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TRANSACTIONS

OF THE

Astronomical and Physical Society of Toronto,

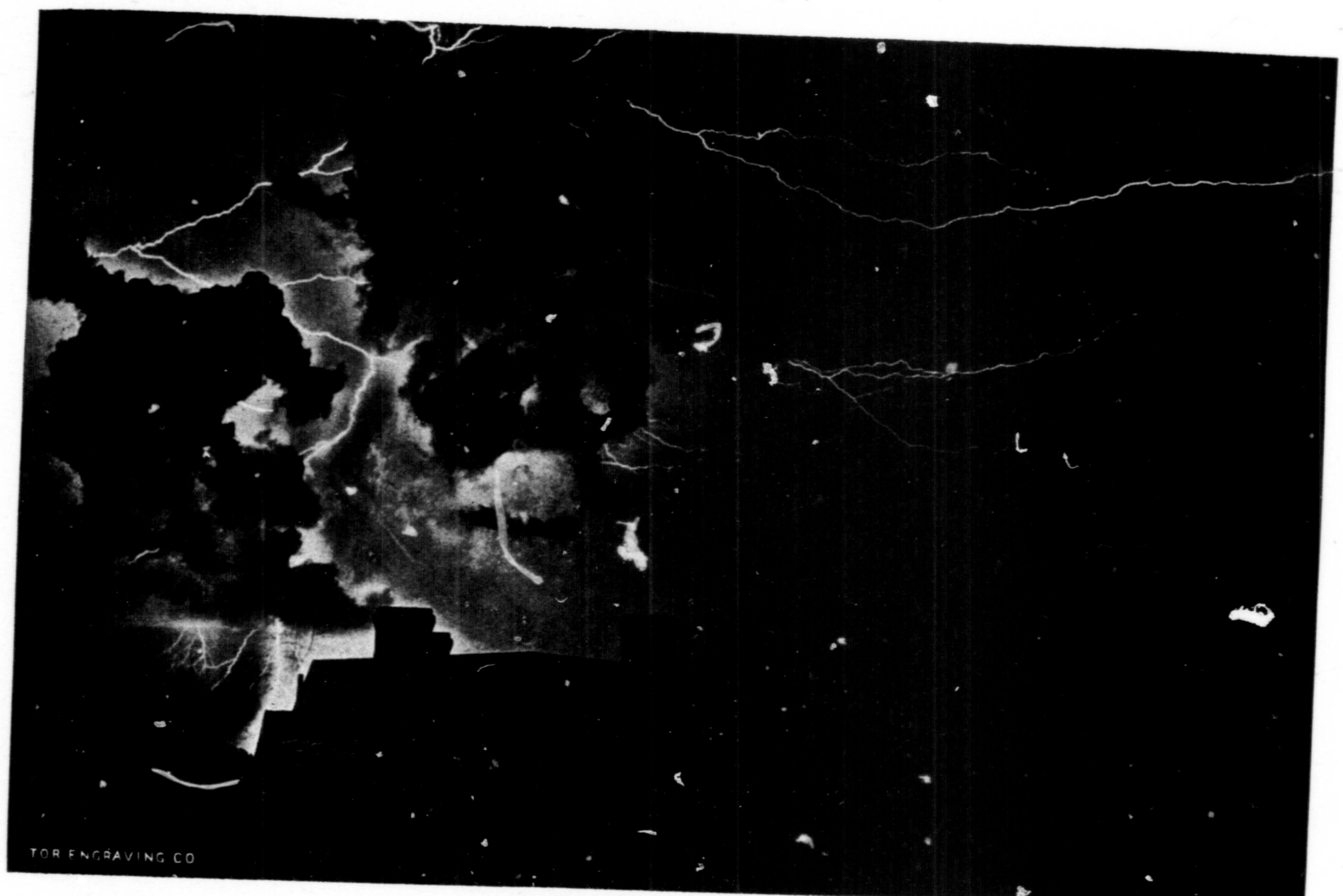
FOR THE YEAR 1896,

INCLUDING SEVENTH ANNUAL REPORT.

PRICE ONE DOLLAR

TORONTO:
ROWSELL & HUTCHISON,
Printers to the Society.

1897.



LIGHTNING FLASH.

Photographed by Mr. Harold B. Lefroy, Toronto, June 6th, 1896.

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[Authors are alone responsible for views expressed in papers or abstracts of papers published in the *Transactions.*]

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TRANSACTIONS

OF

The Astronomical and Physical Society

OF TORONTO,

DURING THE YEAR 1896.

FIRST MEETING.

January 21st; the President, Mr. John A. Paterson, M.A., occupied the chair.

This was a special meeting, convened in the electrical room of the Technical School, and to which the public had been invited. After the reading of the minutes of the annual meeting, the Vice-President, Mr. Arthur Harvey, was requested to take the chair. The President then delivered the annual address on the "Progress of Astronomy in 1895," the full text of which appears at the close of Vol. 6 of the Society's *Transactions*. The thanks of the large and appreciative audience were presented to Mr. Paterson by the Chairman, after which some items of business were transacted.

The Secretary read a letter received from Dr. Sandford Fleming, C.M.G., who had also forwarded some extracts from press reports respecting the recent meeting of the American Society of Civil Engineers. It appeared that this Society had adopted a resolution in favour of petitioning the President, the Senate, and the House of Representatives of the United States, praying them to accept and approve the resolutions of the Washington Conference of 1884, and to act in concert with other nations in this matter; and praying also that the *Nautical Almanac* of the United States be brought into harmony with those resolutions at the beginning of the 20th century.

A cordial letter was read from the Secretary of the Royal Society of Edinburgh, intimating that an exchange of publications would be made. A similar communication was received from the New York Academy of Sciences.

Much regret was expressed on the receipt of a communication from the Paris Observatory, announcing the death of M. Trouvelot, one of the most distinguished in the long roll of French astronomers and physicists.

SECOND MEETING.

February 4th ; the President, Mr. John A. Paterson, M.A., occupied the chair.

An interesting communication was received from Mr. Charles Clark of London, Ont., an associate member of the Society. Mr. Clark reviewed some of the papers published in the *Transactions*, and in which he was especially interested.

The Secretary read a cordial letter from Prof. E. C. Pickering of Harvard College, and covering the transmission of a set of the *Annals* of Harvard Observatory. The thanks of the Society were due to Prof. Pickering for this gift, which formed a most valuable addition to the library.

Miss L. Hill and Miss B. M. Shoults, of Toronto, were duly elected active members of the Society.

Mr. John A. Copland reported that on the morning of January 28th, between 4 and 5 o'clock, he had witnessed a beautiful lunar phenomenon. The Moon herself was the centre of a brilliant white cross, whilst on either side, at a distance of about sixteen degrees, were what might not inaccurately be called great prismatic parlunions, or Moon dogs. Beyond the radius of these, and at the opposite points of the lunar cross, there were rainbow-coloured crescents with their convex sides toward the Moon, whilst all about the sky was "hazed" with ever-shifting swarms of ice particles shimmering in the Moon rays. A diagram in illustration accompanied Mr. Copland's notes.

Mr. W. H. Wylie, of Niagara, had forwarded a drawing of a lunar halo, showing the Moon in the circumference, instead of at the centre as commonly seen. Mr. Stupart thought that this was most probably a part of what would have been a very beautiful display had the sky been clearer.

A part of the evening was spent in discussing the recent discoveries of Prof. Röentgen, of Wurzburg. Mr. Arthur Harvey had prepared some notes upon the subject, and gave a very lucid explanation of the process. Speaking of the simplicity of the method Mr. Harvey said : " This Society has had the privilege of studying, through the kindness of Mr. C. A. Chant and his assistants at the University, the phenomena connected with Crookes' tubes, the behaviour of sparks transmitted through air contained in glass vessels, becoming more and more rarefied by the air pump, and the glow exhibited when the molecules remaining in nearly a complete vacuum seem to have recovered their free paths and to be bombarding the interior of the glass. We have also seen Mr. Chant's reproduction of Hertz's experiments, and seen how even pitch is permeable by electric impulse waves, which it refracts, as a glass prism refracts waves of light having the same velocity but much shorter wave-length. Why did not some of us think of trying what effect these impulses had on a common photographic plate?" Mr. Elvins and others joined in the discussion, all agreeing that the effects of the new discovery would doubtless be far-reaching, not merely as to the application of the process, but also as to the scientific bearing of the new facts on the theories concerning the nature of the ether, of electricity, light, heat, and the constitution of the molecule.

THIRD MEETING.

February 18th; the President, Mr. John A. Paterson, M.A., in the chair.

A letter was read from Dr. A. M. W. Downing, F.R.S., etc., Superintendent of the *Nautical Almanac*, who had kindly forwarded copies of the *Almanac* for 1896-9.

Miss Alice Baxter, of Toronto, was duly elected an active member of the Society.

A note was received from Dr. J. J. Wadsworth, of Simcoe, calling attention to the occultation of Regulus on February 27th; for his own observatory Dr. Wadsworth had calculated, for immersion, 7h., 0m., 26sec., and for emersion, 7h., 40m., 16sec., E.S.T.

Some discussion arose regarding the recent discovery of the Röentgen rays. Mr. Arthur Harvey read some notes from the Journal of the French Academy of Sciences relating to the general subject. It had been reported that M. Gustave Le Bon had succeeded in photographing through an iron plate, with a common oil lamp, without a lens, the sensitized plate being shielded in a particular manner. Mr. J. R. Collins announced his intention of experimenting in this direction, as he had already been conducting a series of experiments in order to determine whether a photographic plate could be affected by the "rays" proceeding from a magnet. Mr. Collins stated that although some success had been claimed by others, he had not been able to convince himself that there is any emanation from the poles of a magnet which will disturb the sensitized plate. He had met with no success whatever, and was compelled to doubt the objective reality of recorded successes.

The Secretary then read the following notes on

PRECIPITATION,

contributed by Mr. J. Hollingworth, of Beatrice, Muskoka.

During a visit paid to Toronto in September of last year, I spent some time with Mr. Elvins, and one of the matters we spoke about was the influence on precipitation of the deforesting of timbered lands. This being a section of Ontario that is at the present time and has been for the last twenty-five years undergoing the process of deforesting, and having a record of the precipitation for the last twenty years, we deemed that it might be of interest to tabulate these observations, and present them for the consideration of meteorologists.

The figures given require but little explanation. In regard to the amount of cleared land existing at the different periods of time covered by these observations, I may say that from documents in my possession I cannot go any further back than 1883, and at that time the amount given was the sum total for the whole of the districts here mentioned, but in 1894 the amount is given for each district separately. As, however, in 1883 I was compelled to give the cleared area for the whole of the districts combined, I have done the same in 1894. It will be seen that in 1894 the area of cleared land was double the amount for 1883; and I think I am safe in saying that in 1883 the area of cleared land in this locality was more than double what it was in 1876. I made out this statement more than two months ago, but finding that I could not give the amount of cleared land as far back as covered by observation, I wrote to the Bureau of Industries. I have written them twice on the matter, but have not had any reply, so conclude that it is information they cannot give. It will be seen that in the earlier years of these observations a greater depth of snow is recorded than in later years. I do not think this is because less snow falls now than in the earlier years; our small clearings in the earlier years were like so many pockets into which the snow fell and lay undisturbed by winds, while now, having a more open area in which it can exercise its force, we have much more drifting than formerly. It will be seen from these figures that the deforesting in this locality has not resulted in decreased precipitation, the late Commissioner Phipps to the contrary notwithstanding.

There is not a doubt but that standing timber is a conservator of the precipitation, and by the moisture given off from the leaves of the trees serves as a moderator of the only two frequent droughts that less timbered lands are subject to; but that the sum total of precipitation is reduced in any given locality by the removal of the timber, I should very much doubt.

	Snow in inches.	Rain in inches.	Total Precipitation
1876*	66·25	26·70	33·32
1877	83·00	26·96	35·26
1878	123·00	34·16	46·46
1879	178·00	25·62	43·42
1880	240·00	34·88	58·95
1881	116·75	28·50	40·17
1882	173·50	29·56	46·91
1883	227·00	31·91	54·61
1884	210·00	26·31	47·31
1885	159·00	27·19	43·09
1886	121·50	32·52	44·67
1887	140.25	22·69	36·71
1888	77·75	26·14	33·91
1889	105·00	25·27	35·77
1890	95·75	28·38	37·95
1891	99·50	30·74	40·69
1892	91·25	31·92	41·04
1893	161·50	29·45	45·60
1894	88·00	26·63	35·43
	2,557·00	545·53	801·27

Average yearly snow for the 19 years	134.58 inches.
Average yearly rain for the 19 years	28·71 "
Average yearly total precipitation for the 19 years	42·17 "

* Ten months' observations.

Dividing the 19 years into three periods, the first of 7 years, and the last two of 6 years each, we have the following yearly averages of rain and snow :—

	Snow.	Rain.	Total Precipitation.
First period, 7 years	140·07	29·48	43·48
Second period, 6 years	155·91	27·79	43·38
Third period, 6 years................	106·83	28·73	39·41

Total cleared land in Muskoka, Parry Sound, Nipissing and Algoma :—

1883........ 96,998 acres. 1894 .... 186,366 acres.

FOURTH MEETING.

March 3rd ; held in the electrical room of the Technical School, the Vice-President, Mr. Arthur Harvey, F.R.S.C., in the chair.

Communications were read from Rev. D. J. Caswell, President of the Meaford Astronomical Society, and from Mr. G. F. Hull, B.A., of Chicago University.

Rev. Joseph Hamilton, of Mimico, was duly elected an active member of the Society.

The Assistant-Secretary announced that the *Transactions* for the year 1895 were now ready for distribution. Copies were laid on the table. The frontispiece to the volume was a reproduction of the drawing of Saturn made by Miss Eva M. Brook of Simcoe. The first report of the Meaford Astronomical Society was appended to the volume.

The Vice-President then addressed the meeting with reference to the special purpose for which the members and their friends had met in the electrical room. Through the kindness of the Principal of the school, several members of the Society, and the Johnson Electric Company, an opportunity was afforded for experimentation with Crookes' tubes, which Mr. C. A. Chant, B.A., had kindly brought from the University. It was the intention to take photographs by the newly discovered method, and to develop the pictures immediately. Mr. J. F. Parkyn, Mr. D. J. Howell, and Messrs. Collins would assist in this work.

Mr. Chant being then called upon gave a brief but comprehensive and lucid exposition of the Röentgen rays and their effects. He led up from the first experiments of Geissler in the making of tubes containing highly rarefied gases to the grand successes of Prof. Wm. Crookes, F.R.S., in making tubes within which the pressure was not more than the onemillionth of an atmosphere. Mr. Chant pointed out that when a current of electricity is passed through such a tube, although we say conventionally that it passes from the anode to the cathode, we are not at liberty to say positively that such is the course. In reality it is most probable that there are two currents passing and repassing. The decomposition of water by an electric current seems to prove this. At all events, when the vacuum is very high the electric current behaves in a very remarkable manner. From the little metallic plate forming the cathode, the negatively electrified molecules of gas left in the tube are shot out in straight lines against the bottom of the glass. These form the cathode rays, so called, and these phenomena had been observed ever since the Crookes' tubes were made. But, beating against the bottom of the tube, they excite waves which have the remarkable properties discovered by Prof. Röentgen. When there are in the path of these waves, or "X" rays, metallic or other bodies through which they will not pass, then these are "shadowed" upon an interposed sensitized plate, and when the latter is developed the shadow mark is seen, and this is a "new photograph."

After having explained all that was known of these rays, Mr. Chant proceeded to experimentation. Here it was thought there was an opportunity for acting upon a suggestion made by Mr. G. E. Lumsden, that possibly if bromide paper were used instead of dry plates, the rays would mark a number of them at once. This was accordingly tried; a number of sheets of bromide were placed on the table, covered up with thick paper, and upon the paper were placed a horse-shoe magnet and a piece of aluminium. The electric current was turned on from the Johnson storage battery and an exposure of some minutes made. The bromides were then taken away and treated by Mr. Parkyn and Mr. Howell. It was most gratifying to find that the impression upon the last sheet was as sharp as upon the first. Another fact was noted and commented upon. The piece of aluminium and the magnet were not in contact when they were laid down in position, but in the picture there was an elongation of the edge of the aluminium similar to what in optics is familiarly known as the "black drop."

At the conclusion of Mr. Chant's lecture and experiments a vote of thanks was tendered to him and to the members who had assisted him. In acknowledging the thanks of the meeting Mr. Chant said that we are yet on the threshold only of that department of physics opened up by

Röentgen's discoveries; a new force is here before us, a force calling for the closest study; waves of ether behave as they were never expected to behave; what may yet be done, what may yet be learned of the nature of the ether and of the constitution of matter no man can say. [Subsequently Mr. Parkyn made reprints of the bromides, which were distributed among the members.]

FIFTH MEETING.

March 17; the President, Mr. John A. Paterson, M.A., occupied the chair.

