course, if the received views as to the nature and conduct of the hypothetical "ether" are correct, there is no possibility of questioning the assumption; but, as Sir JOHN HERSCHEL and others have pointed out, the properties which must be ascribed to this "ether," to fit it for its various functions, are so surprising and almost inconceivable, that one may be pardoned for some reserve in accepting it as a finality. At any rate, as a fact, the question is continually started (the idea has been brought out repeatedly, in some cases by men of real and recognized scientific and philosophic attainment), whether the constitution of things may not be such that radiation and transfer of energy can take place only between ponderable masses; and that, too, without the expenditure of energy upon the transmitting-agent (if such exist) along the line of transmission, even *in transitu*. If this were the case, then, the *Sun* would send out its energy only to planets and meteors and sister-stars, wasting none in empty space; and so its loss of heat would be enormously diminished, and the time-scale of the life of the planetary system would be correspondingly extended. So far as I know, no one has ever yet been able to indicate any kind of medium or mechanism by which vibrations, such as we know to constitute the radiant energy of light and heat, can be transmitted at all from *Sun* to planet under such restrictions, Still one ought not to be too positive in assertions as to the real condition and occupancy of so-called vacant space. The "ether" is a good working hypothesis, but hardly more as yet.

I need not add, that a most interesting and as yet inaccessible problem, connected with the preceding, is that of the mechanism of gravitation, and, indeed, of all forces that seem to act at a distance: as for that matter, in the last analysis, *all* forces do. If there really be an "ether," then it would seem that somehow all attractions and repulsions of ponderable matter must be due to its action. CHALLIS's investigations and conclusions as to the effect of hydrodynamic actions in such a medium do not seem to have commanded general acceptance; and the field still lies open for one who will show how gravitation and other forces can be correlated with each other through the ether.

Meteors and the comets, seeming to belong neither to the solar system nor to the stellar universe, present a crowd of problems as difficult as they are interesting. Much has undoubtedly been gained during the last few decades, but in some respects that which has been learned has only deepened the mystery.

The problem of the origin of comets has been supposed to be solved to a certain extent by the researches of SCHIAPARELLI, HEIS, Professor NEWTON, and others, who consider them to be strangers coming in from outer space, sometimes "captured" by planets, and forced into elliptic orbits, so as to become periodic in their motion. Certainly this theory has strong supports and great authority, and probably it meets the conditions better than any other yet proposed. But the objections are really great, if not insuperable,—the fact that we have so few, if any, comets moving in hyperbolic orbits, as comets *met* by the *Sun* would be expected to move; that there seems to be so little relation between the direction of the major axes of cometary orbits and the direction of the solar motion in space;

and especially the fact, pointed out and insisted upon by Mr. PROCTOR in a recent article, that the alteration of a comet's natural parabolic orbit to the observed elliptic one, by planetary action, implies a reduction of the comet's velocity greater than can be reasonably explained. If, for instance, BRORSEN'S comet (which has a mean distance from the *Sun* a little more than three times that of the earth) was really once a parabolic comet, and was diverted into its present path by the attraction of *Jupiter*, as generally admitted, it must have had its velocity reduced from about eleven miles a second to five. Now, it is very difficult, if not out of the question, to imagine any possible configuration of the two bodies and their orbits which could result in so great a change. While I am by no means prepared to indorse as conclusive all the reasoning in the article referred to and should be very far from ready to accept the author's alternative theory (that the periodic comets have been ejected from the planets, and so are not their captives, but their children), I still feel that the difficulty urged against the received theory is very real, and not to be evaded, though it may possibly be overcome by future research.

Still more problematical is the constitution of these strange objects of such enormous volume and inconceivable tenuity, self-luminous and transparent, yet reflecting light, the seat of forces and phenomena unparalleled in all our other experience. Hardly a topic relating to their appearance and behavior can be named which does not contain an unsolved problem. The varying intensity, polarization, and spectroscopic character of their light; the configurations of the nucleus and its surrounding nebulosity; and especially the phenomena of jets, envelopes and tail,—all demand careful observation and thorough discussion.

I think it may be regarded as certain, that the explanation of those phenomena when finally reached, if that time ever comes, will carry with it, and be based upon, an enormous increase in our knowledge as to the condition, contents, and temperature of inter-planetary space, and the behavior of matter when reduced to lowest terms of density and temperature.

Time forbids any adequate discussion of the numerous problems of stellar astronomy. Our work, in its very nature incessant and interminable, consists, of course, in the continual observation and cataloguing of the places of the stars, with ever-increasing precision. The star-places form the scaffold and frame-work of all other astronomical investigations involving the motions of the heavenly bodies; they are the reference-points and bench-marks of the universe. Ultimately, too, the comparison of catalogues of different dates will reveal the paths and motions of all the members of the starry host, and bring out the great orbit of the *Sun* and his attendant planets.

Meanwhile, micrometric observations are in order, upon the individual stars in different clusters, to ascertain the motions which occur in such a case; and the mathematician is called upon again to solve the problem of such movement.

Now, too, since the recent work of GILL and ELKIN in South Africa, and of STRUVE, HALL, and others, elsewhere, upon stellar parallax, new hopes arise that we may soon come to some wider knowledge of the subject; that, instead of a dozen or so parallaxes of doubtful precision, we may get a hundred or more relating to stars of widely different brightness and motion, and so be enabled to reach some trustworthy generalizations as to the constitution and dimensions of the stellar universe, and the actual rates of stellar and solar motion in space.

Most interesting, also, are the studies now so vigorously prosecuted by Professor PICKERING in this country, and many others elsewhere, upon the brightness of the stars, and the continual variations in this brightness. Since 1875, stellar photometry has become almost a new science.

Then, there are more than a myriad of double and multiple stars to watch, and their orbits to be determined; and the nebulæ claim keen attention, since some of them appear to be changing in form and brightness, and are likely to reveal to us some wonderful secrets in the embryology of worlds.

Each star also presents a subject for spectroscopic study; for although, for the most part, the stars may be grouped into a very few classes from the spectroscopic point of view, yet, in detail, the spectra of objects belonging to the same group differ considerably and significantly, almost as much as human faces do.

For such investigations, new instruments are needed, of unexampled powers and accuracy, some for angular measurement, some for mere power of seeing. Photography comes continually more and more to the front; and the idea sometimes suggests itself, that by and by the human eye will hardly be trusted any longer for observations of precision, but will be superseded by an honest, unprejudiced, and unimaginative plate and camera. The time is not yet, however, most certainly. Indeed, it can never come at all, as relates to certain observations; since the human eye and mind together integrate, so to speak, the impressions of many separate and selected moments into one general view, while the camera can only give a brutal copy of an unselected state of things, with all its atmospheric and other imperfections.

