REPORT ON MARS, No. 12.

WILLIAM H. PICKERING.

In order to study the color changes on Mars to better advantage than heretofore, a color scale has been prepared and tested during the past few weeks. It consists of fourteen divisions which have been colored and numbered provisionally as follows:— 1 is clear sky blue, 2 and 3 are fainter, while 4 is a very pale blue, 5 and 6 are light grey and light green and have been but little used hitherto. 7 is white, 8 is pale yellow, 9 and 10 are darker, the latter resembling the rind of a lemon, 11 is yellow ochre, 12 resembles an orange, 13 has a little more red with it and 14 is a clear light red. The importance, as previously noted, of having the planet and the illuminated paper of the same brightness when estimates of color are made, is shown by the fact that the nearer we bring the light to the scale, the yellower the paper appears. The light employed was a 2 c.p. tungsten lamp shining through the standard blue glass.

TABLE I

COLOR OF THE DESERT REGIONS.

Date	Carbon	Tungsten	Blue
Oct. 2	—	8	14
9	—	9	13, 14+
15	6	10	12
17	10	—	—

The color observations made during the month by means of this scale are given in Table I. The scale was not completed until October 12, so that the observations of the two earlier dates had to be reduced to it from a comparison with previous individual color sketches. The observations with the blue glass are somewhat conflicting, and are more subject to error than the others, because I have not yet been able to secure a torch capable of carrying a sufficiently high candle power tungsten light to produce equality of illumination. They are given now however with the others notwithstanding this fact, since observations made during this month were of particular interest, because as stated in our last Report it was expected that the Martian skies would begin to clear about the middle of October, the vernal equinox on Mars, and that thereafter the planetary markings would become

more distinct. The increasing redness of the desert regions, as indicated by the observations made with the carbon and tungsten lamps, is shown by the higher scale readings towards the end of the month. That is to say, the Martian haze did clear away, showing the true color of the desert regions of the planet. The same fact is also brought out in another way by the increasing clearness with which the canals and lakes appeared, in spite of the fact that the angular diameter of the planet increased during the observations only from 6″.1 to 6″.8.

The northern snow cap appeared white throughout the month, indicating freedom from cloud in that region. When the light is reduced however, either by thin cirrus cloud in our atmosphere or by a deposition of dew on the lens, the snow cap turns yellow, and may then appear of the same color as the clouds, which at this season constantly envelope the southern pole. Indeed this discoloration of the snow is usually the first sign of dew on the lens.

As expected, the northern snow cap reached its maximum size the latter part of September, the Martian date occurring in the sixth week of February, as was also the case at the previous opposition. It will be remembered that eight weeks make a month on Mars (Report No. 10). This seems to have been a somewhat colder season on the planet than the previous one, since the snow reached to a lower latitude during most of the month by 3°.5 or 130 miles (210 km). The lowest latitude reached and maintained was 51°.5 or about that of Greenwich.

TABLE II

DATA OF OBSERVATIONS.

No.	1915	⊙	M. D.	Long.	Lat.	Sun	Diam.	Seeing
		°		°	°	°	″	
1	Oct. 2	352.0	Feb. 41	61	+12	−3	6.1	10, 8
2	" 5	353.5	" 44	29	+13	"	"	8, 7
3	" 9	355.5	" 48	356	+14	−2	6.3	12
4	" 14	358.0	" 53	328	"	−1	6.5	6, 5
5	" 15	358.4	" "	294	+15	"	"	6
6	" 17	359.4	" 55	279	"	0	6.6	6
7	" 18	359.9	" 56	271	"	"	"	7
8	" 19	0.4	Mar. 1	258	"	"	6.7	10
9	" "	"	" "	266	"	"	"	10
10	" 22	1.9	" 4	228	+16	+1	"	10
11	" "	"	" "	253	"	"	"	9
12	" 23	2.4	" 5	223	"	"	6.8	10
13	" "	"	" "	236	"	"	"	11
14	" "	"	" "	246	"	"	"	10
15	" 27	4.3	" 9	158	"	+2	6.9	6

Fifteen observations of Mars were secured during October, the data of which are arranged as in previous Reports and are given in Table II.