Referring to the press reports of the previous meeting, the Assistant-Secretary stated that the claim to having used the multiple process in X rays experiments for the first time, was made in the full belief that the method had not been tried elsewhere. It now transpired that a number of bromides had been exposed together, in the course of some experiments conducted before the French Academy of Sciences, and at about the same time as the experiment had been conducted in the Technical School. No report, however, of the French physicists' work had been received in Toronto at that date.

During some discussion on the possibility of producing pictures or "shadowgraphs" by the action of a magnet upon the photographic plate, Mr. W. B. Musson described in detail the method adopted by several who had claimed to have succeeded. The magnets used had been of much greater strength than those with which Mr. Collins had experimented. Quite possibly magnetic strength might be an important factor.

From Dr. J. J. Wadsworth of Simcoe, was received a photograph of the Moon taken in his 12-inch reflector. The picture bore enlarging remarkably well. The following notes of the doctor's observations of Jupiter were also received:—

February 22nd; 8 p.m., power 210. Two round spots on the disc, one on the eastern edge, and just on the northern boundary of the great southern belt; the other had nearly reached the central meridian and stood out on the brilliant snow white band that lies to the north of the northern equatorial belt; after consulting the almanac, concluded that these spots were satellite I and its shadow. At 9h. 40m. again saw the two spots; at 9h. 57m. the northern spot began to slide off as a golden bead, and in about 4 minutes it was separated from the planet, and was evidently satellite I. Soon after the other spot moved off also.

Knowing that satellites had occasionally been seen during the whole course of their transit, I concluded I had been fortunate enough to see this phenomenon.

On reflection, the fact that the shadow had evidently travelled much faster than the satellite was puzzling.

February 24th; 9 p.m. Again observed on Jupiter; a black spot just as seen two nights ago, at the very same place, on the snowy band, the whitest tract on the planet. With a power of 460 the spot appeared about twice as long as broad, and not quite parallel to the equatorial belt. There were no satellites near enough to cast shadows on the planet. Satellite I. had completed its transit several hours before, and was moving westward. The oval spot might be a cyclone or something like it, on the body of Jupiter.

By special request the paper on Precipitation, presented at a previous meeting by Mr. Hollingworth, was again brought before the Society, and discussed at some length. Mr. Arthur Harvey agreed with the writer that the deforesting of the country had not affected the rain fall, and gave his own experience in observations of this kind for practical purposes. He stated, moreover, that reference to the records of the Jesuits of 200 years ago, will prove that in all this time there has been no change in the climate of Canada. Mild winters came then occasionally as now; wild flowers bloom now at the same time of the year as they were recorded to have blossomed by the first explorers. Speaking of the great lakes, Mr. Harvey called attention to the fact that the area which is tributary to these is very small. Much interest was also taken in a discussion of the results reached by Mr. R. F. Stupart, Director of the Toronto Observatory, who had for the first time collected data from all points on the lakes, and had shown that the precipitation is remarkably constant.

Mr. Elvins then read the following notes on

PLANETARY MASS AND ATMOSPHERE.

I have long thought that a relation exists between the masses of the heavenly bodies and their temperatures, the heat rising as the mass increases. Mercury is too near the Sun to be observed with much chance of success. Venus is somewhat better situated, but its brilliancy is so great that it is a difficult object to observe; its atmosphere, however, often shows dark patches, which I think may be openings through the general mass of clouds which seem to envelope the planet, reflecting light from their outer surface. Like the Earth I think it has polar caps of snow; I have seen a bright spot on the north pole on several occasions during the past fortnight, and similar observations have been previously noted by other observers and myself. The mass of Venus approaches nearer to that of our globe than the mass of any other planet, and it will probably not be very different in its temperature.

In the case of the Moon the temperature is probably very low. Peal and others regard it as glaciated. Langley says that at the full, the temperature is not above 0° centigrade. I need not remind you that the mass of the Moon is very small.

The mass of Mars is only about one-ninth that of the Earth, and it may be on the whole a colder world. The vast polar caps have a great resemblance to snow; they enlarge during the winter and decrease in summer. The canals, about which so much has been written, are just as likely to be rents or fissures in ice-fields, or vast ice crystals on the surface of liquid, as to be vegetation near artificial streams.

Jupiter is the giant world and if the temperature increased with mass its heat must be very great. Careful scrutiny sustains this view; no polar snow caps can be seen; the belts and spots show so many changes that the best observers regard the planet as a very hot body. Proctor even contended that it radiated heat to the satellites, and was in that respect an additional Sun to them.

This speculation is of great interest to me, and I would be pleased sometime to continue the subject, but I think enough has been said to show that it is not void of interest, and that going outwards from the Sun temperature seems to increase with mass. I need scarcely remind you that the mass of the Sun itself is vastly greater than that of all the bodies of the system combined, and that his heat is enormous.

I would also call your attention to the planetary atmospheres which to me appear to follow a similar rule, increasing in density with mass.

The Moon's mass is less than that of any body near enough for investigation and it has practically no atmosphere. Mars comes next in the order. I think there can be no reasonable doubt but that it has an atmosphere, but the observations of Campbell at Lick, and Percival Lowell at Flagstaff, seem to show that its atmosphere is rare, and water scarce; we may safely assume that its atmosphere is not at all very dense or extensive. Venus is next in order of mass. It is not far from the same as the Earth's and it seems to have considerable atmosphere. Spots are sometimes barely visible, which at other times are plainly seen; this may result from the forming and clearing of clouds. The markings, however, are very faint, and whether the changes are due to its atmosphere or changes in our own is not certain as yet.

The Earth's mass is the next in order, and our atmosphere is probably denser than that of any of the smaller planets. The two most distant planets Uranus and Neptune are the next in order of mass. Their mass is much greater than the Earth's, and the spectroscope shows great absorption which indicates a large atmosphere and probably a dense one. In the spectrum of Saturn there is a very marked increase in the strength of the absorption lines or bands which leads us to regard it as having an extensive atmosphere. Next to Jupiter it has the greatest mass of any planet in the solar system. But the giant planet Jupiter with its enormous mass has the most extensive and dense atmosphere of any planet. Its cloud belts and spots are seen to have a different rate of motion, and the spectroscope shows very strong absorption bands.

But the great mass of matter of the solar system resides in the Sun. Its heat is so great as to volatilize the most refractory substances, its density is very small, and if it is not all atmosphere or gaseous it is largely so. An extensive atmosphere exists outside of the photosphere, which produces the Fraunhoffer lines.

SIXTH MEETING.

March 31st; Mr. Arthur Harvey, F.R.S.C., Vice-President, occupied the chair.

Communications were read from Dr. Sandford Fleming, C.M.G., Mr. J. E. Lewis of Darby, Mass., and Prof. G. E. Hale, of Chicago. Prof. Hale had been kind enough to place the society on the exchange list of the Yerkes Observatory and had forwarded the first *Bulletin* issued from that new centre of observation, now in order for active work. A note was read from Mr. A. F. Miller who had received a dispatch announcing the death of Mr. John Goldie, of Galt. The society learned of the event with very deep regret. Mr. Goldie had been an active member since incorporation in 1890, and had been one of the first to aid the Society substantially when the Library was being formed. His donations towards this object were followed by other gifts which very materially assisted the Society in its financial affairs. The contributions of the deceased to the work of the Society had been mainly in the form of letters to one or other of the members. As an instance of his keen observing powers, the fact was recalled that he had reported the Rordame Comet in 1893 on the evening following the discovery, news of this not having reached Mr. Goldie's location at that time. As an example of the successful merchant, still finding time to enjoy the pleasures of scientific study, always willing to aid in the furtherance of any plan for the popularizing of science, the name of the deceased would be long remembered in Canada. The Chairman appointed a committee to draw up a resolution embodying the Society's deep regret at his loss, and sympathy with the family of the deceased.

The text of a memorial addressed to the Hon. the Minister of Education for Ontario, *in re* the financial status of the Society, was read by the Corresponding Secretary and adopted.

Mr. G. G. Pursey presented a series of drawings of the solar disc for the first three months of the year, and read the following notes on

SOLAR OBSERVATIONS.

The opening of the year was very unfavourable for sun-spot observations. The first was made on January 12th, at noon. There were two small groups on the disc, one consisting of four small members, the other of two much smaller, about three days' journey off the eastern limb; the larger group was about one-third across the disc; faculæ very bright on the eastern limb and S. W.

January 14th, 1.30 p.m. The larger group had entirely disappeared; the smaller one had reached the meridian, and the two spots were, as might be expected, wider apart; two areas of faculæ.

January 15th, 9.15 a.m. The two spots previously observed had either merged into one, or one of them had vanished and the other increased in size. Three distinct areas of faculæ indicated the advent of spots.

January 16th, 11.15 a.m. Very dull; could see no trace of the spot seen yesterday, but one was seen on the eastern limb where the faculæ had been observed.

January 27th, 9 a.m. The next observation was made on this day, by which time the spot seen on the 16th as just entering had reached almost to the western limb, and a new group had in the meantime entered.

February. This month was much more favourable for observations, and the Sun afforded much more material to work upon. Altogether eighteen observations were made, and from the 20th to the end there were quite a number of groups, sometimes as many as five or six at once of very considerable interest; several of these consisted of from eight to ten members.

March 2nd. By this time the crop of February had to a great extent passed out. After March 4th there were only a few isolated spots to be seen. For some days I have been looking for an advent in a region where a very distinct area of faculæ has been visible, and to-day (March 31st) I was rewarded by the appearance of two large spots in that exact locality.

I must say that my observations quite fail to corroborate the views held by some of our observers as to the reappearance of spots. The most prominent group now passing across must have entered about the 26th. On the 12th there was one spot nearly out; on the 15th two very small ones went over; on the 17th and 18th there were none visible near the limb, so that the group passing across and that just entering must be new creations. Here I wish more emphatically to advance an hypothesis which I have before hinted at, namely, that all the phenomena connected with solar observation must be referred to one genus; that is to say, the so called willow-leaves, faculæ, prominences, sunspots, are the self-same phenomena, more or less intensified. The surface of the Sun is in its entirety in a state of agitation, rolling up waves of molten matter, into ridges or hills, exceeding our terrestrial hill and dale as much as the body of the Sun exceeds the Earth's; thus the willow leaves. Storms arise from various points from unseen causes, which swell these rolling hills into mountain ranges, it may be lapped with fire foam; these are the faculæ. These objects when seen on the limb of the Sun very naturally would appear as prominences, when by extraordinary disturbance material is projected high up into the atmosphere until it meets with a cooler layer and becomes partially condensed, it appears to us as dark patches on the Sun. These are the spots, which when on the limb will appear to be detached prominences as sometimes seen.

[Mr. Pursey's observations were made by projecting the solar image on a white screen in a darkened room, using a lens of one-inch aperture and 72-inch focus.]

The Assistant-Secretary stated that a paper, written for the Society by Mr. S. E. Peal, F.R.G.S., of Sibsagar, India, had reached him after a very long delay. It was received too late to be embodied in the *Transactions* for the past year, but as the subject was always before the members, it would still be of very considerable interest.

Mr. Peal's paper dealt with

PROBLEMS IN SELENOLOGY—WHAT DOES "TIDAL RETARDATION" ON THE MOON IMPLY?

There can be little doubt that one result of the advances recently made in several directions will be, that the study of selenology is destined ere long to take a new departure. A distinct impetus has been imported to lunar work, through the publication of the beautiful photographic enlargements made by M.M. Weinek and Prinz, of Lick negatives; and others from M.M. the Bros. Henry. As time goes on, these will probably be far surpassed, and enable the student of limited means and moderate aperture to revel in the detail so eagerly sought for, and so difficult to obtain a glimpse of.

But there is also evidence accumulating, that the "new departure" may include some modification of our views *in re* the ultimate character of the lunar surfacing. The old theories are in many respects becoming untenable, and in certain cases the new work is so far incompatible with the old as to reverse our conclusions on several fundamental questions.

It is less than twenty-five years, for instance, since our Astronomer Royal thought that the maximum temperature of the lunar surface under solar heat, might rise as high as "the melting point of iron,"* and the idea was general among astronomers that it was at least as high as + 300° C.

All this is now changed, thanks to the researches of Profs. S. P. Langley, of F. W. Very, and C. V. Boys, who independently demonstrated that it does rise now much above 0°C (the minimum probably falling to — 273° C, and mean not far off, — 100° C).

This great discovery, of course, is momentous, relieving us of the

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* *Manual of Astronomy*, S. P. C. Knowledge, p. 55, 1875.

perpetual *water* problem, while opening the door (pretty widely) for any new advance in "selenology." Again, the newly accepted views *in re* tidal retardation, as the means by which the speed of lunar rotation in past ages has been slowed down, renders untenable the old idea of a solid tide, or "meniscus," giving an ellipsoidal figure, postulated by La Place, Lagrange, and others, to account for the real libration.

Yet we see by Sir R. S. Ball's *Time and Tide*, p. 131, that the old view of a molten lava and volcanic surfacing on our satellite so far holds its ground that the possibility, or probability, of these tides being water-tides, is not yet fully admitted, though so much depends thereon.

There are many other questions on which changes are imminent, but the above two, relating to the surface temperature and nature of the tidal retardation, are the most important in their bearing on future lunar progress.

It is noteworthy that these two questions are in a way intimately associated together, and also with recent discoveries in other directions, such as geology and planetary development. Geology, astronomy and physics are now-a-days far more intimately associated than formerly. Thus in regard to our Moon, the possibility, or otherwise, of such a globe passing from the semi-incandescent to the ice-clad stage, or temperature of — 100° C, without a *prolonged* era of erosion and sedimentary rock formation intervening, is a question on which the geologist will have most to say.

It is hardly allowable, now-a-days, to cut out some 20,000,000 years in the development of a globe, because it does not happen to suit our traditions. No doubt, our Moon being smaller than our Earth, the stages in its life history are shorter; but our knowledge of the Earth's crust, of our vast series of stratified or sedimentary rocks, demonstrates clearly enough that, as secular temperature declines, a vast era necessarily intervenes between the two extremes of a planet's life. It is essentially an era of erosion and sedimentation, of *repeatedly* cutting away and relaying, until on the surface, there is not a vestige of the former era left. It accompanies and is due to the slow fall in secular temperature. In the case of our Moon this stage must have existed and for millions of years.

The question is, "Were these lunar tides of molten lava or water?" If the planet at that time was cool enough for them to have been water, then must the present surfacing have been laid during a later and still colder era. Until this question has been settled for us by the geologist, progress in solving this perennial enigma, as to the character of the lunar surface, must necessarily be at a standstill. It is a question which the geologist must settle.

The idea is very general amongst selenographers that better seeing of detail will solve the problem, but when we remember that as matters stand a power of 3,000 is our limit, and that even if it were increased to 10,000, we should still view the detail at 24 miles of naked eye observation, it is a distance at which even the most expert lithologist would hesitate to classify an unknown rock on another globe. Detail is valuable, but it could not be decided at that distance whether a particular rock was volcanic, sedimentary, metamorphic, organic, or neither.

The search for change, as a clue to the nature of the lunar surface, is praiseworthy and persistent, yet in respect of one feature there has been a singular omission, *i.e.*, in regard to the effect of gravitation all over the surface, especially as shown on the steeper inclines or inner slopes of craters and walled plains, where, as long ago pointed out by Proctor, Neison and others, degradation must be most rapid.

It is precisely here that we find the most remarkable unanimity in the evidence. We seem to have a story written in a clear round hand and plainest language, to the effect that in all cases, from pole to pole, the surface rock is unmistakably white, often snow white.

Now, if the tides before referred to, have been "water tides," it is not difficult to see what this universal surface rock must be, which was laid in a later and colder era, and beneath which all traces of the preceding sedimentary era must be deeply buried.

There are several directions in which we find apparently reliable evidence tending to show that the lunar tides were of water. For instance, recent discoveries in geology demonstrate clearly that our terrestrial ocean floors, are areas of *slow persistent subsidence.* Presumably these areas are the densest, as they are known to be the coldest, portions of the Earth's crust, and the subsidence is the result of shrinkage in the nucleus; necessarily it is a very slow and continuous phenomenon.

It is also an axiom that the continental areas (which include the shallow seas) have always been continents, the great lines of fracture or weakness in the crust are along their borders, and it is noteworthy that this *law* holds good on the Moon conspicuously.

In *Knowledge*, September 1st, 1892, p. 171, this matter was laid before Mr. C. A. Ranyard, and this pre-eminently cautious savant thought that "the evidence brought forward, with regard to the general subsidence of the great lunar maria seems to me conclusive."

The Mare Serenitatis is almost surrounded by "clefts" or fractures of the lunar crust, due to the subsidence bodily of this mare, or enclosed area, and all over the lunar surface the "clefts" are related to adjoining mareal subsidence; so that in this feature we have an indirect proof that the lunar maria were really seas of water.