New methods are also needed, I think (they are unquestionably possible), for freeing time-observations from the errors of personal equation; and increased precision is demanded, and is being progressively attained, in the prevention, or elimination, of instrumental errors, due to differences of temperature, to mechanical strains, and to inaccuracies of construction. Astronomers are now coming to the investigation of quantities so minute, that they would be completely masked by errors of observation that formerly were usual and tolerable. The science has reached a stage, where, as was indicated at the beginning of this address, it has to confront and deal with the possible unsteadiness of the earth's rotation, and the instability of its axis. The astronomer has now to reverse the old maxim of the court, for him, and most emphatically at present, *de minimis curat lex.* Residuals and minute discrepancies are the seeds of future knowledge, and the very foundations of new laws.

And now, in closing this hurried and inadequate, but I fear rather tedious, review of the chief problems that are at present occupying the astronomer, what answer can we give to him who insists, *Cui bono?* and requires a reason for the enthusiasm that makes the votaries of our science so ardent and tireless in its pursuit? Evidently very few of the questions which have been presented have much to do directly with the material welfare of the human race. It may possibly turn out, perhaps, that the investigation of the solar radiation, and the behavior of Sun-spots, may lead to some better understanding of terrestrial meteorology, and so aid agricultural operations and navigation. I do not say it will be so,—in fact, I hardly expect it,—but I am not sure it will not. Possibly, too, some few other astronomical investigations may facilitate the determination of latitudes and longitudes, and so help exploration and commerce; but, with a few exceptions, it must be admitted that modern astronomical investigations have not the slightest immediate commercial value.

Now, I am not one of those who despise a scientific truth or principle because it admits of an available application to the affairs of what is called "practical life," and so is worth something to the community in dollars and cents: its commeraial value is—just what it is—to be accepted gratefully.

Indirectly, however, almost all scientific truth has real commercial value, because "knowledge is power," and because (I quote it not irreverently) "the truth shall make you free,"—any truth, and, to some extent; that is to say, the intelligent and intellectually cultivated will generally obtain a more comfortable livelihood, and do it more easily, than the stupid and the ignorant. Intelligence and brains are most powerful allies of strength and hands in the struggle for existence; and so, on purely economical grounds, all kinds of science are worthy of cultivation.

But I should be ashamed to rest on this lower ground: the highest value of scientific truth is not economic, but different and more noble; and to a certain and great degree, its truest worth is more as an object of pursuit than of possession. The "practical life"—the eating and the drinking, the clothing and the sheltering—comes *first*, of course, and the necessary foundation of any thing higher; but it is not the whole or the best or the most of life. Apart from all spiritual and religious considerations, which lie one side of our relations in this association, there can be no need, before this audience, to plead the higher rank of the intellectual, aesthetic, and moral life above the material, or to argue that the pabulum of the mind is worth as much as food for the body. Now, it is unquestionable, that, in the investigation and discovery of the secrets and mysteries of the heavens, the human intellect finds most invigorating exercise, and most nourishing and growth-making aliment. What other scientific facts and conceptions are more effective in producing a modest, sober, truthful, and ennobling estimate of man's just place in nature, both of his puny insignificance, regarded as a physical object, and his towering spirit, in some sense comprehending the universe itself, and so akin to the divine?

A nation oppressed by poverty, and near to starving, needs first, most certainly, the trades and occupations that will feed and clothe it. When bodily comfort has been achieved, then higher needs and wants appear; and then science, for truth's own sake, comes to be loved and honored along with poetry and art, leading men into a larger, higher, and nobler life.

Professor HUGO GLYNDEN, Director of the Observatory at Stockholm, Sweden, and well known for his studies during recent years of the eight great planets, has been offered, and has accepted, the Professorship of Astronomy at the Gottingen University.—*Nature.*

THE LICK OBSERVATORY.

PROFESSOR E. S. HOLDEN.

It may be of interest to give a brief account of recent work at the Lick Observatory. It is difficult to convey an adequate idea of the excellence of the site, and of the thorough way in which the Observatory has been constructed by the Lick trustees without the aid of illustrations.

The most recent addition to the observatory is an exquisite meridian-circle by the REPSOLD'S, of Hamburg, and the house to contain it.

The meridian-circle house is forty feet square, with the walls double throughout. The inner wall is of California redwood, which is almost incombustible, and beyond this is an air-space of 24 inches completely round the building, on the north side as well as on the others. The outer frame carries a louvre work of galvanized iron which completely prevents the *Sun* from striking any part of the building proper. The ceiling is flat, of wood, and a very large air-space communicates with the room itself through wire netting which covers the sides of the slit. Complete access to any part of the air-spaces, both of the walls and of the roof is provided. On the west, the room opens into a ventilating tower, two stories in height, which also adjoins, and is connected with the house for the meridian-transit instrument, which lies still further to the west. The design of this construction, is to keep the temperature of the two houses and of their air-spaces precisely the same, as that of the external air, and it is probable that this object has been practically attained. The new REPSOLD meridian-circle, which has just been mounted, is of six (French) inches aperture, and is essentially of the same design as the meridian circle of Strassburg, and of the smaller circles of Williamstown and Madison.

It has north and south collimators of six inches aperture, and an east and west collimator of three inches. The three six-inch objectives were made by ALVAN CLARK & SONS.

There are two circles, each divided to two minutes, and read by four microscopes (magnifying forty diameters) to one second.