When any of the large polar marshes, but especially Acidalium, come around the sunrise limb, they are usually followed at a distance, sometimes as great as 200 miles, by a yellow or white area of considerable size. The former color indicates cloud, and is the commoner of the two. The white probably indicates a thin layer of new fallen snow. It must be thin, since it never persists to the central meridian. On October 9, Martian date February 48, a pure white area one-third the size of the polar cap and of the same whiteness and brilliancy, following the Acidalium marsh, stretched from the sunrise limb to within 45° of the central meridian. It must have been an unusually heavy fall for Mars, for this would indicate that it persisted until nearly 11 o'clock in the Martian morning. Its size was rather difficult to determine for, unlike the snow cap, it had no sharply defined southern boundary. It stretched about 600 miles south from the polar cap, or through some 16°, to latitude +37°, and must have covered nearly a million square miles of surface in the visible hemisphere, and very likely much more on the other side of the planet.

On October 18 it was recorded that the limb was no brighter than the surface of the planet just following the Syrtis. This would have been near the central meridian, and indicates that there were no clouds on the limb at that time. That clouds are much more frequent and conspicuous on the limb than on the terminator has often been noted, and rightly ascribed to the foreshortening of the surface of the planet near the limb. How great this foreshortening really is, is perhaps not generally appreciated. On October 23 at $16^h\ 30^m$ the Syrtis was invisible. Ten minutes later it was first detected as a narrow dark line very close to the limb, and separated from it by a narrow bright band of haze. Yet at this time the Syrtis was only 60° from the central meridian, and the breadth of the narrow band of haze measured one-eighth of the radius of the planet, or 0″.4. That is, all the haze existing in 30° of longitude near the equator, or 1100 miles of atmosphere, was concentrated in this narrow band. It is no wonder that a very little haze becomes conspicuous under such circumstances,—the wonder is rather that the limb should ever appear clear at all. On the other hand, on this same date an area fully 1″.5 or 1000 miles (1600 km) in breadth, of very thin light haze bounded the terminator south of Cerberus. It could just be clearly seen, its brightness being recorded as 5.5 while the region north of Cerberus at the same distance from the terminator was marked 5. This observation indicates to us both the thinness of the Martian cloud, and the explanation of why it is so seldom detected on the terminator, even when we know that it ought to be there.

It does not necessarily follow that the haze or cloud is continuous—the same effect would be produced by a large number of little isolated cloudlets. It might be a matter of interest to obtain observations whenever practicable of the times of appearance and disappearance of the Syrtis when near the limb and terminator, during different portions of the Martian year, as an indication of the freedom from haze of its atmosphere. We might thus determine if it ever became visible within 5° or 10° of the limb. On account of its shape, and position on the equator, the Syrtis is better adapted to this investigation than any other marking on the planet.

This same appearance of cloud on the terminator is indicated in a report and drawing just received from one of our associates, Professor Lau. He indicates a region extending some 2500 miles (4000 km) along the southern terminator, with a maximum breadth of 600 miles (1000 km), which he describes as a "faint bluish white region." His observation was made September 28. The writer observed the same region, similarly situated, four days later, but no trace of the bright area was detected. In its place were the usual dark southern maria of the planet. These records of faint terminator clouds visible shortly before sunset in the southern hemisphere, and appearing just at the time, and just after, the northern snow cap reached its maximum size, are interesting indications of the speed with which the water vapor is transferred from pole to pole at this season of the Martian year through the planet's atmosphere, by means of the Martian winds. Professor Lau's cloud was from three to five thousand miles south of the southern boundary of the snow cap.

It seems quite possible that a considerable portion of the water of the planet is kept in circulation, by this natural means of transportation, just as it is upon the earth. At the same time the clouds on Mars are obviously far less dense and less numerous, and consequently far less efficient as water carriers than those of our planet. It is possible to understand therefore why some auxiliary system of circulation might have been evolved to increase the fertility of the land. Now oddly enough something rather different from the ordinary canals has been recorded, which seems to serve this very purpose, just at the time when the polar cap is melting most rapidly. This we shall now describe.

The polar band, or canal bounding the snow cap on the south, made its first appearance in 1913, on the Martian date January 53. This year it was first seen M. D. February 5. The band is often of irregular width, and in the majority of cases, 38 to 7 at the last opposition, is darker on the eastern side of the disk than on the western. In 24 cases there was no choice. This difference is especially marked during the latter part of the Martian February, when the cap reaches into the

lower latitudes, and is melting most rapidly. The irregularity of shape indicates that as the planet revolves from west to east, and as the day wears on, the band grows both darker and wider. During this year's observations, on October 22 and 23, it was thought that the canal could actually be seen to have increased in size in the region to the east of the Syrtis, between the early and later observations. While it is believed that most of the narrow and comparatively permanent canals are due to vegetation, it is fairly certain that this one at least owes its appearance to the existence of marshy land or moistened or thawing soil. It reached its maximum breadth, 800 miles, east of Acidalium on October 9, M. D. February 48. It was only 300 miles in width in the same place four days earlier. The band was again 800 miles in width, this time to the east of the Syrtis, on October 18, M. D. February 56. The next day it was reduced to 500 miles, and three days later for a time practically disappeared. The following day it was again visible in the same place, with a breadth of 150 miles.