But that these maria, as we see them now, are sea surfaces and not sea bottoms laid bare, is abundantly proved by, firstly, their being in the main invariably liquid contours, and secondly, by the total absence on them of the vast sunk and irregular plains seen on all our terrestrial ocean floors, and so characteristic of them, that profound inequality is the rule, without exception.

Thus the question at issue is clearly defined and momentous; either tidal retardation, on our Moon, was effected by seas of molten lava or seas of water. If the former, then there has been—as some suppose—practically an absence of a long temperate era, in which sedimentary rock formation and river sculpture took place, the surface being covered from pole to pole with volcanic debris, cinders and ashes, quite untouched by the hand of time. All through the millions of years during which the temperature of the globe was *slowly* falling, the huge vaporous envelope condensed and passed inside without disturbing the scoriæ and ashes.

If, on the other hand, these tides were tides of water (as in our case), then must the present lunar surfacing have been laid *afterwards,* during the later and still colder period, and the globe be swathed in snow from pole to pole.

The solution of this tidal question has momentous issues for the student of selenology. It means nothing less than revolutionizing our views in regard to the surfacing of our sister globe.

It is abundantly obvious that the present surfacing is not of a "sedimentary" character, the sunk circular floors and raised rings are piled over each other without the slightest regard to drainage. There is an entire absence of the river valley sculpturing, as a characteristic, such as is seen on our earth.

From the thousands of minute craterlets, through the "craters" and "walled plains," up to Mare Crisium, the series of sub-circular formations are really the conspicuous feature. It is the leading characteristic and quite unearthly in its nature.

The question placed before us by the "tidal problem," therefore, is this; are these lunar maria and sunk floors all over the surface, lava floors, and the raised rings lava-cinder rings, or have the floors, both large and small, been water floors, surrounded by snow ranges and rings, laid during the "later and colder era" above mentioned?

The newly accepted views in regard to tidal retardation appear to leave us no alternative but to choose between these two strongly contrasted theories, neither a middle course, nor yet a union between them, is possible, for obvious reasons.

Many photographers seem inclined to "tabu" theories, to look on them as useless, as signs of the amateur, hence it may not be out of place to quote some remarks by Prof. G. H. Darwin, in his sectional address, at the meeting of the British Association in Birmingham, 1886. He says:—

"In each branch of science hypothesis forms the nucleus for observation, as long as facts are assimilated and co-ordinated, we ought to follow our theory. The success of a theory may be measured by the extent to which it is capable of assimilating facts, and by the smallness of the change which it undergoes in the process. A mere catalogue of facts, however well arranged, has never led to any important scientific generalization. For, in any subject, the facts are so numerous and many sided, that they only lead us to a conclusion when they are marshalled by the light of some leading idea. A theory is then a necessity for the advance of science."

SEVENTH MEETING.

April 14th; the President, Mr. John A. Paterson, M.A., occupied the chair.

Mr. J. Brodie of Toronto, was duly elected an active member of the Society.

It was moved by Mr. Arthur Harvey, seconded by Mr. Thos. Lindsay, that Dr. A. M. W. Downing, F.R.S., Superintendent *Nautical Almanac* Office, London, Eng., be declared elected an honourary member of the Society.

This was carried unanimously.

It was moved by Mr. Geo. E. Lumsden, seconded by Mr. J. R. Collins, that Dr. J. A. Brashear, of Allegheny, Pa., be declared elected a corresponding member of the Society. Carried unanimously.

Communications were read from Mr. Percival Lowell, of Flagstaff, Arizona, and from Dr. Brashear, of Allegheny.

The report of the emergent meeting of the Joint-Committee on the Unification of Time, held April 10th, 1896, was presented by Mr. G. E. Lumsden, and unanimously adopted.

Mr. A. F. Miller stated that he was in receipt of a communication from J. Norman Lockyer, F.R.S., who took exception to an expression occurring in Mr. Miller's paper on The Spectra of the Nebulæ, which appeared in the Society's *Transactions* for 1895. The words to which Mr. Lockyer objected were as follows: "To which he has not always accorded whatever credit may be their due in this connection." Mr. Miller explained that when using these words he had in mind a conversation with Mr. Elvins who had stated to him that many years ago he had transmitted to Mr. Lockyer a series of his published letters containing, among other things, a hypothesis regarding meteorites; which, however, Mr. Lockyer had never acknowledged. It now appeared on fuller inquiry that Mr. Elvins' letters had no real bearing on "the meteoric hypothesis"; and Mr. Miller therefore felt in duty bound to retract the words complained of by Mr. Lockyer, and had written to that gentleman accordingly. Mr. Miller desired further that his withdrawal of the words might be allowed to appear in the *Transactions* of the Society.

Mr. A. Elvins asked permission to address the Society in further explanation and said :—

I think Mr. Miller has acted rightly in withdrawing the statement to which Mr. Lockyer objects, but I think a word of explanation from me will show how he was led into the error. I have frequently stated that I think Mr. Lockyer had served me unfairly in paying no attention to letters which I forwarded to him in 1871. The facts are briefly these :

In 1870, after examining the records of the Toronto and other observatories, I came to the conclusion that our rainfall and storms had some connection with sun-spots. These investigations were published in the *Toronto Telegraph* and the *Leader*, and I sent them to *Nature*, with a letter to Mr. Lockyer, asking him to notice them. No reference was made to them in *Nature*, and I concluded that Mr. Lockyer did not regard such subjects as worthy of notice. About a year after, however, Mr. Locker himself, in connection with Mr. Meldrum, took up the subject, and published papers in *Nature* entitled the "Meteorology of the Future," and arrived at conclusions very like those which I had sent to him a year before.

Rightly or wrongly, I concluded that he had suppressed my letters that his own work might be the more prominent by being first in the field. I have often mentioned this, and must have done so in the case referred to by Mr. Miller; there has been a mistake, however, in referring it to Mr. Lockyer's "Meteoric Hypothesis."

The omission of my letter may have been unintentional, and I may have wronged Mr. Lockyer in thought, and words; if so, I regret it, but I have no doubt that it was this circumstance which led Mr. Miller to use the language complained of.

The Committee appointed to prepare a

MEMORIAL TO THE LATE MR. JOHN GOLDIE

reported as follows:—

To the President and Members of The Astronomical and Physical Society of Toronto:—

Your Committee would recommend that the following resolution be inscribed on the minutes of this Society, and a copy forwarded to the relatives of the deceased:—

Resolved, That The Astronomical and Physical Society of Toronto, having learned with deep regret of the decease of John Goldie, Esq., a life member of the Society, desire to express to his family their sincere sympathy with them in this bereavement.

They recollect Mr. Goldie as one of the pioneer workers in amateur astronomy in this province, and as one whose heart was in his work. He spared neither pains nor expense in providing the appliances for research, and used them sedulously in the advancement of his favourite study, and for the good of his fellow-citizens. He was deeply learned in practical astronomy, a careful and accurate observer, qualities which his modesty and beautiful humility kept from attracting that wide spread attention they deserved, but which could not remain unknown to those with whom he came in contact on the common ground of scientific friendship; and it is a duty, as well as a pleasure, for the Society to bear testimony to these facts.

The Society further desire to record the substantial pecuniary aid their Library and instrumental equipment owe to Mr. Goldie's generosity. Nor can they close this tribute to his memory without acknowledging how greatly his friendly nature encouraged, and his noble example stimulated, each and all of his fellow-members in their endeavours to follow where he had led. The simplicity of his character and his kindly disposition endeared him to all; and each feels conscious that the departure of John Goldie has occasioned a vacancy which cannot be filled.

(Signed) A. F. MILLER,
Chairman.

On motion the resolution was adopted and the Secretary instructed to forward a copy to the relatives of the deceased.

The Librarian, in reporting exchanges and presents received, presented a number of copies of the Library catalogue. The thanks of the Society were due to the Librarian, and to Mr. J. R. Collins, who had assisted in the preparation of the copies.

A short paper was read by Mr. Harvey, on solar observations, with the special view of making clear to amateurs a method of readily finding the latitude of spots upon the Sun's disc, at any hour of the day or day of the year. Mr. G. G. Pursey reported that the Sun was clear of spots for the first time since March 15th.

The Assistant-Secretary announced that he had received from Mr. G. F. Hull, of Chicago, an interesting letter containing an account of some experiments conducted at the University of Chicago by Prof. Michelson, pointing to an explanation of the phenomena exhibited by

THE X RAYS.

The following notes were then read :—

About the end of January, 1896, Prof. Michelson read before the Physics' Club, an abstract of Prof. Röentgen's paper announcing the discovery of the X rays. Upon that occasion Prof. M. took exception to the hypothesis of Prof. R., viz., that the rays were due to longitudinal waves, and advanced the suggestion that they were vortex rings of ether shot out from the electric terminal.

On March 20th, Prof. M. again read a paper before the Physics' Club, in which he ennunciated more clearly his hypothesis, and showed how all the known phenomena of the X rays could be explained by means of his hypothesis.

Whatever hypothesis is advanced, it must be capable of explaining the following known properties of the X rays.

1. Rectilinear propagation.

2. Passage through dense opaque bodies.

3 and 4. Absence of reflection, refraction, polarization.

5. Absorption increases with density.

6. Their production by electric impulses.

7. The necessity for high exhaustion.

8. They are produced at the cathode only.

9. (That their velocity of propagation is small compared with that of light, but large compared with molecular velocities—not yet known, but inferred from theory.)

10. The production of fluorescence, phosphorescence, photographic effects, dissipation of an electric charge, heating effects.

Among the numerous theories advanced to account for the X rays, only two so far advanced are worth considering.

These are :—

1. The X rays are longitudinal vibrations in the ether proposed by Röentgen himself.

2. They are projected material particles.

In the *Wied-Ann.*, January, 1896 there appears a paper by Taumann on Longitudinal Waves, in which he attempts to account for the phenomena of cathode rays. Prof. M. thinks the paper a good one, but it does not satisfy. In fact all attempts to explain these phenomena by dealing with longitudinal waves, have proved unsatisfactory.

But more unsatisfactory have been attempts to account for the cathode or X rays by means of the second theory, viz., that projected particules of the residual gas constitute the X rays. It is impossible for us to conceive how particles of a gas can be forced through glass, metals, etc.

On the other hand, we can readily understand how vortex rings of ether can be forced through coarse grained matter. To illustrate this, Prof. M. showed the well-known experiment with smoke rings. By striking a rubber sheet stretched across the back of a box, rings of salammoniac fumes were forced through a circular opening in the front, and the vortices so found (1) moved in a straight line.

2. Passed through metal screens.

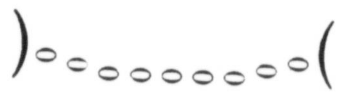
3. Were not reflected, refracted.

4. Polarization is impossible, for the rings have no unique connection with any plane passing through their axes.

5. That absorption increased with density, was seen by placing several screens in the path of the rings.

6. Slow pressures did not form the rings, they must be formed by sudden impulses.

7. To explain the necessity for high exhaustion it is necessary to understand the electric discharge. The following is probably the case. Air particles form themselves into chains, acting as a Gröthuss chain in electrolysis.



As the air becomes rarer the number of these chains becomes fewer, so that it is more difficult for the spark to pass. If the exhaustion is continued the discharge takes the long path outside of the glass. Where there is a great deal of air present in the tube there are a great number of paths of discharge, and this corresponds to the case where the top is taken off the box, or a great number of holes opened—then no rings are formed ; similarly, when much air is present, no X rays are formed by the discharge. As the air is exhausted the electric impulses become more abrupt, and when the number of air chains become too few to carry off the discharge, vortex rings of ether are forced out between the molecules of the cathode, and proceeding in straight lines pass through the coarse grained glass, cloth, wood, etc., as already illustrated.

Objection may be made to this explanation of the formation of ether rings by noting that, as is generally conceded, ether is frictionless, and for the production and destruction of vortices, friction is necessary. In answering this objection we may say that, though we have reason for believing the ether to be frictionless for slow motions, we have no reason for believing it frictionless for rapid motion. A parallel case may be cited. Resin, a fluid for very slow motions, is a solid for rapid motion. Give it time and it will take the form of the vessel containing it, yet made into a tuning fork it will vibrate like steel.

9. The velocity of propagation of the rings may be seen to depend on the energy of the impulse. Consequently if this theory is applicable to the X rays, we may expect to find that there is no definite velocity but one depending on the electric energy of the discharge.

10. The ether rings themselves may vibrate about their configuration of equilibrium. These vibrations may be sufficiently rapid to produce light effects. Hence all the effects of light will follow, viz., fluorescence, phosphorescence, etc.

EIGHTH MEETING.

April 28th; the President, Mr. John A. Paterson, M.A., occupied the chair.

Mr. Alex. Laing, of Essex, and Mr. R. S. Muir, of Belleville, were elected associate members of the Society; Mrs. Geo. Craig, of Toronto, was elected an active member.

A letter was read from Mr. A. R. Goldie, of Galt, Ont., thanking the Society for the expression of sympathy as embodied in the resolution passed, on the occasion of the death of his father.

Other communications were received from Mr. H. B. Witton, of Hamilton, Ont., Dr. Sandford Fleming, C.M.G., and Miss Mary Proctor. It appeared from Dr. Fleming's communication, that there were strong grounds for hoping that the Home authorities would consent to the change in time reckoning as proposed.

Dr. J. C. Donaldson, of Fergus, forwarded some notes of observations of the Moon. In his 3½-inch Cooke refractor, with a power of 326 the three central mountains in Copernicus were plainly visible and also the object known as the straight wall.

The Librarian announced that he had received from Mr. J. F. Parkyn a number of copies of the radiographs, made at the meeting of March 3rd. The prints were particularly sharp and were much appreciated by the members, among whom they were distributed. A copy of Mr. T. Gwyn Elger's map of the Moon had been presented to the Society by Mr. Elvins. This would form one very valuable accessory to the Wilson telescope which was to be used during the summer months for lunar work, it having been decided to resume the meetings of the Lunar section of the Society.

Some discussion arose regarding the significance of lunar halos; Mr. G. G. Pursey stated that however little meteorologists might credit the Moon as a weather making factor, it was certainly true that in England these peculiar phenomena were precursors of rain. In Canada, however, the rule did not seem to hold.

Mr. G. E. Lumsden by special request addressed the meeting on the subject of "A Popular Observatory," and briefly outlined his views as set forth at length in a paper, which had been recently read by him, before the Canadian Institute. It was thought that an observatory could be erected and equipped for a few thousand dollars, which would do credit to Toronto as a city in the line of advancement in all respects. It was forcibly pointed out that a giant telescope was not required. Instruments of moderate aperture would be much more effective for the purpose in view. Mr. Lumsden then stated that he had received a letter from his lordship the Bishop of Moosonee, fulfilling a promise made to send notes on auroral displays as seen in the far north. The text of his lordship's letter, which proved most interesting to the members, was as follows :—

MOOSE FORT, James Bay, Baie des Peres, P. Q.

February 21st, 1896.

G. E. LUMSDEN, ESQ.,

Corresponding Secretary Astronomical and Physical Society of Toronto.

MY DEAR MR. LUMSDEN,—I have not forgotten your kindness to me, nor your having proposed me as a corresponding member of your Astronomical Society, nor my promise to try and write you some notes of any noticeable auroral display on my travels. My silence arises from other causes. I did not reach home till the end of September, and our first mail after that was in January, when I had so much necessary writing that I could not find time to write to you. Moreover, I seemed to have so little to tell you. Auroral displays are so common with us that there seems little to note, except that some are finer than others. We have had more or less auroræ most nights in January and February, and I have not noticed that they portend any change in temperature or weather. I only noted two fine displays on my long journey, from June to September, and in one of these there were features which made it noteworthy. This was on 27th July. We had been sailing along the coast of Hudson's Bay, coming from Churchill to York Fort, and were anxious to reach York, if possible, that night, Saturday. The day was fine but cold, with a breeze from the north. About 5.30 p.m. we were opposite the mouth of the Nelson river, twenty miles wide, when it became quite calm. It was a lovely evening, but cold for July, and presently a light air came from the north as we turned to row up Hayes' river. As it grew dark the aurora began to show up, and by 10 o'clock was very bright and wide-spread, covering the northern half of the sky, well up to the zenith.

I have rarely seen so much motion, the light running about in every direction, waving, and trembling, and quivering, the intenser lights flashing almost like lightning. The brightest spots never remained two seconds in the same place, but travelled about like staff officers galloping about a great battle-field; while the waves and scrolls of lesser intensity in their motions resembled the movements of the various regiments, sometimes in line, sometimes in echelon, and the advance of skirmishers, and charges of cavalry. Even my Indians, accustomed to such phenomena, were watching and talking about it. The sky had become dotted with clouds, which seemed much lower than the light, which seemed to travel behind them, lighting up their edges, but leaving the centres dark. Meanwhile a heavy thunderstorm was evidently in progress far to the south. The lightning was frequent but we heard no thunder. One might liken this to the artillery of the enemy defending some very distant position. The thunder storm never reached us, though we experienced a little rain about midnight. We reached York at that hour, too late to land ; so, as it was an open boat, and the rain promised to increase, I pulled a tarpaulin over me and soon slept the sleep of the weary—I had been pulling at the heavy sweep for some hours—and was oblivious of auroral charms.