Two extra microscopes of seventy diameters serve for the determination of the division-errors. One of the circles is fixed to the axis, and will serve first as a setting circle, so that the same setting will always hold good for the same object, which is a great convenience, and secondly, this fixed circle will serve for star observations in the usual manner. The other circle is movable around the axis by a wheel and pinion. It will serve for fundamental observations when the division-errors of each one-degree mark and the errors of the two-minute marks for four single degrees, ninety degrees apart are once determined. It can also be used to eliminate the accidental division-errors, by turning it each day through some number of minutes, as 7, 11, 13, etc., so that successive observations of the same star will fall on different divisions. The complete division of the two circles, also allows of a determination of the flexure of the circles, etc. The large size of the collimator objectives, permit the pointing of one collimator, on the other with a precision equal to that of the pointing of the telescope on the collimators, and will serve for very precise determinations of the horizontal flexure. Complete provision is also made for reflection observations. A *mire*, or meridian mark eighty feet distant, may eventually replace the south collimator, whose objective is to be fitted to an equatorial mounting, also by REPSOLD. A *mire* may also be mounted some eighty feet west of the circle, on a pier within the main building. Altogether this circle is the most perfect of its class in the United States, if not in the world. It has been inspected by Prof. AUWERS and Dr. KRUEGER, and pronounced by them to be satisfactory in all particulars. Its site is especially good. The elevation above the sea is 4200 feet, and for six or seven months of the year, every night is clear. Half of the remainder of the time is also clear. It is plain that especial advantages will follow from a site which permits of continuous observations. The piers are built in the most substantial manner, of hard brick laid in cement, and their foundations are to be enclosed in air-tight boxes. The astronomical advantages of this perfect instrument, mounted in such a site, in so careful a manner, can not be over estimated. The construction of this meridian-circle house, of a double-house for the observers, and the finishing of the interior of the main building have occupied the whole of this season.

The entire observatory may be said to be complete with the exception of the 36-inch equatorial and of the dome to contain it. The flint disk for the objective of the 36-inch has long been completed. The crown disk has presented unexpected difficulties, no less than nineteen unsuccessful disks having been cast. It is hoped that a perfect disk may be had in a few months, and that the whole objective will be made and mounted in 1887 or 1888. The construction of the dome and of the mounting will be proceeded with as soon as the crown disk is successfully cast. The observatory is now a very complete one, possessing as it does a 12-inch equatorial, a 4-inch transit, a comet seeker, a 6-inch meridian-circle and a photoheliograph, as well as a REPSOLD vertical-circle and a 6-inch equatorial. The main building is practically complete and is perfectly adapted to its uses. Five very excellent clocks (by HOHWU, DENT, C. FRODSHAM and HOWARD), and set of chronometers by NEGUS will soon be available. The beginnings of a large astronomical library have been made. A complete electrical system has been put in for connecting clocks, chronographs, etc., and there are only a few observatories in the world which are in better condition for astronomical work than the Lick observatory now is, even without its chief instrument—the 36-inch refractor.

Minor Planet No. 241 is named *Germania*. It has been erroneously published as the name of planet number 242.

THE MESSENGER FOR 1885.

THE EDITOR.

Our readers may have notice that this number completes volume three of the MESSENGER. Hereafter each volume will begin with January of successive years and contain, at lease, ten numbers of 32 pages each as herebore. As in the past, the MESSENGER will be conducted by ourselves, and in the same general form, but, it is hoped, with improved mechanical execution. Arrangements looking to this end are now being carefully considered and added facilities will be certainly secured. As we are to be relieved in the future of nearly all responsibility in details belonging to the duties of publisher, attention can and will be given to desired changes and more variety in the editorial work.

In this department one thing is clear and certain, that an astronomical journal, to be worthy of the name, must maintain a scientific character worthy of the attention and support of the leading workers in astronomy in this or in any other country. If there is need or call for such a publication, it will receive the support necessary to maintain it provided its scientific character is what it should be. We are aware that in holding the general line of our work closely to this idea of scientific and practical usefulness, we have failed to interest hundreds of people who would read, enjoy and liberally support a publication in the interest of astronomy that was chiefly popular and unscientific. The great number of letters received every month asking for specimen copies of the MESSENGER is a safe index of the popular interest in astronomy, the oldest and the grandest branch in the whole circle of the sciences. In view of this widespread interest in the popular side of our science it is thought wise to devote a few pages in each number of the next volume to a popular summary of late and fresh work in astronomy adapted to the easy comprehension of common readers and students, many of whom have expressed a desire for aid of this kind in pursuing their studies.

On account of the limited space that can be given to any one feature of our work, it may be proper to remind the many friends who may desire to contribute such matter to the MESSENGER, that it should be prepared to occupy as small space as possible consistent with precision and clearness of expression. Variety of matter in paragraph form is especially desired. Attention will be given to queries concerning the facts and theories of astronomy that may be deemed helpful to students, amateurs and teachers. This kind of interchrnge of thought ought to be a valuable stimulant to endeavor as well as a fresh source of useful information for guidance in work or study. The student of astronomy who is determined to think and to work out things for himself, by such aids as these, and in such ways as will thus be easily opened to him, need not fear that his time will be wasted, or thrown away, or that meager returns will be the result of diligent endeavor. The person that is prepared and ready for good work in almost any department of astronomy will very soon find enough work to do with fair remuneration. The kind of work in this science now most needed is something more than that which is derived from books, even in college or public school. To understand the physical facts some observation at least should accompany almost every branch of work. Very small and inexpensive instruments are always useful, if the larger ones cannot be afforded. The great body of ordinary astronomical work, as well as most of the discoveries in all parts of the world, has been made by small telescopes or other common instruments down to and including the common opera-glass.

With such facts before the student or amateur astronomer it would seem only fair to say, that the limitations which are placed on the career of any fair mind with a firm purpose to succeed are those only which are self-imposed and self-determined, when that purpose is made solid in the wisdom and love of a Divine Being.

*On The Original Graduation of the Harvard College Meridian Circle in Situ.**—*Professor W. A. Rogers.*

In the ordinary method of discussing the errors of graduation in a meridian circle, it is assumed that the graduated arc retains its original form throughout the revolution of the telescope. It is certain that this constancy of form is not maintained in the Harvard College meridian circle and it is probable that in all instruments of this class, with the possible exception of the later instruments of REPSOLD, more or less *irregular* flexure of the circles occur. In so far as the bending is symmetrically distributed, an elimination of the error thus produced is effected, but any change of form at unknown points in the arc of revolution will not only tend to vitiate any system of errors derived from observed measures of given subdivisions, but may actually introduce the very class of errors which it is the aim to eliminate.

It is therefore a matter of supreme importance that some method of investigating the errors of a meridian circle shall be devised which does not depend upon unknown variations in the form of the circle whose errors are desired. This necessity is emphasized by the outstanding systematic differences which, at the present time, exist between the observations in declination made at the principal observatories of the world. The maximum amount of this difference is about five times as great as *the probable error of a single observation.* That is, assuming that *e. g.* the declination of a star at 20° south, as observed at Greenwich, is correct, the observation of the same star at Pulkowa will have an error at least five times as great as a skillful observer ought to make in a single observation, on the supposition that his result is affected by accidental errors of observation only. It is doubtless true that the larger share of these outstanding differences is due to errors in the refraction tables employed for low altitudes, but a certain portion are certainly due to errors of graduation augmented by those errors of flexure and eccentricity of

*Read before the Philadelphia meeting of the A. A. A. S.

pivots which are not eliminated by the employment of four microscopes. Until each of these errors has been determined it is useless to attempt the determination of the errors of the refraction tables. In the present paper, an attempt has been made to refer the subdivisions of the graduated circle to a constant unit which is independent of the subdivision to be investigated.