In our last report we described and figured a broad dark band running nearly north and south, and connecting the polar band with the southern maria. It differed from the ordinary canal both in the short duration of its visibility, and in the fact that while it was but a few hundred miles in breadth when first seen, it rapidly increased in size, and before it had faded out was at least 1200 miles in width, its length and breadth being about equal. It started near the Ganges, but travelled slowly easterly to lower longitudes, and when it finally faded away was situated between Margaritifer and Sabaeus. A second straight north and south hazy band 300 miles in width connected the polar cap with the Syrtis in early September and late October of this year, and doubtless was a continuous phenomenon.

The polar band is narrowest where following, that is to the west of, the north and south bands, as if they drained it of its moisture. Or perhaps we should more properly say, the bands start from the western end of the marshes, and are fed by the winds, by the evaporation from the moist regions to the northeast of them. That is to say they intercept in some manner the northeasterly moisture-bearing winds. Indeed it is pretty clear that these bands are the indication and mark left by the auxiliary mechanism, whatever it may be, which transports the water from the northern polar cap to the southern maria. Apparently the duration of their activity is very brief,—only a few weeks,—and is confined to the time when the snow is melting most rapidly.

Their straightness and directness, leading to the nearest portions of the maria, leaves a strong impression on the mind of their artificial character. They seem to be of the same nature as the bands bounding the snow, which cannot be due to vegetation, owing to their rapid

changes. Moreover they never turn green like the maria. If the north and south bands were due to irrigating ditches therefore, they would have to be the ditches themselves, not merely vegetation growing on their banks. But this is impossible, on account of their size and gradual shifting of position. The only possible explanation for them seems to be that they are soil, moistened by precipitation at night from the atmosphere.

This moisture, having reached a lower latitude, is perhaps again evaporated the next day, and transported directly to the maria. If the bands were due to natural currents of air and water vapor, they would surely be inclined to the meridians like our trade winds. Since they are not so inclined, or rather are only slightly so, through a slowly shifting angle, first east then west, they cannot be due merely to natural causes, but must, it would seem, be due to such causess haped and guided in some manner by intelligence. Whichever of the two explanations we adopt, we seem to be driven back to intelligent direction. There really seems to be no other explanation for them, with the information at present at our disposal.

On November 26, 1913, M. D. February 51, in the same region where the straight band took its origin, that is from the Acidalium marsh, a faint narrow line was seen extending 20° to the west of north, until latitude +20° was reached. It then turned sharply to 20° towards the east, and ended in Auroræ Sinus. Two days later it was much broader, but did not extend beyond the location of Lunae Lacus in latitude +20°. Two days later yet, M.D. February 55, and again February 56, it was seen as a continuous curved band joining Acidalium with Aurora. This curved band was clearly seen in its entirety this year by Professor Lau on September 28, M. D. February 37, and he also detected Lunae Lacus, which was not visible until several months later in the previous opposition. Four days after his observation the region became visible in Jamaica as previously mentioned, and his drawing was fully confirmed. He therefore saw the curved band complete this year eighteen Martian days before it had been seen to form at the previous opposition.

On October 5, M.D. February 44, the southern maria in longitude 30° were first suspected of showing a greenish tint as compared with those at the north. Four days later the color was clearly developed. On September 14 and again October 2 they had been recorded as grey. In 1913 the first greens appeared on M. D. February 44 on the same date as this year, none being visible ten days earlier. On October 23 of this year the maria were described as distinctly green.

On October 5, the Acidalium marsh was central, well developed, and dark. It reached one-third way across the disk to latitude +32°. Its

color was dark grey, but a bluish tint was suspected. The conditions were too unfavorable however to render this certain. It had appeared fully developed three days earlier. On October 9 it again appeared bluish, but it was too small to judge with certainty of its color, the corrected diameter of the disk being only 6″.3. It was tested for polarization, but none could be detected. On October 27 a large dark polar marsh was noted near longitude 158°. It evidently corresponded to the twin bays, Propontis and Castorius, of the last opposition, but our sky was too cloudy to make trustworthy observations possible.