Again, on the night of the 19th August and morning of 20th, there was a fine display. This time we were in a canoe on the coast of James Bay, between Albany and Moose Fort. Along this coast you have to accommodate yourself to the tides, for the coast is flat, and the tide goes out many miles. So it came to pass that we had to break camp and start at midnight. The water was hardly deep enough to float the canoe, the bottom was studded with boulders, and we had to keep well out from the land. Happily it was quite calm, and there was a bright aurora, which enabled us to see our surroundings. There was not much waving or motion, but the light was bright and widespread. It lasted till about 4 o'clock, when the morning star was just rising, and it became very dark till the dawn. This was followed, just before sunrise, by one of the most wonderfully glorious skies I have seen, a blaze of red and gold at first in the east, and then a fiery red over all the sky. The prophecy of foul weather was soon fulfilled. The sky became very dirty and threatening, and a strong north-east wind sprang up. We could not make much progress against it, and the waves threatened to swamp our canoe. The tide was now so far out that we could not get to land without wading a mile or two through mud and water, but we made for a lee shelter seaward, a shoal, or reef, at high tide, but a good sized island now. Here we made camp, and spent a miserable twenty-four hours, in pouring rain, a perfect gale of wind, and thunder and lightning at intervals during the day. I don't know whether the aurora, or the red sky was responsible for the storm !

I trust this account may be found of a little interest : it does not pretend to be at all scientific. I have asked Mr. Nicolson, who makes all our weather observations at Moose Fort, to furnish me with notes of auroræ he has specially remarked this winter, and he has promised to do so. I shall hope to add them to this. It is with great diffidence that I send these few notes, and ask you to read them, if you think fit, to the Society, with my compliments. And with kindest regards to yourself,

I beg to remain,
Yours sincerely,
JERVOIS A. MOOSONEE.

Mr. Nicolson's report was as follows :—

AURORA OBSERVATIONS AT MOOSE FACTORY, SEASON 1895-6.

Date.	Time Observed.		Class.	Weather.
1895				
September 15	7	p.m.	II.	
" 16	7	"	II.	Fine from 16th to 19th.
" 18	7	"	II.	
" 19	7	"	II.	
" 23	10	"	II.	Raining on 20th. Fair on 21st.
				Raining on 24th. Fair on 25th.
October.. 13	9	"	IV.	
" 14	9	"	III.	Fair on 14th. Showery on 15th
" 29	7	"	II.	Fair on 30th. Snow and rain on 31st.
December. 7	7	"	II.	Dull on 8th and 9th.
" 10	7	"	II.	Fine 10th to 12th.
" 18	7	"	III.	Snowing on 19th and 20th.
" 26	6	"	III.	Fine on 27th and 28th.
1896				
January.. 3	6 & 10	"	II.	
" 4	7	"	IV.	Fair on 4th.
" 5	7	"	III.	Fine and clear on 5th and 6th.
" 9	6	"	IV.	Fair on 7th. Snowing on 10th and 11th.
" 21	10	"	III.	Fair on 22nd. Snowing on 23rd.
February. 3	7	"	III.	Fair on 4th. Snowing on 5th.
" 8	7	"	II.	
" 9	7	"	III.	Snowing on 9th.
" 10	7	"	IV.	Fair on 10th. Snowing on 11th.
" 12	8	"	II.	Fine on 12th. Snowing on 13th.
" 14	7	"	IV.	Drifting on 14th. Fine on 15th.
" 16	9	"	II.	Fine on 17th. Snowing on 18th.
" 29	7	"	III.	Strong wind, snow and drifting on 1st March.
March... 3	7	"	IV.	
" 4	7	"	II.	Fine.
" 5	7	"	IV.	Fine on 5th and 6th.
" 10	9	"	III.	Fine on 11th to 15th.
" 13	7 & 10	"	III.	
" 14	10	"	III.	

Mr. Nicolson distinguishes the classes as follows :—

Class I. This is characterized by the presence of at least *three* out of the *four* magnificent varieties of form, viz., arches, streamers, corona and waves.

Class II. A combination of *two* of the leading characteristics of the first class, would serve to mark the second.

Class III. The presence of only *one* leading characteristic, either streamers, or an arch (without corona), or irregular corruscations with moderate intensity would denote this class.

Class IV. On this class are placed the most ordinary form of auroræ, as a mere northern twilight or a few streamers.

The Corresponding Secretary was requested to convey to his lordship and to Mr. Nicholson the thanks of the Society for their interesting communications.

NINTH MEETING.

May 12th; the Vice-President, Mr. Arthur Harvey, F.R.S.C., occupied the chair.

A letter was received from the Secretary of the Leeds Astronomical Society and covering the transmission of copies of the Society's *Transactions.* Cordial communications were also read from Dr. A. M. W. Downing, F.R.S., etc., and from Mr. T. Gwyn Elger.

The text of an official communication forwarded to the office of the Governor-General, *in re* the Unification of Time, by the Secretaries of the Joint-Committee was read and approved.

The report of the Society's work for 1895, prepared for presentation to the Royal Society of Canada, was read and approved. Mr. Geo. E. Lumsden was appointed to represent the Astronomical and Physical Society at the annual meeting to be held at Ottawa, May 19th.

It was moved by Mr. A. Elvins, seconded by Mr. T. Lindsay, that the Lunar section of the Society resume proceedings, and that the first meeting be held May 19th, at the residence of Mr. Arthur Harvey, who had kindly offered to place his instruments at the service of the members and their friends. This was carried.

The following notes of observations made at the Toronto Observatory were read by Mr. Lumsden:—

May 8th; observations of Jupiter, made at the observatory in company with Messrs. Stupart, Blake, Paterson and Miller, began a little before 8 p.m.; definition remarkably fine until about 9.15, when it grew average; the telescope, the 6-in. refractor, bore well every power, even up to 500, which was used several times in the evening, though that of 240 was preferred; the first event attended to was the passage of the shadow of satellite IV., which was beautifully seen; special attention was given by Mr. Paterson to the ingress of I., which was timed at 9.34. 18. or 9.35. 20. when a high power was applied, and the planet and the moon were seen to be still separated; even when contact was no longer doubtful, the moon was shown distinctly against the dimly darkened limb of the planet; the moon was lost very soon, somewhat sooner than is usual; the egress of the shadow of IV. could not be timed as the spot was lost somewhere during the last fifth part of its journey; the eclipse reappearance of III. was noted, but, for some reason, the moon was not detected until it had come out of the shadow and had taken on its ordinary appearance; the transit ingress of I. was taken, and shortly after the observation came to a close, the dome being hot; during the intervals of Jovian phenomena, Castor, *epsilon* Boötis and Saturn received attention; *epsilon* was well divided but showed several diffraction rings around each member of the system; Saturn came out beautifully, several of the satellites were easy objects; the dark belt on the northern half of the ball was clear and all saw the crape ring across the disc; Mr. Miller was able to follow it even into the ansæ; the Cassini division was easily perceptible in the ansæ but not elsewhere; the limb of the planet showed out sharply against the sky; every one was pleased with the evening's work, and Mr. Stupart was thanked for his kindness in putting the telescope at the service of the party and for being present as well, as also Mr. Blake, who came over expressly.

Continuing, Mr. Lumsden stated that he had communicated with several observers in Ontario, with a view to having observations made on the evening of May 22nd, of the occultation of a 9th magnitude star in Cancer, by Jupiter. This phenomenon was among those predicted by Mr. Marth in the *Monthly Notices*, and being so rare an event, it was hoped some success might be attained.

The Chairman read some notes on the occultation of the Pleiades by the Moon, which he had observed on April 15th. Mr. G. G. Pursey reporting solar observations, stated that there had been several days recently when no spots were visible. A discussion followed on the subject of solar photography, and the validity of the photographs of the corona, without an eclipse, said to have been taken in England. A letter from Mr. T. S. H. Shearmen, of Brantford, was read bearing upon this subject. A short paper on the subject was announced for a future meeting.

The Chairman then called upon Mr. Alex. Laing to exhibit an orrery which he had constructed, and which it was claimed was admirably suited for illustrating celestial motions. The mechanism was much admired, Mr. Laing explaining the construction and pointing out various advantages possessed by it.

It was moved by Mr. Pursey, seconded by Mr. Lindsay, that the Society recommend the orrery as an excellent apparatus for the purposes for which it was intended. This was carried.

TENTH MEETING.

May 26th ; the President, Mr. John A. Paterson, M.A., occupied the chair.

Mr. Geo. E. Lumsden gave a brief account of the proceedings at the annual meeting of The Royal Society of Canada.

A communication was received from Dr. J. A. Brashear, of Allegheny, as follows :—

ALLEGHENY, Pa., May 14, 1896.

To the President and Members of The Astronomical and Physical Society of Toronto.

GENTLEMEN :—Will you accept my best thanks for the pleasure you have given me in electing me as a corresponding member of your Society. It is always pleasant for one who has devoted the best part of his life to work of a scientific character, to be associated with those who are earnestly working for the advancement of science, and helping to push onward the borders of human knowledge. I appreciate this membership among a people for whom I have always had a very warm place in my heart ; I shall endeavour to be of some use to you, and not a "drone" in the busy hive.

With best wishes for your success, believe me,

Very cordially yours,

JNO. A. BRASHEAR.

A report of the Lunar section meeting, was received from the Vice-President, Mr. Arthur Harvey, at whose residence the meeting had been held. Invitations had been extended to the members, and especially to those contemplating taking up the study of the heavens.

OUT-DOOR MEETING.

The members of The Astronomical and Physical Society of Toronto, usually meet for observation at President Paterson's, Walmer Road, where their reflecting telescope, presented by Lady Wilson, is kept. But on Tuesday night, the 19th inst., they were invited by Vice-President Arthur Harvey, to visit him at 78 North Drive, which is better placed for observing objects near the western horizon. The invitation was especially extended to those actual or prospective members who had telescopes of less than 3 inches in diameter, or none at all.

The evening was quite propitious, and as Mr. Gilbert's fine 3-inch glass was, by that gentleman's kindness, placed on the lawn, while Mr. Harvey's was used within the residence, an excellent opportunity was given to a score or so of the Society's members to become familiar with the telescopic aspect of several celestial objects.

The observations were conducted with a system which enabled all to take ample time. Mr. Harvey used a power of 82, throughout. Mr. Gilbert two powers, of about 50 and 120, respectively.

At a few minutes past 8 o'clock, Mercury was found, and closely examined. His disc, of a leaden grey colour, now appearing like a half-moon, remained visible for half an hour. There was no need to explain even to the youngest member, the reasons for the planet's nearness to the Sun, or his phase, or the red colour he assumes when he sinks close to the horizon; but these phenomena seemed highly interesting to those who had only been able to read and hear about him, and now for the first time saw the planet through a good glass.

When Mercury had set, the telescopes were turned on Jupiter, and this grand object was viewed with much delight by the novices. Their great surprise seemed to be the wide distance of some of the moons from the giant planet himself; the impression gathered from reading, being that they were close to his girdle, whereas they were seen to be so far away as to stretch half across the field of the telescope or more. Two were prettily placed to the east of him, so close to each other as to resemble a double star; the other two swung off far to the west of him. His belts were seen, and it was singular to notice how at first the novices could only see a single belt, the great southern equatorial band, but after a rest, and at a second and third trial, three others could be made out. After a little more experience the enlargement of the belt, where the red spot is to be seen by higher powers, was plainly made out by most of the observers, who could then also see the flattening at Jupiter's poles as well as the difference in size and brightness of his moons. It is hard to say which caused more pleasure, the brilliancy of this noble system through Mr. Gilbert's glass, with a power of 50, or its much enlarged but less bright aspect with higher powers.

Jupiter had sunk so low as to suffer in clearness from atmospheric refractions, Saturn had reached a favourable position, but the seeing was only moderately good in the south. However, it was only the practiced observer who could notice this, and the beauty of the ringed planet called forth many expressions of enthusiasm. The Cassini division in the rings could hardly be seen, and only two of the satellites. With glasses of only 3-inches diameter one cannot hope to observe the various parts of the ring system, which at the present time shows six concentric bands, arranged like so many benches in an amphitheatre.

The Moon, at about eight days old, was the next object examined. The Mare Serenitatis was in full view, crossed by its brilliant streak, which extends straight from Tycho in the other hemisphere. The Hæmus mountains were on the terminator and shewed up magnificently, as did several of the ring and wall plains. The observers could notice, after a little practice, a greenish tinge in one of the maria and the varying gradations of brightness in their parts.

Over two hours passed like a flash, and the observers—all young in experience, though not all young in years—wended their way to the trolleys, reserving double stars and nebulæ for another night.

OCCULTATION BY JUPITER.

Mr. Lindsay reported the observations made at the Toronto Observatory on the evening of May 22nd. Mr. F. L. Blake, chief observer, had prepared to note the occultation by Jupiter which had been announced. The star was seen when quite close to the edge of the planet's disc, but at about ten minutes before the time predicted for contact, G.M.T. 15h. 2m., the seeing became somewhat poor and the exact moment of occultation was not recorded. The planet was low in the horizon, which interfered with good seeing throughout. The failure to make the observation complete was much regretted, particularly as phenomena of the kind had been but rarely recorded. Letters were read from Mr. W. F. King, C.E., of Ottawa, and from Prof. C. H.

McLeod C.E., of Montreal, both of whom were unsuccessful on account of cloudy skies, in making the observation. Dr. J. C. Donaldson, of Fergus, had observed in his $3\frac{1}{2}$-inch refractor and had seen the star until about five minutes from the time predicted. Dr. J. J. Wadsworth, of Simcoe, had taken great pains to observe, and had removed an obstruction to the view from his observatory. In his 12-inch reflector the star was seen until it was about four seconds of arc (estimated) from the limb of the planet.

Mr. J. R. Collins had observed in his 6-inch reflector with results similar to those of the others who had attempted to note the occultation

None of the observers had used any appliance for cutting off the glare from the planet, and the non-success was attributed solely to the low altitude of Jupiter.

Reports of lunar observations and some drawings of special features were received from Mr. A. Elvins. Mr. Lumsden also read the details of his observations from May 15th to 25th. Referring to some difficult features on the lunar surface, Mr. Lumsden said: "I have never been able to follow Schröter's Valley up to or into Herodotus, nor have I been able to see the cutting in the south-eastern wall of Herodotus clearly shown in the drawing which illustrates the report of the Lunar section of the Brit. Ast. Assn. for 1890. But I am willing to ascribe this to a telescope which may not be so perfect as it ought to be, and am waiting, with some eagerness, the results of examining these mountains with the Collins' $10\frac{1}{2}$-inch, which is being constructed for me."

ELEVENTH MEETING.

June 9th; the President, Mr. John A. Paterson, occupied the chair.

Mrs. W. Goulding, of Toronto, was elected an active member of the Society.

A letter was received from Miss Mary Proctor, of New York, announcing that an expedition would leave Philadelphia on the steamer Ohio, on June 27th, for the coast of Norway, there to view the total eclipse of the Sun, August 8th. Much interest was taken in Miss Proctor's communication and the hope expressed that Toronto might be visited by her on her return from Europe, and in the course of her lecture tours.

The President reported the meeting of the Opera-glass section of the Society, held at Walmer road, June 2nd; a paper on the constellation Cygnus had been read by the President, the first part of the evening having been spent in observation.

It was announced that Mr. J. G. Ridout intended shortly to pay a visit to England and the Continent. The Corresponding Secretary was requested to hand to Mr. Ridout such letters of introduction as would enable him to meet the Society's correspondents in certain centres of scientific work.

Mr. A. Elvins desired to call the attention of the members to the recent discoveries in physics and read some notes as follows, on

RAYS OF ENERGY—THEIR REFRACTION AND EFFECTS.

Light giving objects such as the Sun emit a multitude of rays beside those which the eye recognizes as light.

Some of these are longer in wave-length than the red, others are shorter and more rapid than the violet. (The ultra violet has been photographed, the infra red has been mapped.) All rays of energy suffer refraction when they enter a denser medium (at an angle) than that through which they have been moving, and so again when they emerge from it.

The amount of refraction depends on at least three things, (1) the wave-length of the ray; (2) the density of the matter through which it passes; (3) the shape of the body through which it moves.

1. All forms and densities of a prism will refract the red rays, but will refract the violet more. The greater number of waves to the second of time the more they are refracted.

2. Flint glass will refract more than crown glass, water less than crown glass.

3. A lens of small curvature refracts *less* than the same glass with greater curvature, the more convex the greater the refraction, the sphere being greatest possible.