The success which has attended the use of the electro-magnet clamps in the dividing engine constructed for the writer at the Waltham watch factory, suggested the application of the same principle to the investigation of the errors of a meridian circle, and to the feasibility of the graduation of the circle *in situ*, if this investigation should be successful. In this engine, is an arm which at one end moves between two stops, one of which is movable, the other end rests upon the cylindrical shoulder of the screw which is to receive equal increments of revolution.

Two magnets are attached to this arm, the cores of which are fitted to the curvature of the index circle of the screw. A third magnet of similar construction is attached to the bed-plate of the machine, and independent of the arm. When the two upper magnets are in circuit, the arm becomes firmly attached to the index without the slightest disturbance of position, and the index is carried forward the required amount by moving the arms between the two stops. During the upward motion of the arm the lower magnet holds the index while the two upper magnets are free, thus allowing the arm to make contact to the two upper stops in preparation for the next downward stroke.

It has been found from experiment that under similar conditions as many as 5,000 movements of the arm will in repeated trials give the same arc of revolution. It did not, therefore, seem too much to expect that the same method might be successfully applied to the movement of a meridian circle over equal arcs of revolution under exactly the conditions which prevail in actual work with the instrument. It was therefore determined to try the method with the meridian circle of Harvard College Observatory.

Professor PICKERING kindly authorized the expense of the construction of the necessary apparatus, which was designed by Mr. GEO. B. CLARK, of the firm of ALVAN CLARK & SONS, and which was made under his superintendence.

A ring having an outside face of two inches was made in two halves and securely fastened to the axis of the telescope. The magnet arm was made in such a manner that the only connection with the ring was made by the contact of the cores of the magnets at the periphery of the ring. A very heavy bed-plate of iron was securely clamped to the marble pier in such a manner that the edge might be made perpendicular to the axis of rotation and at a distance of about five feet from the center of the axis. The stops are heavy plates of iron with projecting oval surfaces of tempered steel which move along this table, and which are held in position by heavy clamping screws. They are arranged for a movement of the telescope over arcs varying between 0° and 30°. With the aid of the graduated circle of the telescope it is found easy to set the stops quickly and accurately by tapping the stop-plates with a light hammer.

It was found that a bichromate battery of six cells was sufficient to clamp the magnet-arm securely to the ring.

It will be at once understood that unless the ring upon which the magnet-arm rests is truly circular, the arm will rise and fall with the revolution of the telescope, thus giving rise to periodic errors proportional in amount to the deviation of the periphery of the ring from a true circle. The test of this circular form was made by means of a microscope attached to the iron bed-plate with which the movement of the arm vertically was observed and measured, a graduated polished metal plate being clamped to the arm for this examination. It was found that during one-half of the revolution of the telescope very little motion of the arm could be detected, but that during the remaining half the maximum rise of the arm amounted to about $\frac{1}{20}$ mm. As would be expected the chief part of the disturbance occurred at those points at which the magnets passed the junction of the two halves of the ring.

It does not seem advisable to encumber this paper with the details of the observations which were made with the ring in its original form. An attempt was made to compare the 30° divisions of the graduated circle by a reference to the fixed distance between the stops, four microscopes being read for each contact, with the expectation that the effect of the error in the form of the ring could be measured by means of a microscope of high power which should measure directly the accumulated error of the arc of revolution at the contact points for each arc of 30°. It will be seen that this expectation was not realized for the summed series of errors of the 30° points of the circle.

From seven sets of observations extending from July 3 to July 15, the following relative errors were found, the polar point being taken for the origin.

ARC.	ERRORS.	Z	ARC.	ERRORS.	Z
°	"	"	°	"	"
0— 30	+1.38	+ 1.38	180—210	−2.49	+8.00
30— 60	+2.83	+ 4.21	210—240	—1.42	+6.58
60— 90	+2.92	+ 7.13	240—270	—2.90	+3.68
90—120	+1.41	+ 8.54	270—300	—3.58	+0.10
120—150	+1.73	+10.27	300—330	+0.03	+0.13
150—180	+0.22	+10.49	330—360	+0.13	+0.00

Some of accumulated errors at contact points from measures with microscope:

	Errors in Division of Micrometer Screw.	Error in Arc.		Errors in Division of Micrometer Screw.	Error in Arc
°	"	"	°	"	"
0— 30	.0	+0.0	180 -210	+17.6	+1.5
30— 60	+ 1.6	+0.1	210—240	+11.2	+0.9
60— 90	+ 7.6	+0.6	240—270	+ 4.6	+0.4
90—120	+10.6	+0.9	270—300	+ 0.0	+0.0
120—150	+16.8	+1.4	300—330	— 1.2	−0.1
150—180	+18.8	+1.2	330—360	+ 0.0	+0.0

It will be seen that the general form of the two summed series is the same but they widely differ in the maximum value. It became at once obvious from this preliminary investigation that it would be necessary to grind the circle, upon which the magnet arm rests, to an exactly circular form. This was very successfully accomplished by Mr. CLARK in the following way: A slide rest carrying an emery wheel was firmly mounted nearly opposite the axis of the instrument. The motion to the emery was given by means of an old-fashioned spinning wheel. The operation of grinding was conducted as follows:

One assistant turned the spinning-wheel, Mr. CLARK managed the slide rest, which governed the movement of the emery wheel, while I, at one end of the telescope, gave a nearly uniform motion in revolution with the aid of an assistant stationed at the other end. When the operation of grinding was completed, it was found that a complete revolution of the telescope could be made without the slightest trace of disturbance in the position of the magnet-arm under a microscope having twelve times the magnifying power of microscopes attached to the telescope.