On October 18, M. D. February 56, the Syrtis was central. It was certainly not green, but looked greyish brown. On the other hand the western portion of the southern maria was greenish grey. This was their autumn. It may be remembered that at the last opposition we noted that the greens appeared in the autumn, but were not conspicuous in the spring time. There was no indication of the marsh often seen at the extreme northern end of the Syrtis, latitude +15°. Several times Thoth was suspected, but if visible it must have been extremely faint. The next night it was practically certain that Thoth was developing, but it was still near the limit of visibility. A dark point in the end of the Syrtis was suspected, but there was much trouble from dew on the lens, rendering observation difficult. Cloudy weather intervened, but October 22 was clear, and Thoth appeared fully developed and darker than the Syrtis. The latter however was near the limb. For this reason it was impossible to form any certain opinion regarding the existence of the Syrtis marsh, still a small spot was again suspected. There was more trouble from dew. October 23 was clear and dry, seeing 10 and 11. Thoth was conspicuously visible, and although the Syrtis was near the limb, the marsh was now well developed, and darker than any other portion of the disk save Boreosyrtis. The latter was clearly grey, the former probably blue. This was the first appearance of the marsh this year on Mars, and if any observers of the planet are working to the west of Jamaica, they will doubtless be able to tell us more about it. It will not again be seen here until the latter part of November. Cerberus was seen October 22, and again the following night. It and Thoth were the first canals, excepting those associated with the polar cap, to be visible this year; diameter of the planet 6″.7. Nuba Lacus (Jarry-Desloges) was also seen October 23, and the canal Marsyas (J. D.) suspected. The first lake visible was Lunae Lacus on October 2. A minute lake was also seen in the position of the forked bay of Sabaeus October 9.

To make more readily comparable the advance of the seasons on Mars during the present and the past oppositions, Table III has been prepared. The eleven phenomena considered are the first appearance

of the polar, the north and south and the curved bands, the first appearance with a sharply defined southern boundary of the Acidalium marsh, the time when the polar cap attained its maximum size, the first appearance of a green coloration in the southern maria, the time when the polar band attained its maximum breadth to the east of Acidalium, the last appearance of the north and south band, and the first appearance of the Syrtis marsh, of Thoth and of Cerberus. Two dates are given in the third and fifth columns. For phenomena 1, 2, 3, 4, 6, 9, 10 and 11 the second date indicates the first appearance, and the first date the last observation when the phenomena in question might have been seen, but was not detected. For the fifth and seventh phenomena the two dates are selected from the whole series of observations as being the two between which the maximum probably occurred. The eighth case, unlike all the others, is a disappearance, and the first figure therefore gives the last date when it was visible, and the second the first date when it was not seen. The fourth and sixth columns give the means of these dates and their deviations. Those dates which it was possible to determine with some accuracy, and in which especial confidence is placed, are printed in heavy faced type. The last column gives the second mean minus the first. From it we see that in some respects the present season is earlier than the last, and in some ways it is later. In the case of special markings such as the Syrtis marsh and Thoth, the deviation sometimes exceeds a Martian month, but for general phenomena, such as the maximum of the snow, the appearance of the polar and north and south bands, and the green areas, the deviations are much less. In both cases the seasons this year seem to be a trifle late, for the general phenomena about nine days, for the special about 20.

TABLE III.

Relative Advance of the Seasons.

No.	Phenomena	1913	Mean	1915	Mean	'15—'13
1	Polar band	Jan. 39, 53	46± 7	Feb. —, 5	5	+15
2	N. and S. band	" 36, 40	**38**± 2	" —, 5	5	+23
3	Curved band	Feb. 53, 55	**54**± 1	" 5, 41	23±18	−31
4	Acidalium marsh	" 53, 55	**54**± 1	" 5, 41	23±18	−31
5	Snow max.	" 28, 55	42±13	" 17, 48	32±16	−10
6	Green areas	" 34, 44	**39**± 5	" 41, 44	**43**± 1	+ 4
7	Polar band, max.	" 15, 27	21± 6	" 48, 53	50± 2	+29
8	N. and S. band, dis.	Mar. 3, 4	3± 1	" 53 —	53	− 6
9	Syrtis marsh	Jan. 17, 53	35±18	" 56 Mar. 1	**1**± 0	+60
10	Thoth	" 17, 53	35±18	Mar. 1, 3	**2**± 1	+62
11	Cerberus	Feb. 8, 34	21±13	" 1, 4	3± 1	+38

The first two phenomena occurred so early in the season that the earlier limit could not be well determined at this opposition, but we may draw the following conclusions from the remaining data:—

(*a*) The curved band was certainly invisible February 53, in 1913. This year it had already clearly appeared by February 41, or twelve days earlier. As we have already seen, it was detected by Professor Lau four days earlier still.