The Sun's rays strike the Earth and pass through its atmosphere, and the rays which pass through this medium which is transparent to light waves, come to a focus far off in space; but some rays will not be visible but will nevertheless exist and be very potent for other effects. The ultra violet cannot be seen, but will act powerfully as a chemical force, waves of magnetism are not visible, but they produce mechanical effects.

All of those and others doubtless are focused at different distances from the Earth's surface, some outside, probably some inside the surface.

It seems to me quite likely that those different foci of energy must produce great changes in the *atmosphere*, and in the Earth's *interior* when they are focused, so as to be in any particular zone, and some natural phenomena which are puzzling may be due to this cause.

I think this ought to be remembered in studying cyclones, tornados, thunder-storms, auroræ, earthquakes, and volcanoes.

The Assistant-Secretary announced that he had received the notes from Mr. T. S. H. Shearmen, which had been promised for some time on

SOLAR CORONA OBSERVATIONS DURING SUNSHINE.

I have been interested in watching the recent revival of the use of a pin-hole for purposes of astronomical research. I say "revival" because the application of pin-hole photography in attempts to observe the solar corona in the absence of an eclipse was originated by me many years ago; and hence, had those who have been recently repeating my experiments consulted *The Observatory* for 1885 and 1886, or the first volume of the *Transactions* of The Astronomical and Physical Society of Toronto they would have found that they were merely applying superfluous additions to a method already in existence and fully tested here.

There is, however, a radical difference between my method of treating the pin-hole image and that recently applied. My reason for adopting a pin-hole to form the image was to do away with false detail due to scattered light from minute scratches or dust on the object-glass or speculum; and to still further guard against error the plate containing the hole was made to rotate—the sensitive plate, of course, remaining fixed. No such rotation seems to have been used in the recent experiments. Then again, the recent experimenters enveloped their plates in metallic foil. Such a proceeding in the case of rays from a pin-hole at once produces false detail.

Before referring to my present plans for the better solution of this important problem, let us take a brief glance over the ground, and see what methods have already been employed in the task. The importance of the subject has attracted the attention of investigators for many years; and at the beginning of the inquiry we find Profs. Bond, Langley, and others, trying elevated stations and various devices for simply screening the Sun and viewing its surroundings by the unaided eye, or with low optical power. Profs. Wright, Harkness, Dr. Pupin and the writer, have devised fluorescent methods. The first serious attempts to use photography in the search were due to Dr. Huggins and myself. Having described some of our results in papers read before The Astronomical and Physical Society of Toronto on former occasions, I will only stop to glance at the work now being carried on by Prof. G. E. Hale, of the Yerkes Observatory. Prof. Hale attempted in the first place to use for the purpose a special form of his well-known spectro-heliograph. This was used at Chicago, on Pike's Peak, and even on Mount Etna, but no true corona was obtained on the plates. Prof. Hale therefore gave up the method, and has now turned his attention to an attempt to "map" the corona by the aid of the bolometer. This method also occurred to me many years ago, and after waiting for proper appliances I wrote, in 1890, to Prof. Langley (the inventor of the bolometer) for his opinion regarding the probable result of such an attempt. He replied that he thought it "very improbable that any modification of the 'bolometer' would succeed in differentiating the solar corona from the solar luminous irradiation." Prof. Langley still holds this opinion, as the following extract from a letter which I received from him a month ago will show: "In reply to yours of the 27th, I can only say that my impressions have not changed since I wrote the letter of September 10th, 1890, from which you are at liberty to quote....." In a letter received about the same time from Prof. Hale, the latter is not without hope, as the following extract will show: "....In September and October of last year I made a series of experiments with a bolometer at Lake Geneva, and obtained some results which, while not conclusive, lead me to expect that the experiments I intend to make this summer with new and greatly improved apparatus will be not altogether without value."

Such, in brief, is a skeleton list of the more important plans and attempts which have been used to solve one of the most difficult problems in solar observational work. The exceeding difficulty of the task has made the slightest approach to success extremely interesting. Hence we can appreciate the remark of Prof. Hale, in a letter received a few days ago, when referring to the bolometric method: "It may be an impracticable idea, but I intend to give it a thorough test before abandoning it." As the originator of the method I heartily echo every word of this.

My present plan will not be completed till shortly before the total solar eclipse of the coming summer. The real test of the reality of coronal impressions on a photographic plate is found at such a time. If plates taken in Canada at the coming eclipse, for instance, show similar rifts and extensions to those which may be taken in Norway or Japan, the coronal origin of the former will be proved at once. I have, whenever occasion offered, for more than ten years past, tried to prove the reality of the markings on my plates in this way; but I have never yet been favoured with a really transparent sky simultaneously with such an occurrence. The nearest approach to it was in 1886; but even then my photographs were taken three days after the eclipse, as the following extract from my letter in *The Observatory* for that year will show: "I determined to give the method a final test on 1886, August 29, hoping to prove the coronal origin of the markings on my photographs by taking photographs here of the uneclipsed sun, and comparing them with those of the total eclipse taken elsewhere. Unfortunately, the atmosphere was not clear enough on the 29th. On September 1, however, I obtained two photographs showing corona-like markings. Successful results have also been obtained on September 8, 11, 13, and 14. In *all* the photographs taken during September, the coronal rays are higher near the N., E., S., and W. limbs of the Sun. The general form of the corona is, therefore, that of a cross. Minor changes occur, however, from time to time." To lessen the chances of failure at a single station, I am arranging with others, at the coming eclipse, to use my coronagraph at stations separated by wide intervals.

Having glanced over the leading plans proposed and tested in the research, we may well pause and ask, What have they, all put together, accomplished? Have we, in fact, ever secured a trace of the corona on a photographic plate, or seen it visible by any of the methods named? After careful consideration it would appear somewhat probable that we have; but we cannot prove it as yet. Leaving out the fluorescent and bolometric methods I believe a few of the photographs of Dr. Huggins and myself do show occasional *traces* of the true corona; but, as already mentioned, I cannot, in the absence of eclipse testimony, prove this in the case of my own photographs. On the other hand, Dr. Huggins once thought he had proved it in the case of his plates taken in 1883. Photographs taken by him in England just before and after the eclipse of that year, showed corona-like markings somewhat resembling those shown on plates taken at Caroline Island during totality. Of these markings a conspicuous dark rift near the Sun's N. pole seen in the eclipse photographs is apparently well shown on the plates taken in England.

Here we may leave the past and prepare ourselves for the next eclipse to prove whether we have been treasuring up solar realities or merely recording instrumental shadows; and even should we then fail in this the words applied to the disciple of old still hold good—"Seek, and ye shall find."

TWELFTH MEETING.

June 23rd; Rev. C. H. Shortt, M.A., occupied the chair.

It had been arranged that this meeting would be for outdoor observations, and after the reading of the minutes of the previous meeting and of communications received, the members adjourned to the lawn of the Technical School, where several telescopes had been placed in position. Among others was a 3-inch refractor by Dollond, which had been used at the Toronto Observatory in earlier days, before the present excellent equipment had been completed. Mr. R. F. Stupart very kindly sent this instrument over. Its performance was as perfect as could be desired. Mr. Lumsden had also brought his 10½-inch reflector into service, and Messrs. Collins Bros., their 6-inch reflector, one of their own construction. The evening passed very pleasantly and profitably in observing various celestial objects, and in a general discussion.

Mrs. Savigny presented a pencil drawing of the lunar surface as seen without optical aid on the evening of June 20th. The sketch was unique in that it showed every feature visible to the naked eye on a night when the seeing was most excellent, probably as fine as it can ever be in Toronto. The drawing is preserved in the Society's album.

Mr. Lumsden presented a report of the Lunar section's work, and of his own observations of various lunar features. A short note of some interest was appended to this report: "After putting away the telescope, and while shutting up the house, I caught sight of a lightning or June bug on the grass north of the verandah. I knelt down by it and for a long time examined its light, when emitted, with a pocket spectroscope. The examinations were not satisfactory, the light being too faint, but I noticed that every fifth emission was redder in colour than the preceding four. I went to this trouble because these fire flies do not occur often with us in the city, and because they do not seem to give out their light with full brilliance when in captivity, though I have taken them for that purpose as a paper by our Mr. A. F. Miller will show, he having critically studied several specimens selected from a couple of dozen collected for him. I caught the fly after a while, and was astonished to see that the insect was only about one-third of the size commonly met with. I presently released it."

Mr. Lindsay had prepared some notes and a diagram in illustration of the conditions which render an occultation by the Moon visible in a given locality, and having special reference to the occultation of Jupiter on the afternoon of June 14th. Toronto was within the limiting parallels for visibility, but was too far west. The demonstration was as follows:—

At the moment of true conjunction of Jupiter and the Moon, the central meridian of the Earth's disc, as seen by an imaginary observer on Jupiter, was 56m. 42sec. east of Washington, or 47m. 20sec. east of Toronto. On the fundamental plane, passing through Earth's centre, and at right angles to the line joining the centre of Jupiter with that of the Earth, Toronto was passing eastward, and slightly northward, on the elliptic curve into which the latitude was projected.

Referring to the tables of the Ephemeris, we find that the Moon was moving (in terms of radius unity of the fundamental plane) 0·5455 eastward, and 0·1970 southward, hourly. The resulting motion across the plane was 0·5801 in a direction making an angle of 70° 9′ with the central meridian. The problem, then, is to find whether at any point of Moon's path the distance of its centre from Toronto was less than ·2723, its semi-diameter. This would be the problem presented to the observer on the planet—a solution is most easily reached by plotting successive positions of Toronto on the plane and the positions of the Moon at the same times, thus:—Employing the usual notation, the centre of the ellipse into which the latitude of Toronto was projected is given by the formula $\rho \sin \varphi' \cos \delta$, ρ being the Earth's radius, φ' the geocentric latitude, and δ the declination of Jupiter = 18° 57′ 54″ N.

Here we have $\rho \sin \varphi' \cos \delta = \cdot 6495$.

The co-ordinate of Toronto on the plane north of the centre is given by $\cdot 6495 - \rho \cos \varphi' \sin \delta \cos h$, where h is the hour angle selected. Let the first value of h be 1hr.; then take intervals of 20m. or 5°. The successive values of η will be found to be ·4220, ·4282, ·4360, ·4456, ·4566. Again, the co-ordinate of Toronto east of the meridian of the fundamental plane is given by $\rho \cos \varphi' \sin h$. Taking the same values of h we have for successive values of ξ ·1875, ·2478, ·3062, ·3623, ·4156. To find the co-ordinates of the Moon at corresponding times, we have for successive multipliers of the hourly motion, in parts of an hour, ·211, ·544, ·877, 1·210, 1·543.

The resulting values of x, the co-ordinate of the Moon east, are ·1151, ·2967, ·4784, ·1600, ·8417. With the same multipliers of the hourly motion south, and referring to the Ephemeris for the value of $Y = 1{\cdot}0140$ (the co-ordinate north at conjunction), we have for successive values of y ·9725, ·9068, ·8413, ·7757, ·7100. We may now tabulate the differences between x and ξ and between y and η thus—

$x - \xi$.	$y - \eta$.
·0724 Moon west.	·5505 Moon north.
·0489 Moon east.	·4786 " "
·1722 " "	·4053 " "
·2977 " "	·3301 " "
·3261 " "	·2534 " "

We have thus a series of right angled triangles on the fundamental plane, and by inspection alone we can see that the hypothenuse of none of these is less than ·2723, therefore no occultation was possible at Toronto.

Mr. Elvins and Mr. Blake had observed the approach of the Moon to the planet in the 6-inch refractor of the observatory, and Mr. Lumsden had observed in his 10-inch reflector. The day had been beautifully clear, and details on Jupiter's disc well brought out.

THIRTEENTH MEETING.

July 7th; the President, Mr. John A. Paterson, M.A., occupied the chair.

Mr. T. Gwyn Elger was duly elected a corresponding member of the Society.

Letters were read from Prof. Hendrickson, Washington; Dr. J. A. Brashear, Allegheny; and Mr. D. E. Hadden, of Alta, Iowa. Mr. Hadden, among other interesting items, gave a brief account of a visit to the observatory of Drake University in Des Moines, Iowa. The equipment included an excellent $8\frac{1}{2}$-inch refractor by Brashear, a fine helioscope, filar micrometer, etc. Referring to the subject of coronal photography, Mr. Hadden stated that he questioned the corona pictures obtained in England by Mr. Packer, and could not credit that the apparatus said to have been used would disclose the delicate corona to the photo plate. Incidentally the eclipse of 1900, which would be total on a line passing through the Southern States, was referred to.

Mr. Arthur Harvey introduced a subject of interest to meteorologists, by reading some notes on rain fall as observed in Paris, France. It appeared that when a record of the hourly precipitation was kept, it became distinctly noticeable that there was more rain in the afternoon than in the morning, or any other time. It was thought that an hourly record might be kept at Toronto, and the results compared with those reported from other stations.

Observations of the Sun were reported by Mr. Pursey and Mr. Lumsden. The latter stated also that arrangements had been made for the systematic sketching of lunar features by several observers, each selecting three objects.

Mr. J. R. Collins read a paper dealing with some of the optical and mechanical principles involved in the construction of the telescope, and having special reference to the best method of mounting reflecting telescopes so that the distortion produced by flexure of the glass might be avoided. It was said that when we reach the large apertures the silver-on-glass reflector is fully equal to the refractor in light gathering power. There is a great deal of light lost by absorption as the rays pass through an objective of such thickness as it is necessary to make for a great refractor. In the case of the silvered surface, the reflection is total, within about 10 per cent. Several mirrors figured and polished were shown by Mr. Collins, who had constructed a machine designed especially for the rough grinding, before the more delicate work by the hand is undertaken. With regard to testing, Mr. Collins considered that by the "artificial star method," it was possible to detect an almost infinitesimal departure from a true parabolic surface, such as to be perfect, a speculum should possess.

FOURTEENTH MEETING.

July 21st; the President, Mr. John A. Paterson, M.A., occupied the chair.

A cordial letter was read from the Secretary of the Natural History Society of New Brunswick, covering the transmission of a volume of reports and requesting exchanges; the Librarian was instructed to forward such volumes of the Society's *Transactions* as were in print, much pleasure being expressed at being able to exchange regularly with the New Brunswick Society.

Several sketches of lunar ring plains were received from Mr. A. Elvins, who had undertaken with some other members to sketch lunar features as regularly as possible. In commenting upon the drawings, Mr. Elvins remarked that he had, for the first time, observed a small crater in a region of the surface which he had long studied, thus showing how easy it is to overlook minute objects, and how much study and attention are necessary to master even a small portion. Mr. Arthur Harvey, in reporting his observations of the Sun, stated that he had noticed recently when a large spot was near the limb, that there was a distinct bulging out of the otherwise perfectly rounded outline of the disc. The question was raised whether it is ever possible to see the great tongues of flame in the fiery envelope by telescopic aid alone.

Mr. Lindsay reported the meeting of the Opera-glass section, which had been held during the preceding week at the residence of the President. After a pleasant hour in constellation study, Mr. Arthur Harvey read a paper on "Meteors," which it has been decided to embody in the *Transactions* of the Society. The full text of Mr. Harvey's paper follows:

FALLING STARS AND METEORITES.

The Germans have an excellent word for matter scattered through space; they call it star-stuff; for, as a small seed may be the parent of a large tree, a minute particle of matter, now apparently errant in the so-called void, may be the nucleus of a huge star—one of the orbs to be, in that distant future when Arcturus shall have grown dim and Aldebaran have been in some way dissolved. For among the stars of heaven, as among the ephemerides of Earth, change, of the nature of growth and decay, must be the inevitable rule—death being everywhere the law of life; so that the once misnamed "fixed" stars must to the Eternal eye be as evanescent as the dew drop is to ours.

It is of course wrong to think of space as void; we have been using the word for centuries because we do not know what fills it. It is also wrong to speak of errant particles, for the rules which keep Saturn ringed with his myriads of meteorites govern and make concordant the motions alike of stars and star-stuff.

Some law there is which causes atoms in space to coalesce, a point of attraction to be formed, particles with particles to aggregate, a new body to be brought into being about this centre, and a celestial life to be born—probably to be extinguished as a separate entity, after a brief career, but possibly to be the one among millions which is to grow into the very centre of a system of planets, each sustaining a thousand thousand beings of complex organization. We cannot yet surely tell whether shooting stars, meteorites and comets are inchoate worlds or whether they are the *disjecta membra* of broken systems. In either case, they are bodies which in the onward rush of the Sun towards some point in Hercules or thereabouts, have come within his attractive influence. As a right whale, driving through the ocean, strains out on his sieve of whalebone great quantities of small marine organisms for food, so the Sun, with his drag-net of planets, sweeps into his system innumerable morsels.

Those which are large enough to be seen before diving into the Earth's atmosphere—seen, that is, either by reflected light or other light called mainly into being by the Sun—we call comets, because of the fiery hair (coma) which trails behind them. I am unaware of any physical distinction between these and the meteorites which come plunging down upon the Earth. The incandescence of the latter is, however, a quite different thing from the light of comets, it is caused by friction in their passage through the air, which developes heat and light.