Before proceeding to describe the new series of observations, it will be necessary to refer to the means employed to neutralize the momentum of the telescope produced by the shock of contact with the stops. It was found that the disturbance produced by contact made by a hand-movement of the arm, that there was a liability to a maximum error of about 3″. This amount was sensibly reduced by inserting a piece of writing paper between the arm and the stop, and then completing the movement by withdrawing the paper. The next experiment was with an air-buffer attached to the stop-plates, with which the initial contact was made; but it was found that the movement against the air-spring for the remaining distance to the stop was not sufficiently uniform, although there was a decided improvement over results previously obtained. A water-buffer was then employed; the water from a cylinder attached to the stop-plates being forced by a weight-pressure through a cylinder of small diameter. With this buffer as a momentum arrester, it appears from a long series of observations for contact, that the probable error of a single contact is about 0.03″ or about $\frac{1}{10}$ of the ordinary value for a single observation with four microscopes.

Eight sets of comparisons of the 30° divisions of the circle have already been made with the improved apparatus, with the following results:

CORRECTIONS.

DATE.	0–30	30–60	60–90	90–120	120–150	150–180
	"	"	"	"	"	"
July 28,	+0.22	+1.63	+1.43	−0.34	+0.64	+0.49
" 29,	+0.07	+1.47	+2.39	−0.36	+0.51	−0.57
" 30,	−0.15	+2.91	+2.49	+0.13	+0.48	−0.60
" 31,	−1.02	+3.00	+2.34	−0.79	−0.16	−0.38
Aug. 1,	−1.38	+2.03	+1.35	−0.84	+0.60	−0.35
" 1,	−0.19	+0.97	+0.96	−0.94	+0.45	+0.59
" 4,	−1.16	+0.61	+0.37	−1.10	+0.69	−0.29
" 4,	−1.16	+1.54	+1.46	−1.23	+1.02	−0.02
DATE.	180–210	210–240	240–270	270–300	300–330	330–360
	"	"	"	"	"	"
July 28,	−0.72	+0.74	−0.73	−1.53	−0.85	−0.98
" 29,	−0.84	+0.52	−0.95	−2.55	+0.38	−0.06
" 30,	−2.47	+0.10	−1.10	−1.87	+0.37	−0.43
" 31,	−1.10	+0.66	−1.00	−1.53	+0.62	−0.63
Aug. 1,	−0.63	+1.43	−0.50	−1.72	−0.19	+0.21
" 1,	−0.05	+1.36	−0.76	−1.74	−0.08	+0.40
" 4,	−0.04	+1.57	−0.13	−0.76	+0.30	−0.13
" 4,	−0.42	+1.06	−0.28	−1.90	+0.07	+0.26

Taking the means of the separate determinations of the 30° spaces we have:

Spaces.	Corrections.	Summed Series=z.	Spaces.	Corrections.	Summed Series=z.
0 – 30	−0.60″	−0.60″	180 – 210	−0.78″	+1.70″
30 – 60	+1.77	+1.17	210 – 240	+0.93	+2.63
60 – 90	+1.60	+2.77	240 – 270	−0.68	+1.95
90 – 120	−0.68	+2.09	270 – 300	−1.70	+0.25
120 – 150	+0.53	+2.62	300 – 330	−0.08	+0.17
150 – 180	−0.14	+2.48	330 – 360	−0.17	+0.00

It is the intention to continue the examination of the subdivisions of the circle throughout the coming year. The subdivision of the 30° spaces will be made by setting the stops for that number of subdivisions, which can be safely made at one time without danger of the introduction of errors depending on the temperature. With two assistants, one to read the 4 microscopes, and one to record, the examination of the 30° divisions can be completed in about $1^h\ 20^m$.

If it shall be conclusively shown from an investigation of the present graduations of the circle that this method will give greater accuracy than former methods of investigation, it is the purpose to produce a new set of graduations just inside of the original graduations.

In conclusion it may be said that an excellent test of the method will be had when the telescope is reversed and the errors of the other circle are determined. The errors of this circle have already been determined for each single degree by comparison with a graduated metal arc of 15° with which each 15° of the circle was compared.

EDITORIAL NOTES.

Volumes II and III of the MESSENGER can now be had complete in numbers or bound, as preferred. The price for unbound volumes is $2.00; for the bound in plain style, light or black, $2.75. Volume I can be supplied only on special order.

As most subscriptions end with this number, it will be a favor if our subscribers will promptly indicate to us whether or not the MESSENGER shall be continued for the year 1885. It is our purpose to discontinue it at once where it is not desired.

For the many, many letters of encouragement and appreciation, which the kindness of friends has prompted from many parts of this and other countries, we are especially grateful. In some ways it would be gratifying to publish extracts from correspondence of this kind, but we have refrained from it uniformly, because the object of such notices might be misunderstood.

The items of astronomical news of various kinds that have been furnished by many in the past, have been valuable to our readers as we have been repeatedly assured by professional workers. We desire to call attention again to this important matter, and to solicit, respectfully, from every one, brief statements of fact or news that may be worthy of general attention. The astronomer, like any one else in special lines of work, wishes to know what others are busied about, how they work and how they succeed. Sentences brief and to the point, if but few in number, will be worth many times their cost to individuals in the benefits they may confer on others.

It has been a pleasant surprise to notice how many clergymen of various names are found on our subscription lists. Some are observers, others are mathematicians and all apparently much interested in the progress of our science. This is natural, since astronomy furnishes one of the grandest of the scientific fields for the play of imagination, for illustration, for lessons in the higher law, so called. drawn from many of those mental operations of the skilled analyst, and the keen and watchful observer. The azure depths are full of the handiwork of ONE who has spoken the LIVING WORD

Those whose duty it is to care for clocks that regulate extensive railway or city time services, may find the little device in use at the observatory of Carleton College a convenient arrangement. The mean time clock is corrected almost daily by means of an electric current and two magnets. The current is directed and measured (roughly) by the aid of a galvanometer and a commutator made neatly from a cheap pocket compass and a ring of wood, at a cost of about two dollars. By a turn of the index of the commutator a current of electricity magnetizes a temporary magnet and the pendulum of the clock is accelerated or retarded so gently that its common rate is disturbed only temporarily while the current is acting. Turn the index, and the current is reversed, and the opposite effect is produced on the clock pendulum, and the needle of the galvanometer always indicates to the eye of the observer which way the clock is being corrected, and how rapidly, by the number of degrees it is deflected from its zero position. It is very convenient, certain and surprisingly exact.

COMET BARNARD, 1884.

The following are the elements of the orbit of BARNARD'S comet computed by Dr. J. MORRISON of Washington, D. C.:

ELLIPTICAL ELEMENTS.

Epoch, 1884. Sept. 24.5, Washington Mean Time.