(*b*) The southern boundary of the Acidalium marsh was not clearly defined formerly on February 53. This year it was certainly sharp, February 41, or twelve days earlier.

(*c*) The maximum of the snow and the green areas appeared nearly together, and at about the same time both years. An examination of all the observations of the snow would make it appear that in both years the maximum occurred about February 37 $\pm$10 days.

(*d*) The date of maximum of the polar band probably depends on Martian local conditions, especially temperature, since it changes its breadth very rapidly.

(*e*) The date of disappearance of the north and south band is a rather indefinite quantity, since it fades out very gradually.

(*f*) The appearance of the Syrtis marsh, of Thoth, and of Cerberus can be determined with considerable accuracy, that is within a day or two, but are clearly liable to great variations in different years, depending on Martian conditions independent of the seasons, and of which we now have no knowledge.

During the last opposition there is evidence that the Syrtis marsh appeared three times, reaching a maximum size near the Martian dates January 53, March 10 and March 47. It was not visible on the dates January 17, February 28, April 28, May 6, May 43, nor June 17. Its first appearance at both oppositions coincided closely with the appearance of Thoth.

None of the finer detail was detected this year before October 2, M. D. February 41. Since then however the canals and lakes have begun to come out as follows. The six sections of the planet have been indicated by capital letters as in Report No. 8.

October 2. **B** Lunae Lacus.
October 5. **A** Acidalium marsh, Margaritifer.
October 9. **A** Deuteronilus, Callirrhoe, Lake in Sabaeus at forked bay.
October 22. **E** Cerberus, Thoth, Boreosyrtis.
October 23. **E** Cerberus, Thoth, Boreosyrtis, Marsyas (J.D.), Nuba Lacus (J. D.)
October 27. **D** The twin marshes of Propontis and Castorius.

We are now at the height of our autumnal rainy season in Jamaica,

and on account of the unfavorable weather conditions it has been impossible during the past two presentations of the planet, and up to November 1, to secure any satisfactory observations when the central meridian lay between 63° and 223°. The condition of a considerable section of the surface, fully a quadrant, is therefore so far unknown. It is greatly to be hoped that somewhere else in the world accurate drawings have been secured of this region. The writer would be pleased to communicate with any such observer.

In the October number of POPULAR ASTRONOMY, Dr. Lowell questions the actuality of the shifting of the canals, and states that the appearance itself is not new, having been detected nineteen years ago at the Lowell Observatory. The appearance to which he refers is much older than that, as it was recorded by Schiaparelli in 1879, and again in 1882, for three different canals, Araxes, Laestrigon, and Titan (Flammarion 1, 333, 336, and 360). His interpretation of what Schiaparelli, as well as of what he himself saw, is very likely correct.

His claim of exceptionally good seeing at Flagstaff it is thought is well founded. The writer spent six months there when the first telescope was erected, and wishes to say that he has never seen better seeing either at Arequipa, where he spent two years, nor in Jamaica, where he has now spent five, than the best seeing at Flagstaff. Indeed there is practically no choice between the best seeing in the three places. It is his impression however that there is considerably more good seeing in Jamaica than at either of the other stations. This is perfectly natural, for not only has it a more uniform climate from day to day, with a smaller daily range of temperature, but at Flagstaff they have a long winter when the seeing is inferior, and at Arequipa a long cloudy season, which also comes during the northern winter. Although we in Jamaica are at present in the midst of one of our rainy seasons, and this has proved to be an extraordinarily wet year, with two hurricanes in our vicinity, and four days in the last three months when the rainfall ranged from six to ten inches, yet on thirteen nights out of the thirty-one in the past month, our seeing has been recorded from 10 to 12, 6 being about the best that we have in Cambridge, and 12 being perfect for an 11-inch telescope. Eight nights were completely cloudy.

Dr. Lowell's suggested explanation of what we have called shifting canals is that the apparent shifting is due to the existence of two similar canals which appear one at a time, first one and then the other, and that the second is then mistaken for the first.