There may be an intimate relation between comets and flights of shooting stars. It is thought, indeed, that some comets which have elliptical orbits, and therefore periodically return to the Sun's neighbourhood, give off and leave behind them some of their constituents. Whether these comets were originally part of the sun-nebula, or have been turned from their independent paths by the comet-catching planets, is open to question; the latter is now the favourite hypothesis.

Somewhere in space we may suppose such a body moving, when, lo! it feels the attraction of a distant Sun—not visible as a great blazing orb but as a tiny disc, no larger than our Uranus appears; brighter, of course, but as yet giving no appreciable heat. Slowly the pull, or the push, increases, and our comet is launched upon the course which, though quiet at first, is to lead to mad excitement. If there were an observer on the comet, he might notice the increasing size of the little Sun, the slow opening out of the stars apparently surrounding it, and perhaps the gradual appearance of others of small magnitude beyond. In time it would shine with greater brightness—as large as Mercury, as large as Mars, as large as Jupiter or Venus is to us—and then surrounding stars would fade, while the observer would find himself in daylight. This picture assumes him to be upon the sunward side of his comet-world. If his none too solid seat should steer clear of Saturn, Jupiter, or other planets, which would probably be the case, he would find his course steadily accelerating, until with a swift rush of seventeen miles a second, added to whatever of initial sunward velocity the comet had when it yielded to the mystical affinity, he would be whirled round the Sun; its light would pale, its heat decrease, and an epoch of comparative quietude would succeed the coruscating glories of perihelion passage. Then on and on again, slowly losing the motion due to gravity, wandering until some other star assumed the rôle of monarch. But if by chance our observer, on the way to or from the Sun, should pass near some planet, a twist in his path would occur—an enforced change in his direction, another element, would be introduced into his comet's orbit—and lo! in lieu of a hyperbola, which means freedom to rove from star to star, his path would become an ellipse, which means a ring of marriage between the comet and the polygamous Sun; while as for the freedom of the universe and liberty to go and come and perhaps grow and become an independent mighty luminary—the raven's croak of "never more" must needs apply, unless an exactly similar twist, most unlikely chance, should change the orbit to its original shape.

Now, if we imagine comets as small nebulæ, more or less condensed about their nuclei, we can easily see what an unwonted agitation among their particles must needs occur. As they come near the Sun, as the forces of attraction and repulsion become intensified, temperature perhaps changes, for a comet's envelope may be gaseous and retain within it the warmth radiated from the Sun. Their tails increase in brightness and apparent size, often quivering with what may be electrical energy. This expansion may not be a real thing; perhaps the change is only in condition. However, in the agitation which prevails among their component parts, they appear to leave behind them flights of material particles. Some of these trains are so long and broad that it takes the Earth several days to pass through them, though it travels in its orbit over a million and a half miles a day. Most of them are, however, much less extensive, and only a day or two is occupied in traversing the aggregation. As their orbit has definite elements, the Earth passes through it each year at the same angle, and each swarm appears to come from the same point in the heavens. This point is called the radiant, and the swarms are named after the constellations in which their radiant is—Perseids, Andromedes, Leonids, Orionids, Cygnids, etc. Mr. Denning gives a list of no less than 218 radiant points.

When these bodies dash into the atmosphere they become intensely heated by friction. The smaller ones become sublimed and nothing reaches us but the finest dust, which under the microscope takes the shape of sporules, and can be detected in the deep sea dredgings at places remote from the coasts of our continents, where no terrigenous deposits bury them under layers of mud, and where no great quantity of globigerina ooze, the product of the shells of small marine organisms, is being deposited. They can be observed in the sweepings from the decks of ships at sea, in the dirt which collects on the snow in Greenland, and on the summits of lofty mountains. Most of these falling stars we never see; they are too minute to give out light enough as they burn. Myriads of others we do see, and in places where the air is dry and clear, such as the Central Asian plains, the display is brilliant, ten or twelve a minute, whenever the Moon is hidden. The colours of them are then distinctly seen, and are very various. Even here there is never a dark, clear night that we cannot see many of them—these being the larger ones, which do not burn up at once, but generally throw off trails of incandescent particles. It seems as if there were a similarity of physical constitution among the meteorites of each particular swarm, for in some they are mainly yellow, in others noticeably red, while the Geminids often have a greenish hue in their nuclei. Some take longer to sublime than others, their trails being longer. Their rate of motion varies much. An experienced observer can thus distinguish a typical Andromede from a Perseid or a Lyrid.

On the question of visibility of falling stars a great deal could be written. Careful experiments have shown that a 30-candle power white light can be seen for five miles. But as stars become incandescent perhaps 100 miles higher, and have become dissipated before they reach the fifty mile or at least the twenty-five mile limit, it is plain that all which have less than about 1,000 candle power are not seen at all, while those which are generally seen must be of sufficient size to emit a light when burning equal to that of from 1,000 to 10,000 candles. Bolides are brighter still. We can therefore comprehend after a fashion how infinitely numerous the invisible smaller ones may be, the visible ones being so many! Then arises the question of heat. The portions which fall to Earth are usually very hot—the intensely incandescent surface having transmitted heat to the interior, or the explosion having caused it, but the degree must depend greatly upon the nature of the component material —(a Mexican meteor, July, 1896, is reported to have appeared like a burning mass and to have buried itself in the Earth, water flowing from the spot, and being almost boiling hot for hours).

Mr. A. S. Herschel gives the particulars of five meteors as to which there were sufficient data for conclusion, and his results, in tabular shape, are highly interesting. They are as follows:—

HEIGHT.		LENGTH OF SLOPING PATH.	VELOCITY PER SECOND.
ON APPEARANCE.	ON DISAPPEARANCE.		
72 miles.	59 miles.	29 miles.	42 miles.
82 "	76 "	53 "	44 "
53 "	43 "	19·5 "	32 "
60 "	26 "	35 "	17 "
68 "	8 "	107 "	39 "

All these nocturnal displays are of stars which are moving towards perihelion, for at night the half of the Earth where they become visible is turned away from the Sun. Very few are known to reach the Earth at night; those which fall can, with difficulty, be located, and the only authentic instance I have come across is the fall of a couple of small meteorites at Mazapil, Mexico, which happened during a shower of Bielids (as the Andromedes are sometimes called, for their orbit agrees with that of Biela's comet), that was revealed through some luminosity which prevailed where they fell, and enabled the observer to locate the spot with accuracy. But an equal number of stars fall on the side of the Earth turned towards the Sun, for the Earth probably crosses as many returning as going streams, but they remain invisible; the glare of the Sun overpowers their little candles.

It is in the day, however, that we see most of those which reach the Earth without being dissipated. The society possesses a few of these aerolites, so their constitution and appearance is not altogether unfamiliar. They differ materially among themselves. Some are all nickeliferous iron, and are called siderites; some have particles disseminated through the mass, and are called sporado-siderites; some have little iron, and are oligo-siderites, while a few, without iron, are asiderites. The great Madrid meteorite of July 10th, 1896, is in some respects typical. Since the Earth revolves from west to east, these meteors, on approaching the Earth, naturally seem to move in the other direction. This meteorite was seen or heard of at Barcelona; over Madrid its outer surface scaled off with a terrific explosion, and a cloud of what seemed like smoke hovered in the air, while the main mass was hurrying westward, and after being noticed in Portugal, probably dipped into the Western Ocean. The people were terribly frightened, thought the end of the world had come, and began to say belated prayers. Such aerolitic displays are not without danger, but people are seldom hurt by them, and they are as nothing in comparison with volcanic outbursts or earthquakes. Its analysis, due to Mr. Mirat, who secured one of the pieces, has just appeared:

Silica	58·86	Metallic Min	7·75	Aluminum	2·36
Magnesia	15·95	Ferric Sulp.	7·28	Nickel	1·30
		Ferric Oxide	5·11	Lime	0·51

with traces of manganese, phosphorus, chromium, potassium, lithium, and of organic matter vitrified.

There are, of course, many which pass near the Earth and do not reach it. They may be twisted into different orbits, and still have the Sun for their centre, or they may be swung into orbits around the Earth or even the Moon. These would, of course, not be visible though incandescent, but they may occasionally be detected while passing before the Sun or Moon. The dark spot passing over the Sun, which was thought to be an intra-mercurial planet and was named Vulcan, may have been a meteorite, of the dimensions of a small planetoid. And on July 21st of this year, 1896, Prof. W. A. Brooks (of Brooks' Comet), observing the Moon with a 10-inch equatorial at Geneva, N. Y., saw a dark, round object pass slowly across the Moon from east to west, which he believes to have been a meteor, too far outside the atmosphere to become ignited. Its apparent diameter was one-thirtieth that of the Moon, and it took between three and four seconds to cross the disc. Supposing it to have crossed the line between the Moon and Earth at right angles, and to have moved at 50 miles a second, or say 200 miles while crossing the 30′ the Moon's disc averages, the distance from the Earth must have been 20,000 miles. If it moved at half that rate the distance must have been 10,000 miles, and its diameter must have been about three miles.

It seems curious that this object should not have been seen after passing across the Moon—not as a dark body, but as a bright one. Being as large in disc as Jupiter, and enjoying the Sun's light as well as the Moon, why was the light not reflected, and why could not Prof. Brooks trace this possible satellite after it had crossed the Moon?

The last branch of the subject here to be attended to is connected with nebulæ. You are now ready to consider the view I have for some time entertained, that nebulæ are really comets on a larger scale—as much larger than the comets of our solar system as the universe of stars is greater than our family of planets. The idea that one law pervades space in this respect also is to me a very attractive thought.

Shooting stars appear for a few brief moments only. Comets we see at not infrequent intervals, their changes in size and form occupy only a few hours, or at most days. It may take a generation to detect changes in the nebulæ, and yet, so huge are these bodies, that any important alterations taking fifty years to accomplish, must be the result of tremendous activity and almost incalculable velocity.

On comparing a sketch I made last winter of the great nebula in

Orion, a constellation well named the California of the skies, with that given in my edition of Sir John Herschel's astronomy, published in 1842, differences are apparent which I do not like to ascribe to careless drawing. This nebula was discovered in 1618 by Cysato, and has been mapped by many, including Herschel, of whom Secchi in 1867 and 1868, and Roberts in 1889, are very reliable. In the interval between Herschel's diagrams and the present time, the *nubecula oblongata* of the former has disappeared. It was marked by him as a straight line of nebulosity between the *nebula Marianii* and the *regio Picarduana*. In Roberts, the *Sinus Magnus* was filled by a luminous cloud, now no longer there. Secchi shows the great proboscis as one formation; it now seems to bifurcate and has a newly formed expansion on its tip, like a sort of fungus.

One would think that photography would soon determine the present conditions of the nebulæ, and that changes would be soon and certainly detected by its aid. But even the photographic method has its difficulties—the sensitiveness of the plates varies, so does the length of exposure and the condition of the atmosphere during that exposure. An exposure of hours, which brings some otherwise unobserved details to view, obscures others, by destroying the delicate shades of light on the most conspicuous regions.

FIFTEENTH MEETING.

August 4th; Mr. E. A. Meredith, LL.D., occupied the chair.

Reports were received from several members who had taken advantage of the fine observing weather. The Opera-glass section had continued the meetings for constellation study while the members forming the Lunar-section had been engaged in sketching, which work was becoming more and more interesting. A drawing of the Sea of Nectar was reproduced by Mr. Lumsden, on the black board, and the particular features described.

Mr. G. G. Pursey presented a short account of his solar observations: On July 26th there appeared just over the N. E. limb of the solar disc an area of faculæ which seemed to culminate in a very bright central point forming a very distinct white spot. On the 27th, the appearance had not materially changed, but on the 28th, the hitherto white spot had assumed a dark shade which it has retained. On the 29th, the spot seemed divided into two, which again re-united by the 30th. August 1st was cloudy. August 2nd, the spot was seen again divided into two quite a distance apart, or a new spot had come into view. August 3rd there was again but one spot visible although the seeing was good. August 4th a remarkable change had been effected, for not only had the second spot reappeared but an additional and apparently a double (dumb-bell shaped) also was seen, forming with the other two an equilateral triangle.

Mr. A. F. Miller presented a sketch of three chromospheric forms as seen by him on August 2nd 7h. 30m., at position angles respectively of 75°, 135°, and 317°. He had measured the height of the last and found it to be 26,000 miles.

The business of the meeting was curtailed in order to afford time for the reading of a synopsis of Mr. H. L. Clarke's paper on

THE LIFE HISTORY OF STAR SYSTEMS

which had appeared in the June number of *Popular Astronomy*. Mr. W. B. Musson had been specially requested to prepare this, and had sketched on the black-board copies of the drawings which illustrated this very important subject. The paper set forth very clearly the views of Prof. See, of Chicago University, and those of Prof. G. H. Darwin, of Cambridge. The latter had applied all the resources of the higher mathematics to the theory of tidal friction, and, selecting the Earth-Moon system as an example, had shown how the Moon had been literally pushed farther and farther off by the action of the great tides when both bodies were plastic. Prof. See carried the same reasoning, and an equal skill in mathematical analysis into the stellar spaces and selecting various binary stars known to be physically connected, not merely optically double, showed how such systems might be formed. The most noticeable point brought out in the investigation was that a nebulous mass set in rotation, may assume other forms than the spheroidal, which latter, it will be remembered, is the resulting figure according to the La Placean hypothesis. Since the time of La Place the science of pure physics had advanced greatly, and it was now held that he was not entirely correct in his outline of the history of a nebula rotating on an axis, and subject to the laws of gravity. The form which Darwin and

See maintained may result is that of a pear, the apiod shape, or again that of a dumb-bell finally breaking into two. And it was, moreover, a remarkable fact that there are in the heavens many objects which have this appearance, and seem to be destined to develop into systems of two suns revolving about their common centre of gravity. Mr. Musson was specially congratulated on the reproduction of the drawings, which made clear the reasoning advanced by the author of the paper.

An interesting discussion followed, in which several members took part. Mr. Lindsay thought that however plausible the theory might seem which carried a nebulous mass from a chaotic state to the pear-shaped figure, then to break into two equal or unequal masses, it was certain that such a theory would not account for the origin of our own solar system. There were many binaries in the heavens, but our Sun is alone. He thought that the weight of existing conditions, and the infinitesimal chance of fortuitous combination, placed the La Placean hypothesis on the firmest foundation. Mr. Elvins pointed out that neither the La Placean nor the new theory would explain the existence of the spiral nebulæ of which there were many examples. Mr. Lumsden called attention to the study of the Andromeda nebula by the aid of photography, from which it appeared that several rings might be thrown off at once. In closing the discussion, Mr. Musson said that the subject was a very wide one indeed, and it was not to be expected that any one theory would account for the origin of all stellar systems. It was much more likely that the history of nebulæ varies; that here the conditions lead to throwing off rings, and there to a resolution into two bodies only, and so on, in what variety we know not.

SIXTEENTH MEETING.

August 11th; the President, Mr. John A. Paterson, M.A., occupied the chair.

It was expected that Dr. J. A. Brashear, of Allegheny, Pa., who was summering in Muskoka, would have been present, but his arrangements had not yet brought him to Toronto. The Doctor had, however, written a short account of his observations of the Perseid meteors, which was read with interest. Several of the members had observed the August shower, particularly on the evening of the 7th. In connection with the general subject, Rev. Canon Macnab reported briefly :—

"August 6th, midnight; auroral arch and streamers visible; 12h. 30m., aurora very active, waves of light flashing to zenith; at 12h. 45m., display decreasing and clouds forming. August 7th, clear, no aurora visible."

Enquiry at the Toronto Observatory had elicited the fact that the magnets were considerably disturbed during this display. It was noted also by Mr. Pursey, that on the 6th, 7th and 8th of August, there were no spots on the solar disc. A large spot began to form on the 9th.

Mrs. J. Fletcher opened an interesting discussion on the evidence of there being changes taking place on the lunar surface. Mr. Lumsden and Mr. Elvins took part. The latter drew special attention to the necessity of taking everything into account in a question of this kind. Variations due solely to difference of illumination might be readily recorded as physical changes.

The President had been requested to prepare some notes on

METEORIC SHOWERS

generally, and to read the paper by Mr. G. J. Stoney in *Monthly Notices* on certain observations which are required to settle some points regarding the Leonids. In taking up the subject, Mr. Paterson dealt with the mathematical investigation of meteor orbits, but in a popular way, divesting it of other than simple arithmetical formulæ. The reasoning which led astronomers of the first half of the present century to fix the periodic time of the Leonids at $33\frac{1}{3}$ years was clearly outlined. It is now known that the swarm has its perihelion point at a distance from the Sun equal to the Earth's distance, while the aphelion point is at the orbit of Uranus. Kepler's third law being applied, it is seen at once that if the period is 33 years the mean distance of the meteor track from the Sun must be about 10, that is the cube root of the square of 33. If the mean distance is 10 and the minimum 1, then the maximum must be 19, that is out at Uranus' orbit; the unit of distance being that of the Earth from the Sun, and the unit of time the Earth's year.