$M=$	7°	13′	19.″52	Mean Equinox, 1884.0.
$\pi=$	300°	57	44. 43	
$\omega=$	5	11	23. 56	
$i=$	5	28	18. 94	
$\varphi=$	35	37	2. 59	
Log $a=$		0.4862043		
Log $q=$		0.1069968		
Log $\mu=$		2.8207001		

Period=1958.4158 days.

C—O.

	$d\lambda \cos \beta$	$d\beta$
Aug. 12.	+ 6″.52	−3″.21
Sept. 15.	+ 9″.85	−8″.09
Oct. 14.	+31″.(?)	+1″.4.(?)

This orbit was calculated from positions obtained July 25, August 24, and September 23.

The period given by Dr. MORRISON is 50 days less than that found by BERBERICK (SIDEREAL MESSENGER No. 29, p. 284).

My last observation of this comet before the October *Moon* interfered was on the night of October 24, when it appeared a mere glow in the field. It seemed scarcely possible that after the *Moon* withdrew the comet could be seen again. However on the night of Nov. 5, I made a search for it with my five-inch BYRNE refractor, and after close sweeping I found it. It lay less than one-half degree north and preceding the 5½ m. star B. A. C. 7722, and was excessively faint. An effort was made to see it with the six-inch equatorial, but from the rather contracted field it was not possible to glimpse it, the rising *Moon* probably preventing. Nov. 6 it was again detected with the five-inch, being small and most excessively faint. It could not then be seen with the six-inch. From the fortunate fact that a small faint star was involved near the center of the comet, I succeeded in getting a position. Later, I once or twice faintly glimpsed the comet with the six-inch.

The night of Nov. 7 was clearer and the 'seeing' better. Found the comet with five-inch and could hold it steadily, though it was a great strain on the eye-sight. Tried it with six-inch; not seen at first, but afterwards by straining the eye it was feebly glimpsed, but it was impossible to hold it steady for a second at a time. In the five-inch could hold it quite steadily. Succeeded in getting comparison with 8 m. star, from which the comet's place can be obtained.

A comet eye-piece of some thirty diameters made by Bausch & Lomb, Rochester, was used on the five-inch; this, giving a field of about one and one-fourth degrees, gave more contrast than the six-inch.

To me these observations are conclusive proof that there are certain faint objects that may be seen in a comparatively small telescope which cannot be seen in large instruments. Apparently the comet, at the last three observations, has been the faintest object I have yet seen in the heavens. Should the weather prove good, I shall expect to follow it for some time yet.

It would be interesting to know how the comet appears in some of the large telescopes.

Vanderbilt University,
Nashville, Tenn.
E. E. BARNARD.

MINIMUM OF ALGOL.

Under date of Nov. 9, John H. Eadie, Bayonne, N. J., says: "A minimum of *Algol* occurred this evening. At 7½ o'clock the light of the star was very dim, but not quite at a minimum. When I again saw it at 9^h 45^m, it had considerably increased in brilliancy showing that a minimum had been reached between the times given."

The dates of minima given in the last Messenger were wrong as has also been kindly pointed out by Dr. T. D. Simonton of St. Paul. The above figures are in Paris time. The translator should have subtracted 5^h 17^m 33^s to give Washington time.

NOTE ON A SOUTHERN NEBULA.

A very large nebula was noticed at the Cincinnati Observatory on the evening of Oct. 18th. On looking for it in the catalogues the following curious facts were discovered. Although easily seen with a four-inch glass, it is not given by the Herschels. It seems first to have been discovered by Capocci at Naples, and by Harding at Gottingen, about the year 1827. See *Astr. Nachr.* No. 120 and Bode's *Astr. Jahrbuch* for 1827. Capocci places it in R. A. 333° 30′; Decl. —21° 40′. Harding in R. A. 334° 30′; Decl. —21° 45′.

In D'ARREST'S catalogue of nebulæ for 1850 he remarks under R. A. 330° 50′; Decl. −21° 33′, "Announced as new by CAPOCCI, *A. N.* No. 120. This nebula, never observed since, I have looked for in vain in favorable nights. I think, therefore, the R. A. may be ten minutes too great and the nebula identical with H. II. 1=*h*.2143. Position and description agree on this supposition."

In 1857 (*Astr. Nachr.* No. 1072) WINNEKE gives the position according to HARDING and remarks, "This nebula is in the catalogue of neither HERSCHEL. A large nebulous mass easily visible in the finder."

It is probable that D'ARREST looked for the nebula with too high a power. It is best seen with a power as low as 15. This may also account for its absence from the catalogues of the HERSCHELS. Its position for 1885, as determined here, is: R. A. $22^h\ 23^m\ 18^s$; Decl. —21° 26′. It is about five minutes west of *Mu Aquarii*.

Cincinnati Observatory, J. G. PORTER, Astronomer.

THE FIGURE OF THE PLANET URANUS.

Dr. SEELIGER, di ctor of the Munich Observatory, has employed the 10½-inch refractor (which has been remounted by the REPSOLDS in measures of the discs of the various planets. He employs a total reflecting prism back of the eye-piece and can therefore cause any diameter of the planet to appear at any angle with the vertical.

Measures of this kind have been made (on ten nights) on *Uranus* and Dr. SEELIGER'S result is clearly against any ellipticity of the disc.

In this he disagrees with several late observers (SCHIAPARELLI, YOUNG and others) but agrees with the conclusions of LASSELL, BRUHNS, ENGELMAN and others. The question is not settled, in any event, but this latest result is interesting specially on account of the method employed, which avoids a dangerous kind of constant error.

ON A HITHERTO UNEXPLAINED OBSERVATION BY CAPT. GILLISS.

I desire to suggest a probable explanation of a hitherto unaccounted for observation of GILLISS' given in Vol. 6 of GOULD'S *Astronomical Journal* p. 94. This was an occultation by the *Moon* observed at Santiago de Chile, 1852, Feb. 29, at $7^h\ 40^m\ 48.^s3$, local mean time of a star noted as 7.8 magnitude. This star could not afterward be recognized, although Mr. FERGUSON made a special and careful search in the region occupied by the *Moon* at that time, and found only stars of the 10th magnitude. GILLISS remarks that had it been possible to see a star so small as a 10th m., it certainly could not have been mistaken for one of 7.8 m., and moreover that it is more probable that the occulted star was doubtless obscured by cirrus clouds, and its magnitude under noted.

The suggestion I have to make is that this was an occultation of the star *Eta Geminorum*, although this explanation is so obvious that it is strange it should not have occurred to Capt. GILLISS or Professor FERGUSON. Perhaps some reader of the SIDEREAL MESSENGER may have the time and inclination to settle the point by calculation. It may be added that *Eta Geminorum* is a variable; although, of course, the limits (3.2—4.2 m.) are too narrow to have any bearing on the question.