In Report No. 3 it is noted that the difference in longitude between Aryn and Margaritifer according to Schiaparelli is 21°.3 while according to Lau it is 28°.1. The difference 6°.8 amounts to 250 miles, and would be about 1″. It would be almost as great as the distance between the

two branches of the forked bay of Sabaeus. Both authorities used micrometers, and it is inconceivable that the difference should be due to errors made by two such careful observers. Neither does it seem likely that a marking resembling Margaritifer or Aryn should have appeared slightly to one side of the true one, which should in the meantime have disappeared. Canals are tangent to either side of Aryn, and prolong Margaritifer. If either Aryn or Margaritifer shift, the associated canals must shift with them.

In Report No. 4 it is shown that in six weeks the southern ends of the twin bays near Propontis and Castorius shifted westerly (in a terrestrial sense) through about 10° of longitude, or some 280 miles. A glance at the figure will show that there could by no possibility be a lack of identification of the bays. The bays coincide with the two canals Brontes and Hades on Antoniadi's map (Flammarion **2**, 592).

In Report No. 7 it is shown that observations by M.G. Fournier made at the observatory of of M. Jarry-Desloges indicate a mean change in longitude of 2°.9 for sixteen clearly defined points on the surface of the planet in four months. Thirteen points moved toward the west, two toward the east and one was stationary. Aryn and Margaritifer each shifted 7° in longitude. Most of the others shifted less.

In Report No. 6 a change in Elysium is described. A few additional facts are now added. The first clear representation of it seems to have been by Lohse in 1873, who represented it as a circle 1200 to 1400 miles in diameter. In 1877 Green represents it as an ellipse measuring 750 by 1000 miles. Schiaparelli did not see its northern boundary in that year, but in 1879 represented it as an elongated pentagon measuring 750 by 1400 miles. In his map based on all of his observations up to 1886 it is shown as a regular pentagon with rounded sides, 1100 miles in diameter. In 1892 several careful drawings by Professor Douglass and the writer all show it as a circle 600 miles across. In 1903 its general shape was circular but with a strongly marked southern angle. It measured 1200 miles in a north and south direction (Mem. B.A.A. **16** Part 4, Plate IV). In 1911 it was clearly pentagonal according to Jarry-Desloges and his observers, diameter 900 miles (Observations **3** Plates XII and XX). At the last opposition it was repeatedly noted by the writer, at first with some surprise, that its southern angle had disappeared, and that it was now elliptical, slightly elongated in a direction north-east and south-west and measuring 1350 by 1200 miles. It is true that in 1884 Schiaparelli recorded all the canals surrounding it as double, the diameters of the two pentagonal circles being 1400 and 1000 miles respectively, but even admitting their duplicity, this would not account for the smaller dimensions above recorded, nor for the remarkable changes in its shape. Elysium is a

large and conspicuous object, readily seen and easily drawn. It is impossible that such difference in its size and shape could be due to errors. The only explanation available seems to be that the canals which form its boundaries shift in their places.

Other instances of shifting might be cited from Reports Nos. 5 and 8, but these are perhaps sufficient to show that Dr. Lowell's suggestion of a wrong identification of the canal will hardly explain the phenomenon in question, as described in these Reports.

Mandeville, Jamaica, B. W. I.

THE POSITION OF THE SUN IN SPACE.

WILLIAM ALBERT MASON.

For over half a century astronomers have been successfully engaged as far as our present standards permit us to judge, in more or less accurately locating in the magnificent reaches of space about us hundreds of our stellar neighbors. Not only have their distances from us rather definitely been determined, as well as their motions and speed, for they all are traveling at stupendous velocities through the interstices of space, but a large number of stars with companion suns revolving about them not only have had their orbits and periods of revolution accurately calculated, but through these factors actually have been weighed and their masses compared with that of our sun. It is not a little surprising and disappointing then, while so much is positively known about our neighbors, even to the constituent elements that make up the masses of these flaming suns, that so little has been done satisfactorily to locate our sun in its relative position in space, establishing in a positive proposition its dynamic share in the great aggregations of suns that the unaided eye so plainly sees about us. For it is inconceivable that our sun is isolated in space. The cause of the unsatisfactory progress made in the past in this special research is in part probably a psychological one. The objective study of external phenomena always is simpler and more natural than the introspective study of hidden and relative conditions. External stimuli and their projection by the mind to the sources of the sensation, with whatever objective data may determine the facts of existence of these external entities, seem a fundamental mental process.

Yet on the other hand our mental deductions of the facts of natural phenomena are not always reliable. Actual position and inherent or relative motion in space often are hard to define or assign. Even in