A most interesting point raised in regard to the Leonids is the possibility that they were, at one time, a compact cluster of meteoric matter, rushing in upon the Sun, but that the gravitational influence of the planet Uranus forced the cluster into a new path, an elliptic orbit, and drew it out into a ring form. As the swarm is at present, the richest region forms one-sixteenth of the whole orbit, and eventually the meteors may be so drawn out by the perturbations of the planets as to be spread evenly all round the orbit.

In the course of Mr. Paterson's remarks he referred to the vast amount of mathematical work which has been accomplished in the endeavour to sketch the history of the Leonids. Much of it, it was true, is beyond the powers of the ordinary amateur, but the outlines of the theory should be known. His own efforts to illustrate by diagrams were quite successful, and the members became sufficiently interested to arrange for systematic observations of the advance guard of the swarm.

Dr. E. A. Meredith stated that he had seen the great swarm of 1833, and had a vivid remembrance of the display. Being asked to prepare a paper on the subject, Dr. Meredith promised to do so, for a future meeting.

SEVENTEENTH MEETING.

September 1st; the President, Mr. John A. Paterson, M.A., occupied the chair.

Mr. A. F. Hunter, B.A., of Barrie, Ont., a corresponding member of the Society, was present, and the members had the pleasure of hearing from him an account of some of the proceedings at the American Association Meeting in Buffalo. Mr. Hunter thought that the meeting of that body next year would be held conjointly with the meeting of the British Association in Toronto.

The Corresponding Secretary stated that he had received from Miss Mary Proctor a brief account of the solar eclipse as seen from the deck of the steamship Ohio on the morning of August 9th. The position which had been selected was north-west of the Island of Stöt, near the promontory Kunnen—Lat., 66° 57′ north; Long., 13° 31′ east. The sky had been cloudless and the atmosphere clear, so that a splendid view was had of the Sun's corona and prominences. Totality lasted 1m. 35sec., during which time the temperature fell from 53° to 51°. The planets Jupiter, Mercury and Venus, became visible.

Miss Proctor's letter and her drawing of the solar corona were subsequently published in the Toronto *Mail and Empire.* The drawing showed that the streamers directed from the solar poles were shorter and less brilliant than those extending to the east. On the west a streamer reached to a distance of about three times the Sun's diameter. Near the western limb there were two large prominences; several smaller ones were seen on the eastern limb.

The President briefly reported a meeting held at Rosedale for the purpose of affording a number of friends forming a garden party an opportunity to observe celestial objects. Reflecting telescopes had been kindly placed on the grounds by Mr. Lumsden and Mr. Collins.

Reports of observations were received from Mr. G. G. Pursey and Mr. A. Harvey. The latter called attention to the peculiar appearance of the Sun when setting, due to atmospheric refraction. Observations had been made on August 25th, from the deck of a steamboat in the middle of Lake Ontario, and had been as satisfactory as if the phenomenon had been seen in mid-ocean, there being a perfectly clear horizon line. Mr. Harvey wished to remind observers of this fact.

The thanks of the Society were specially due to the Vice-President, Mr. R. F. Stupart, who had kindly donated to the Library a set of the Greenwich *Nautical Almanac*, very nearly complete, from 1844. It was announced that Mr. Stupart would visit Paris to attend the International Conference of Meteorologists of 1896, and it was hoped that a report of the meeting would be presented to the Society in due course.

The President stated that since the last meeting of the Society, Dr. J. A. Brashear had paid a hurried visit to Toronto, but had not been able to arrange for being present at a regular meeting. A few of the members had, however, met Dr. Brashear at the residence of Mr. Lumsden, and had spent a most enjoyable evening with him. All had been charmed with the genial personality of the Doctor, who had imparted much valuable information on subjects in which he was specially interested and concerning which he is known world-wide as an authority. It was certainly the general impression that the Society was fortunate in having on its list of corresponding members a gentleman of Dr. Brashear's standing in the scientific world.

EIGHTEENTH MEETING.

September 15th; the Vice-President, Mr. Arthur Harvey, F.R.S.C., occupied the chair.

Among other visitors, Rev. D. J. Caswell, Ph.B., President of the Meaford Astronomical Society, was present, and from him was received a brief report of the progress being made and the interest being taken in astronomical studies among the members of the Meaford Society. Mr. Caswell was requested to prepare an extended report for publication in the *Transactions*.

Mr. G. E. Lumsden stated that he had recently had the pleasure of meeeting Dr. G. W. Hill, late of Washington, who had been visiting Mr. A. T. De Lury, of University College, Toronto. The Society would be pleased to learn that Mr. De Lury had been successful in his endeavours to procure for the Library of the Society copies of those very valuable contributions to astronomical science which represented in considerable part the life work of Dr. Hill, one of the most distinguished mathematicians of the new world. The thanks of the Society were due to Mr. De Lury and through him to Dr. Hill, for this kindness.

Mrs. Geo. Craig gave a minute description of an auroral display on the evening of September 13th. Referring to solar work, Mr. F. L. Blake reported the progress being made at the Toronto Observatory in sketching the appearance of the solar surface. One large group of spots had extended fully one-fourth across the disc. Mr. A. F. Miller, who had also been interested in observing this, stated that the group presented the appearance of a long black line, and was quite visible to the unassisted eye. It had been noted that the spots were more than usually near the solar equator.

A letter was read from Mr. T. S. H. Shearmen, who had removed from Brantford to Woodstock, Ont., and had taken charge of the observatory of Woodstock College. It was hoped that a detailed account of the equipment would be forwarded by Mr. Shearmen and that he would be able to transform the institution into a "popular observatory" in the full sense of the term.

The Corresponding Secretary read the following letter, received from Mr. David Boyle:—

G. E. Lumsden, Esq.,
Secretary Astronomical and Physical Society.

Dear Sir,—The following meteorological observation may be worth noting: On the evening of the —— of August, when driving in an easterly direction along the north shore of Rice Lake (near the village of Hiawatha), a slight shower passed towards the south-east, and as the sun was at our back the conditions were fairly good for rainbow effect. A triple bow made its appearance, extending from the horizon about fifteen degrees—the most easterly one being the brightest, the most westerly one with reversed colors next in brilliancy, and that in the middle comparatively faint.

Having withdrawn my eyes from the bows for a few moments, when I next looked I observed that two of them had united at the horizon, leaving the upper extremities fully as widely apart as the two exterior bows were when first seen. Leaving out of account the slight arc that was visible, the bows presented a V-shaped figure.

Never having seen any such phenomenon before, I would be pleased to know through your Society what the conditions of the atmosphere were to produce this effect.

I am, yours respectfully,
David Boyle.

Toronto, September 15th, 1896.

The Chairman stated that observations similar to that made by Mr. Boyle had been reported from the Ben Nevis Observatory, and were discussed in the publications of that institution. None of the other members had personally observed a phenomenon of this character. Mr. Stupart, to whom the question would ordinarily have been referred, was not present.

Mr. J. G. Ridout, by request, gave an account of his recent visit to Europe, which proved most interesting. He described at some length the Natural History sections of the South Kensington Museum and the British Museum, these departments having arrested his attention to the exclusion of others more strictly in the line of physical research. Mr. Ridout had also had an opportunity of inspecting several of the great continental arsenals, and described these very minutely, though they were still further removed from the more peaceful departments of science, which interest the amateur in physics.

NINETEENTH MEETING.

September 29th ; Mr. A. Elvins occupied the chair.

Mr. J. E. Maybee of Toronto, was duly elected an active member of the Society.

A letter was read from Prof. G. E. Hale of the Yerkes Observatory, who wrote to thank the Committee having in charge the arrangements for the British Association visit, for information furnished. It was stated that the dedication of the Yerkes Observatory would be so timed as to admit of the Association attending at the ceremony.

From Dr. J. J. Wadsworth was received a detailed account of his observational work, brought up to the end of June, 1896. His remarks on Saturn had a special bearing on former observations :—

"During June I observed Saturn many times, seeing the same appearances reported last year, namely, the Cassini division, the crape ring, the north equatorial belt, the shadow of the globe on the north-east part of the ring, the same blunt appearance of this part of the ring (from which Mr. Harvey inferred that the ring must be lenticular in form), and also the satellites, one, two, three or four in number, but hard to identify, except Titan. I also observed several times the south polar region of the ball, obtruding or protruding beyond the south limit of the rings ; that is, I saw the south pole of the planet. I see from some of the journals that the possibility of seeing this, this summer, has been denied. It is stated the rings hide the south polar region completely. I saw the south pole very distinctly on June 27th."

Mr. T. S. H. Shearman had been asked for some notes regarding his work at Woodstock, and in response forwarded the following sketch of

WOODSTOCK OBSERVATORY.

During the years 1878 and 1879 there was erected by the aid of the friends of Woodstock College an Astronomical Observatory, of which but little has been heard outside the town in which it is situated. Having been requested to give a descriptive account of the observatory, I would say that, pending the publication of my present series of observations, I hope the following notes will give a general idea of the building and instruments, and of the past and proposed future work of the observatory.

Prof. Montgomery and others deserve great credit for the energy and pains with which they succeeded in housing and swinging to the skies Ontario's largest refractor. The observatory has a very good horizon, and is well removed from sources of tremor. A street arc light to the west may occasionally glow a little too brightly, but otherwise the horizon is fairly clear. The building was originally a wooden structure, but a few years ago it was bricked over. It is divided into three rooms, the eastern one being octagonal, and containing the 8-inch equatorial refractor. This room is covered by an iron dome about sixteen feet in diameter, having a slit for observation of fourteen inches. This is too narrow. The computing room is about ten feet square. The transit room is ten feet wide and about eleven feet in length. It contains a transit instrument of about 2-inch aperture, with declination circle read by two verniers. The sidereal clock is an excellent one by Howard, of Boston, Mass., and was erected at the time of the transit of Venus in 1882. It has mercurial compensation, gravity escapement, and electrical attachments for chronograph. The clock is bolted to stone piers rising free from the floor.

The equatorial telescope has an aperture of eight inches and a focal length of over ten feet. It was made by the late H. Fitz, of New York. Right ascension and declination circles are attached, which will shortly be read from the eye end of the instrument. A driving clock is attached, and was made, I believe, by Chanteloup, of Montreal. The instrument carries magnifying powers up to 800, but for planetary detail a reduced aperture of about six inches is usually employed. A filar micrometer with position-circle and two eye-pieces is attached.

For many years the observatory has been, like many other college observatories, a place where time could be obtained and the pupils shown objects of general interest. One of the former Principals of the College, the Rev. Newton Wolverton (now President of Bishop College, Marshall, Texas), did some very good work and made extensive preparations for the observation of the last transit of Venus. Unfortunately, clouds prevented the successful termination of his labours.

During the past few years the teaching staff of the college could not spare time for astronomical research, and therefore during the summer of 1896, having moved to Woodstock, I was, through the kindness of Rev. N. Wolverton (of Marshall, Texas), Principal McCrimmon, of Woodstock, and Prof. Clark, placed in full possession of the observatory.

My work here so far has consisted principally in getting the instruments in order and in concluding researches begun at Brantford. My researches on observing the corona of the uneclipsed Sun are being continued here, as are also other solar studies. Variable star work, stellar parallax, a determination of the brightness of the outer satellites of Uranus, stellar photography, and other subjects will receive attention in the near future.

From notes left by Prof. Wolverton I find his determination of the position of the observatory to be :—

Latitude 43° 5′ N.

Longitude 5h. 23m. 02·67s. W.

The difference in longitude between here and Toronto was found during the preparations for the transit of Venus in 1882. I am now making a new determination of the position.

Dr. A. D. Watson then read the following paper on

THE REFORMATION AND SIMPLIFICATION OF THE CALENDAR.

The calendar as a register of time divisions and periods is more or less conveniently adjusted to synchronize with certain regularly recurring natural phenomena, dependent upon the relations of our Earth to the other celestial bodies. Our own calendar, in particular, is the result of an effort to adjust the various divisions of the civil year to an exact relation with the natural or solar year. The methods which have been adopted by the different nations of the ancient and modern world are very numerous and interesting. As this paper is intended to be practical, no systematic reference will be made to calendars other than our own, excepting for the better understanding of the subject in its bearing on the system of time divisions now in use in our own and other civilized lands. The calendars of our own times are not the product of an exact scientific method. They are rather the latest stage, we trust it is not the final, in the evolution of a practical method by which time periods are adjusted and registered. While the imperfections of our present calendar render further changes necessary, the reformations of the past encourage us to hope that such reforms will be made as will enable us to enjoy the use of a perfected system. The diversity of calendars now in use is largely of religious origin, depending upon the varying degrees of significance attached to the changes of the Moon. The Mohammedan calendar will serve to illustrate the purely lunar year, which in this case contains 12 months invariably, but as one lunation occurs in 29·5305868055 days, they make their months alternately of 29 and 30 days' duration, and to each of 11 years in every period of 30 years, they add one day, in order to include the time by which one lunation exceeds 29·5 days. The year is thus purely lunar, and consists ordinarily of 354 days, consequently the beginning of the year, traverses all the seasons in about 32·5 years.

The modern Jewish calendar is luni-solar, for while the months and years are lunar, the number of months in the year is varied so as to make the average year solar. Thus in every Metonic Cycle, which consists of 19 years or 235 lunations, they make 7 years embolismic, *i.e.*, they add the month Veadar, or second Adar, placing it in the middle of the year, which with them begins in the autumn. They have also a device for arranging the time for the occurrence of their religious festivals, by adding a day occasionally to their second month, just as we do in leap years. In other years they subtract a day from their third month for the same purpose. Their ordinary year consists, therefore, of 354 days, and their embolismic year of 384 days, but either of these may be increased or diminished by one day. Our own system gives us an example of a purely solar calendar. In it the lunar phenomena are entirely ignored as agents for determining the length and composition of the year.

The Roman calendar is that which forms the basis of our own, indeed many of the peculiarities of our calendar, can be understood only in the light which a study of the Roman calendar affords. Although most of the evils which mar the calendar now in use are chargeable to Roman influences, we are happy in having discarded their system of naming the days of the months, for we are thereby relieved of the clumsy method of numbering the days backwards from the Nones, Ides and Calends.

The history of the Roman calendar begins with Romulus, under whom the Roman year consisted of ten months, which were named March, April, May, June, Quintilis, Sextilis, September, October, November and December. The months of the Roman calendar have never since been so conveniently named, for this approximately ordinal method was corrupted in the very next reign, when January was added at the beginning of the year and February at its close. Although the numbers of the months hitherto used became inapplicable to them without a readjustment, they were nevertheless retained, and are mostly in use in our own times. In the calendar of Romulus the year consisted of 304 days, March, May, Quintilis and October having 31 days each, and each of the other months 30 days. It is said that days were introduced without names in order to complete the solar year. Numa's reformation has been already referred to, and consisted of the introduction of two new months, one at the commencement and the other at the close of the year. February remained the last month of the year until 452 B.C., when it was changed to its present position by the Decemvirate. The year in Numa's calendar at first consisted of 12 months of 29 and 30 days alternately, corresponding nearly with 12 lunations, but the year thus constituted contained 354 days, and as even numbers were considered unpropitious, another day was added to make the number odd. A further change was made in the same reign by introducing an extra month of 22 and 23 days alternately, into every second year. This 13th month was intercalated between the 23rd and 24th of February, the last month of the year. This change made the year approximately solar, as it now averaged 366$\frac{1}{4}$ days. A little later, when advancing knowledge proved such a year to be too long, the intercalary month was omitted in every 24th year, after which the average civil year corresponded very nearly with the solar. This clumsy system was thrown into confusion in the succeeding centuries by the intrigues of priests and politicians, and excepting the change in the position of February, effected by the Decemvirs, there appears to have been no serious reforming movement down to the very last days of the Republic. But the corruptions of the calendar could not escape the eagle eye of the great Julian reformer. Calling to his aid the astronomer Sosigenes, he proceeded in the first place to correct the errors of the past, and then to provide as far as possible against their recurrence. The former of these tasks required heroic treatment. So great had been the departure from Numa's methods, that it was necessary, in order to restore the vernal equinox to its position under Numa, to add two months to the year 707, A.U.C., which was the 47th before the Christian era. The year thus prolonged contained 15 months, or 455 days, and is known as "the last year of confusion." The average year was thenceforth to be maintained at 365$\frac{1}{4}$ days by giving the odd months, *i.e.*, the 1st, 3rd, 5th, 7th, 9th and 11th, 31 days each, and the others, excepting February, 30 each. February was to contain 29 days, excepting every 4th year, when it had 30 days. The extra day was inserted by repeating the sexto-calendas or 25th day of February, which thus became a bissextile month and made the year bissextile. The first interference with the Julian calendar occurred under the first Emperor Augustus. Quintilis had been named July after the great Triumvir, Sextilis was, therefore, changed to August in honour of his colleague and successor. But July being seventh and August eighth, the month of Julius had one day more than that of Augustus, in accordance with the method of Julius Cæsar already referred to. This was not to be tolerated by the dignity of Augustus, and, therefore, February was once more depleted of a day to be added to the month which bore the Augustan name. This change moved the sexto-calendas back in February to the 24th, and brought three months of 31 days each into one quarter. The latter of these results was partially remedied by taking the 31st day from September and November and adding it to October and December, thus was the length of the months arranged in a manner which, though extremely inconvenient and irregular, has prevailed ever since. It is necessary only to mention the more recent reformation by Gregory; how the Julian year being about $11\frac{1}{4}$ minutes longer than the true solar year, civil time began to lag behind the Sun; how Gregory in 1582 resolved to omit 10 days from October of that year and thus overtake solar time; how he directed that thenceforth three leap year days were to be omitted from every four centuries; how the countries of Europe, one after another, adopted the new style (England only in 1752, when January 1st was restored as the beginning of the year instead of March 25th), till now only Russia and Greece maintain the Julian calendar. The Gregorian calendar year is only 26 seconds longer than the solar year. Such a disparity will amount to only one day in over 3,323 years, therefore, if the year 3,324 (when the divergence will amount to about half a day), were made a common instead of a leap year, and the same rule were adopted with all multiples of that year, the divergence thereafter would never amount to much more than half a day. Such a method would maintain an almost perfect harmony between the civil and solar years, for all future time.