S. C. CHANDLER, JR.

Cambridge, Mass.,
Oct. 31st, 1884.

ELEMENTS OF BARNARD'S COMET.

(Communicated by Commodore S. R. FRANKLIN, U. S. N., Sup't Naval Observatory, Washington.)

The following Elements of Barnard's Comet of 1884 have been computed by Professor E. FRISBY, U. S. N., from observations made at the Naval Observatory, on the evenings of August 12, September 15, and October 20:

Wash. M. T.		h	m	s	App α h	m	s	App δ °	′	″
Aug.	12.	8	40	46.8	17	2	49.31	− 36	43	2.4
Sept	15.	9	48	7.0	19	21	1.09	− 29	32	35.2
Oct.	20.	7	9	32.5	21	20	25.05	− 17	5	58.9

From which are derived the following elements:

Time of Perihelion passage August 16.289528 Gr. M. T.

$$\left.\begin{array}{lrrrr} \omega & = & 5^\circ & 23' & 51.2'' \\ \pi-\omega & = & 300 & 46 & 18.2 \\ i & = & 5 & 24 & 48.7 \\ \varphi & = & 34 & 51 & 49.3 \\ \log a & = & 0.474164 & & \end{array}\right\} \text{Mean Equinox } 1684.0$$

$$\mu = 689.858''$$

$$\text{Period} = 1878.65 \text{ days.}$$

Comparison with the middle place gives

$$\delta\lambda\cos\beta = +2.6''$$
$$\delta\beta = -\ \ 0.6$$

$$\left.\begin{array}{l} x = [9.999983]\, r\, sin\, (36\ \ 8\ \ 43.2 + v) \\ y = [9.942476]\, r\, sin\, (306\ \ 25\ \ 31.6 + v) \\ z = [9.683488]\, r\, sin\, (305\ \ 13\ \ 19.9 + v) \end{array}\right\} 1884.0$$

M. VAN DER VEN has printed in the *Archives du Musee Teyler* (series II., parts 1, 2) an examination of a universal instrument made by the REPSOLDS for the Musee Teyler. This paper is of interest on account of the full details of the observations, which are given, and the complete way in which the sources of error have been traced.

OBSERVATIONS OF COMET BARNARD, 1884, MADE AT THE CINCINNATI OBSERVATORY.

1884.	Mt. Lookout Mean Time.	App. R. A.	Log. $p. \Delta$	App. Decl.	Log. $p. \Delta$	No. of C'mp	C'mp Star.
	h m s	h m s		° ′ ″			
Sept. 17,	7 46 09	19 29 01.26	8.204			6	1
" 17,	8 21 18			− 28 53 40.5	0.910	12	1
" 18,	7 27 01	19 32 33.36	8.398	− 28 34 04.5	0.912	14. 8	2
" 20,	8 43 11	19 40 29.85	9.155	− 27 51 58.8	0.903	10. 6	3
Oct. 14,	9 24 46	21 03 02.67	9.379	− 19 10 30.4	0.894	16.10	4
" 15,	7 45 44	21 05 51.65	8.619	− 18 50 28.0	0.874	10.10	5
" 16,	9 48 30	21 09 04.64	9.446	− 18 27 32.3	0.899	10. 8	6
" 18,	8 20 06	21 14 49.91	9.265	− 17 46 11.5	0.878	10.10	7

Star	Mean R.A. 1884.0	Red to App.	Mean Decl. 1884.0	Red to App.	Authority.
	h m s	s	° ′ ″	″	
1	19 28 48.10	+ 3.56	−28 55 15.2	+ 13.0	½ (O. Arg. 19737-8 + Yar. 8374)
2	19 32 38.28	+ 3.54	−28 32 44.7	+ 13.3	2 Comp. with O. Arg. 19660
3	19 37 11.42	+ 3.51	−27 54 57.3	+ 13.7	½ (O. Arg. 19901 + Yar. 8462)
4	21 02 16.64	+ 3.26	−19 11 36.6	+ 19.6	O. Arg. 21151
5	21 03 59.94	+ 3.22	−18 48 01.6	+ 19.6	O. Arg. 21183
6	21 11 26.56	+ 3.24	−18 28 15.0	+ 19.9	Newcomb 947
7	21 11 46.13	+ 3.19	−17 56 49.5	+ 20.0	O. Arg. 21282

During September the comet was bright with a well-defined nucleus. In October it was large and faint, with no appreciable condensation, and the observations were correspondingly difficuit and uncertain. The filar micrometer was used throughout, except for the last observation, which was made with a scale micrometer.

Professor WILSON observed in October; myself in September.

J. G. PORTER, Astronomer.

Cincinuati Observatory.

KRAKATOA ASHES.

The following interesting note respecting the eruption from the volcano of Krakatoa in August, 1883, is from a private letter from ALFRED BICKNELL, Boston, Mass.:

"At the date of the eruption the bark 'Wm. H. Bessie,' of Boston, a vessel of 1,100 tons, was in the Straits of Sunda, on her passage from Batavia. My informant, S. GIBBS, was then mate—now master of the bark. He said they were twelve to fifteen miles in a direct line from Krakatoa when the eruption began, and it soon became too dark to run from the shower of ashes. Being in twenty-five fathoms, they lay with anchors down for over forty-eight hours, and until it was light enough to see. During most of the time the darkness was so great, that at noon the hand could not be seen within a few inches of the eye. The ashes fell in such enormous quantities that all hands were constantly engaged in shoveling them overboard, as well as they could in the darkness. The sea was not "rough," but a tremendous current was running. As soon as they could see at all, they weighed anchor, and found the ashes on the surface of the ocean 600 miles away. They kept a few barrels for scouring, but on their arrival here last December I went to the vessel and procured a quantity. The "Bessie" was probably as *near* the volcano as any one that escaped unharmed, and for many hours they were in momentary expectation of being overwhelmed by the eruption."

Mr. BICKNELL favored the MESSENGER with a specimen of the ashes. They are fine, heavy and gray in color, closely resembling marl.

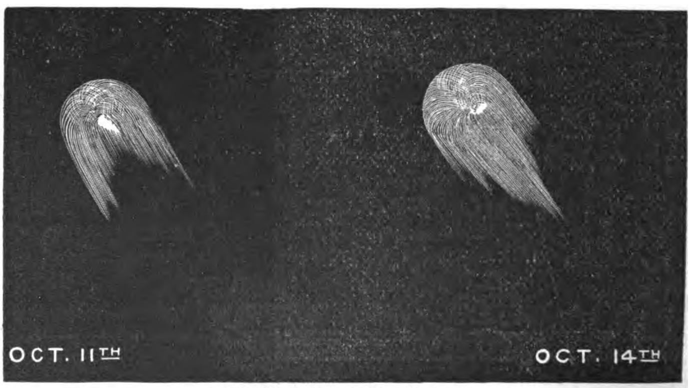
SATELLITES OF SATURN.

Professor A. HALL, Naval Observatory, Washington, D. C., kindly offers the following important note:

"The ephemerides of the satellites of *Saturn*, given by Mr. A. MARTH in the June number of the Notices of the Royal Astronomical Society, are nearly correct, and will be found very convenient in use. This is especially the case for the faint satellites *Mimas and Hyperion*. This is the first year for which a good ephemeris of *Hyperion* has ever been given."

WOLF'S COMET.

Observations of the comet Wolf have been made with the nine-inch reflector upon every suitable occasion, mainly as a study of its physical characteristics. The changes in form and brightness have been numerous and interesting. My first observation was made on September 25, when it was an easy telescopic object in moderate moonlight. The nucleus was small and star-like, the coma large, tolerably well defined and elliptical in outline, the major axis in a line with the *Sun*.



Wolf's Comet, by Brooks.

I append two drawings of the comet made on the evenings of Oct. 11th and 14th, respectively. On October 11th, the nucleus was small, hard and well defined, and a stumpy brush-like tail was seen with close attention, pointing from the *Sun*. On the 14th inst. the appearance of the comet had changed very much; the nucleus being larger and more nebulous, while the form of the tail was that shown in the second sketch. These features were faint and delicate and best seen with magnifying powers of sixty and eighty. Eye-pieces giving a flat field and black sky ground are needed for this class of work. On November 9th the comet appeared to me much fainter than it should be theoretically, and the ill-defined central condensation was mottled, presenting the appearance of a faint star-cluster when viewed with a power too low to resolve it.

Red House Observatory,
Nov. 13th, 1884.

WILLIAM R. BROOKS.

EASY STUDIES OF THE CONSTELLATIONS.

These notes are for those who know little about the face of the sky, as it appears from night to night, but wish to know more; those who have an interest in the elements of astronomy and would like to use their eyes and give careful attention to what they see, though they have no good star-atlas or even an opera-glass to aid them in these plain observations. Very much can be done in the way of self-instruction if the common observer will give attention to what he sees and form the habit of writing down the substance of what has been seen. It is quite useless to try to remember almost anything that one wishes to reproduce accurately. Definite notes must be taken at the time and while the object is before the eye if a person wishes to be sure of what he has seen, or to have any real value attach to his ideas in the future.

Now, with note-book in hand the young observer wishes to begin a half-hour study of the sky, on any clear night at 10 or 9 o'clock respectively, on the first or fifteenth of the present month.

Facing the north, the observer will remember that the geographical latitude of his place is equal to the altitude of the Pole of the celestial sphere which is closely marked by *Polaris* or the North Star. In latitude 45° north, for example, this star would appear to be 45° in altitude from the north point of the horizon, or half way to the zenith. A line drawn from the north point of the horizon through *Polaris*, the zenith, and the south part of the horizon is the Prime Meridian. The constellation of *Ursa Major*, the Great Bear consisting of seven stars about as bright as *Polaris*, and forming a figure like a dipper is seen passing the meridian from west to east, in the latitude supposed, less than half way from the horizon to the North Star Two bright stars on the right form a line with the North Star and are called the Pointers, because by them a person may always quickly locate *Polaris* at night if the points of the compass are uncertain.

The next point of interest is their names and distances from each other. The eight stars spoken of are all nearly of the same brightness and the Pointer nearest the Pole (28¾° distant) is called *Dubhe*, the other *Merak*; distance between them about 5°; west 8°, in bottom of the Dipper, is *Phegda*, north nearly 4½° is *Megrez*, next in handle is *Alioth*, 5½°, then *Mizar* and *Alcor*, a neat naked-eye double star, in the bend of the handle and 4½°; and finally *Benetnash*, 7°. This last distance is accurate enough to be used as a scale to practice measuring distances in the heavens. Note that and use it.

Observe when the Pointers are passing the meridian exactly below the *Polaris* and then observe them one hour later and so practice in telling time by the stars.

SUN-SPOTS.

The long-delayed maximum of solar spots, now undoubtedly passed, has attracted universal attention to the spot-periodicity. To-day and yesterday the visible hemisphere of the sun was, for the first time in nearly fourteen months, observed to be entirely free from spots; the occasion next preceding this being 1883, Sept 25. During the past two years, the only additional days on which the sun was observed to be without spots were, 1882, Oct. 9 and Dec. 3, and, in 1883, Feb. 23, and May 25, 26, 27, and 28.—*Science*. Nov. 14. DAVID P. TODD.

Mr. E. F. SAWYER, Cambridgeport, Mass., saw only two meteors from the *Leonids* Nov. 13, 14, 15, during a watch of 1^h 40^m. They were as faint as a 5th m. star. It was thought that the Earth passed through the lower part of the stratum.

Subscriptions and orders not previously acknowledged: James Jackson, Paterson, N. J.; Reading Room, Washington, and Jefferson College, Washington, Penna.: D. Stock, M. D., Federal St., Camden, N. J.; Library of Johns Hopkins University, (Vols. I, II, III,) Baltimore, Md.; John M. Black, 1334 Chestnut Street, Philadelphia, Pa.; Aaron B. Chapman, 183 Portrea St., New Haven, Ct.; Robert Elliott. Hannibal, Mo.

BOOK NOTICE.

Vierstellige Logarithmer von F. W. REX: J. B. METZLER. Stuttgart, 8 vo. pp. 64.

This is the best four-place logarithm-book which has ever fallen under the writer's eye. The logarithms of the trigonometric functions are given for each 10′: from 2° to 12° log. sin. and log. tan. are given for each tenth of a minute, and from 0° to 2° for each tenth of a minute. There are tables of addition and subtraction logarithms, Napierian logarithms, squares, cubes, chords, etc. The tables of proportional parts are very full. The type is large and plain, and the paper excellent. H. A. H.

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NOTE.—The numbers following the titles of Articles designate the pages of Volume III. Those in parenthesis are the numbers of the Minor Planets.