It is a matter of opinion as to whether the reformation of Gregory was productive of any advantages commensurate with the great inconveniences which have followed its adoption in such irregular fashion by the different states of Europe. However this may be, it seems a pity that while so much effort has been made to harmonize the civil with the solar year, so little attention has been given to the adjustment of the various subdivisions of the civil year upon any convenient or rational basis.

A more recent effort to reform the calendar was made by the first French Republic. The reform was, however, more interesting than meritorious, and had little of originality but much of change from the system which it was intended to displace. The day was divided by a decimal system, similar to that which is said to have been used in China 2,000 years ago. They followed the ancient Egyptians by dividing their year into 12 months of 30 days each and adding five supplementary days to complete the ordinary year. They added a 366th day to their ordinary year "whenever the position of the equinoxes required it." They followed the ancient Greeks by making a division of the month into three periods of 10 days each, and rested on the tenth day. They adopted a period of four years, which they called a Franciad, corresponding with the Greek Olympiad. In most of these changes they appear to have been actuated by a spirit of revolt against existing institutions rather than by any true desire for reform. This calendar perished with the first Republic.

Whereas the day and year are clearly based on the motions of the Earth, the month doubtless had its origin in the Moon's changes, for we find that in almost all countries 29 or 30 days were made either singly or alternately the length of the month, and this corresponds very nearly with 29·530586805 days, which is the average period of one synodic lunar revolution. But while the day, the month, and the year, are the only time divisions which have any astronomical significance, the week of seven days cannot be ignored in any calendar adapted to modern use. Such a period has its sanction in a far higher realm than that of astronomical motions, namely, its convenience and usefulness to humanity. Not only the Sabbath but the whole week has apparently been "made for man."

Many theories have been advanced to explain the origin of the week. It is claimed by some that it derived its origin from the fact that it is approximately one-fourth of the period occupied by one lunation. This is doubtful, especially as there has never been any attempt made to vary the length of the several weeks of a month, by intercalation or otherwise, in order to make four weeks exactly correspond with one month, a result which could have been accomplished with far greater advantage than many so-called reforms have secured with a greater expenditure of ingenuity and with equally important disadvantages. Others are convinced that the week is accounted for by a series of facts in connection with ancient Astronomy and Astrology. The facts are these: There were seven so-called planets known to the ancients. These were named in the old Egyptian papyri in the following order:—Saturn, Jupiter, Mars, the Sun, Venus, Mercury, the Moon. The day was divided into 24 hours, each of which was consecrated to a particular planet. Each day received the name of that planet which presided over its first hour, thus, if the first hour was consecrated to Saturn, that day was called Saturn's day (Saturday); then, as the hours were devoted to the planets in their respective order, the 8th, 15th and 22nd hours were, like the 1st, under the protection of Saturn. It follows that the 23rd and 24th hours would on Saturn's day be devoted to Jupiter and Mars respectively, and consequently the 1st hour of the following day would be under the protection of the Sun, and was, therefore, named Sunday; similarly, the Moon's day followed (Monday), then Mars' day (Fr. Mardi), then Mercury's day (Fr. Mercredi), etc.

A very numerous class of persons maintain that we have the true origin of the week accounted for in the writings attributed to Moses. These as a rule will accept no substitute theory or any additional light, as they regard the record in Genesis as complete and satisfactory. It is, perhaps, not a sufficiently practical theme to warrant any contention.

The order of days in the Roman week follows that of the Egyptians, but the 1st day is Sunday instead of Saturday. It is said that the beginning of the week was changed to Sunday by the Hebrews, because of their abomination of everything Egyptian. However this may be, we know that Saturday was the holy day of the Hebrews, though accounted by them the 7th day of the week. Modern nations generally follow the Hebrews in reckoning Sunday the 1st day of the week. As to the names of the days, the Roman countries use the Egyptian and Roman titles; the Teutonic nations have discarded most of the planetary names, while the Hebrews still designate the days of the week by number. Concerning the divisions of the day it may be added, that Hipparchus reckoned them from midnight to midnight, but Ptolemy from noon to noon, and unfortunately modern astronomers have followed Ptolemy. In the civil calendar of modern Europe the day commences and ends at midnight, and thus avoids the necessity of using double dates for events which occur between sunrise and sunset.

In constructing the calendar *de novo*, it would be observed, that the week has an exact measure in the day, being arbitrarily composed of an integral number of days; but of the day, the lunar month, and the solar year, the only time divisions which have any astronomical sanction, not one of them has any integral relation to either of the others. It follows, therefore, that without the adoption of the device of intercalation, no practical calendar can be constructed. The objects to be sought are the maximum of uniformity, symmetry and convenience. Our calendar is perhaps in no point so conspicuous as in the absence of all these qualities; besides, it gives no substantial advantages to offset the great irregularities which have been so gratuitously introduced. Of the time divisions just named, the day is already adjusted to all the others, and may, therefore, for the present be dismissed, excepting as a constituent of the other time divisions. The week has never been adjusted either to the month or to the year or its quarters. The month has been adjusted to the year, but in a most unsatisfactory manner, the months varying at present from 28 to 31 days in duration. It therefore appears that inasmuch as the day and the year are invariable and are already arranged by the Gregorian calendar, the week and the month only remain to be adjusted. But we have already concluded that the week must not be disturbed, hence any important change is precluded in any time division other than the month. It is very fortunate that this is the case, for the month has its origin in the phenomena of the night, and the Moon may be ignored far more conveniently than the Sun.

It is very clear that a Gregorian year cannot be secured without intercalation, we must, therefore, be prepared to accept the inevitable. At the same time we must secure what uniformity we can with the least possible inconvenience. It may be accepted as a principle that no change must be made unless it is warranted by clearly preponderating advantages.

Let us first examine the ordinary year of 365 days. We find the only measures of 365 to be 5 and 73, and therefore it is clearly a very inconvenient number of days to deal with, for a week of 5 days, or a month of 73 days which does not consist of a whole number of weeks, is out of the question. Let us lay aside another day with our Leap Year Day to be dealt with hereafter. We have 364 days left. Now the measures of 364 are 2, 4, 7, 13, 14, 28, 52, 91 and 182. Taking these factors into consideration and neglecting the smaller measures, we find that 28 is divisible by 2, 4, 7 and 14; 52 is divisible by 2, 4, 13 and 26; 91 is divisible by 7 and 13. The year of 364 days is, therefore, divisible into 2 half years or 4 quarters, or 13 months or 52 weeks, each of these quarters being exactly divisible into 13 weeks, and each month containing exactly four weeks. Such a year involves a change in the length and number of the months, and the quarters are equalized and contain exactly 91 days each, instead of varying as at present from 90 to 92 days. There appears to be no valid objection to a month of 28 days. We do not adhere to any lunar period in our present calendar, besides the period of an actual lunar revolution about the Earth is 27·32166 days, and the month of 28 days does not greatly differ from such a period. It is admitted that such a consideration is of no practical advantage, but is stated in order to show that a month of 28 days has at least no disadvantages when compared with our present month period. Moreover, when we remember that $29\frac{1}{2}$ days is the approximate period of a synodic lunar revolution, and is as much less than 31 days as it is greater than 28, we find that a month of 28 days has more astronomical sanction than one of 31 days. Besides we have already one month of 28 days, and if the months were all uniformly of that length, there would then be a constant relation between the length of the month and the period of the Moon's changes, and this would certainly be a decided advantage, though perhaps not a sufficient one of itself to warrant such a change as we propose. We shall, however, be able to point to far greater advantages as we proceed. Every observer has noted the convenience of finding that at the close of February in every common year the days of the week are not disturbed in their relation to the days of the month; thus, if February 1st fall on Sunday, then March 1st will also occur on that day; if February 28th fall on Saturday, March 28th will be Saturday also. Even so much is very convenient, but if we can introduce our 365th and in leap years our 366th day, which we have thus far ignored, into the year, in such a way as not to disturb the symmetry of its parts, the convenience of the present February-March arrangement will prevail throughout every year. Nothing is simpler than the accomplishment of such a condition. At present the beginning of the year traverses the whole week in 6 years, likewise the beginnings of successive months traverse the week with the utmost irregularity, owing to the various lengths of the different months. It follows that it is almost impossible to know on what week-day any future date will fall, excepting by labourious calculation or by reference to a printed calendar. Now we have found that omitting one day from the ordinary year the 364 days that remain are divisible into exactly 52 weeks of seven days each, into 13 months of 28 days, or 4 weeks each, and also into 4 quarters of 91 days, or 13 weeks each. We should thus have a year symmetrical in every part, but how shall we introduce the remaining day without destroying the symmetry of the other subdivisions of the year, for this extra day and also Leap Year Day must have a place in the calendar and in the year? The problem is solved easily enough, for it is not necessary or desirable to introduce this extra-symmetrical day into any of the other subdivisions of the year. All the requisite conditions may be met by making this extra day the 1st day of the year and calling it simply New Year's Day, keeping it as a holiday, and making the following day, Sunday, the 1st day of the 1st month, the 2nd day of the year. The 366th or Leap Year Day might be appropriately and symmetrically added at the close of the year, excluded like New Year's Day, from the week, the month, and the quarter, and named simply Leap Year Day. It would thus immediately precede New Year's Day and would follow Saturday 28th of 13th month. The following draught of the calendar, reformed and simplified as herein proposed, would serve to illustrate clearly the description here given :—

New Year's Day, 1st day of the year (1st day of the 1st month being the 2nd day of the year).

Month	S	M	T	W	T	F	S
	1	2	3	4	5	6	7
1	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28

* * * * * * * * * * * * * *

(Here follow the months 2 to 12, but being uniform they are omitted without loss of clearness).

Month	S	M	T	W	T	F	S
	1	2	3	4	5	6	7
13	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28

Leap Year Day—in leap years only, last day in the year.

I am aware that a year of 13 months has been suggested before, but the disposition which I have made of New Year's Day and Leap Year Day removes every objection which has hitherto been urged against such a change and gives a quarter of exactly 13 weeks.

Leap Year Day might also be made a holiday with very happy results, as it would occur like New Year's Day in the holiday season, and, being placed at the end of the year, the half years would each contain an equal number of days even when these extra days are included. Thus, in leap years, New Year's Day and Leap Year Day would be symmetrical, though not included in other subdivisions of the year, and each half year would contain 183 days, whereas in the present leap year the first half of the year contains 182 and the other half 184 days. In common years the first half has only 181 and the second 184 days.

The change suggested could be made most conveniently when the beginning of the year in our calendar falls on Saturday. This would occur in the years 1898 and 1910. Saturday, January 1st, 1898, would be named New Year's Day, 1898, without any disturbance of our present usage, and Sunday, January 2nd, would become 1st of 1st month, 1898. December 31st would be 28th of 13th month, 1898. In 1904, our next leap year, Saturday 28th of 13th month, would be followed by Leap Year Day, 1904, then by New Year's Day and 1st of 1st month, 1905. The introduction of an additional month would involve no serious disturbance which would not be outweighed by many advantages. The tendency in these days is to number the months, and this tendency should be fostered, not only because that method requires less writing, as it certainly does, but because it is much more convenient and in harmony with modern methods. Although the mythic names now in use are supposed by some to have some strange poetic or sentimental fascination, the new method suggested has already been adopted with fine effect in the world of poetry. If the old names should for a time be retained, either alone or with the numbers, as designations of the months, then the new month should be regarded as being introduced between June and July, for in such a position it would displace the other names more symmetrically than if it were introduced in any other part of the year. This shortening the winter months and increasing the number of months in warm weather would make the summer appear longer and the winter shorter. This effect would, I admit, have only the value of an appearance, but that is sometimes considerable. The new month would in such a case need a name, and though that is a very unimportant matter, the Saxon peoples might appropriately term it *Rosemonth*, as that name would be appropriate to the season. But the system by which the months are numbered is vastly more convenient and desirable, and violates none of the canons of present popular usage, besides all computations of time involving more than one month, would by its adoption be reduced to simplicity itself.

In carefully reviewing the proposed system it will be seen that it makes a week instead of a day the unit of the calendar, and consequently the unit of civil time. The result is that all the chief divisions of the year have the week as an exact measure, begin with its first day and end with its close. The fact that the month is not an exact measure of the quarter is of no moment, as in business the quarter is seldom named without stating the number of weeks involved. The week being without any other sanction than that of its adaptation to human interests, is very appropriately named the unit of civil time, and should therefore be the chief measure of all the prominent divisions of the year.

In estimating the favorable and unfavorable aspects of the reform proposed in this paper, we notice among the

ADVANTAGES.

(1) The convenience of having months of equal lengths. To have every month end on the 28th day as certainly as it begins on the 1st is a reform the value of which is clear without any comment. (2) There is likewise an advantage in having the month, the quarter, and the half year, consist invariably of a constant number of weeks, the quarter consisting, as proposed, of 13 weeks instead of varying as at present from 12 weeks and 6 days, to 13 weeks and 1 day. (3) The symmetry which is given to every division of the year and which is perfected in leap years, when Leap Year Day at the close of the year balances New Year's Day at its commencement. (4) The week, the month, the quarter, and the half year, all commence with the first day of the week. The advantage of such a feature will be more readily suggested by contrasting the present year 1896 of our present calendar, in which the months begin in order on the following days:—January on Wednesday; February on Saturday; March on Sunday; April on Wednesday; May on Friday; June on Monday; July on Wednesday; August on Saturday; September on Tuesday;

October on Thursday; November on Sunday, and December on Tuesday. In the proposed simplified calendar Sunday would replace all the others for this and every year as the initial day of the month. (5) Each particular day of the week would occur constantly upon the same days of the month, and this is true of all days and months, and in consequence of the disposition made of New Year's Day and Leap Year Day, it is likewise true of all years, the week not being displaced at the end of the year. Thus Sunday would fall on the 1st, 8th, 15th and 22nd of every month, and similarly with every other day. And this is true in every month and in every year. (6) If any date be mentioned, whether past, present or future, the day of the week on which it would fall would be immediately known, without any calculation and without referring to a printed calendar, as each particular day of the week would soon associate itself inseparably with its coincident month dates. Thus Sunday, with the dates 1st, 8th, 15th and 22nd; Friday, with 6th, 13th, 20th and 27th. If the days of the week were also numbered as they were by the ancient Hebrews, then the numbers of the days in the first week of each month would always indicate the day of the month. It is doubtful, however, whether this change would be generally approved. (7) It would be almost impossible to forget either the day of the week or of the month, for one of them would in almost all cases be known, and would immediately suggest the other. Thus, if it be known that the day is Monday, then the date must be either the 2nd, 9th, 16th or 23rd, and the question as to which of these days would be settled, for we never get so much as seven days out in our reckoning. (8) Printed calendars would henceforth be ornamental, never necessary. (9) Dominical letters could be dispensed with, as they have no relation to a year whose week-day is constant. (10) The solar cycle would also be of no further use, for, like the Dominical letter, it has no possible relation to a year of which the second day is always Sunday. (11) The system of epacts would be greatly simplified, for the changes of the Moon would vary constantly throughout the year, instead of irregularly, as at present. New Moon would occur a day and a half later in every month than in the month immediately preceding. Thus, in the year 1900 new Moon would occur on or about the 1st day of the year, the golden number of that year being 1. Then, after the lapse of 10 or 13 months of the proposed calendar, the new Moon would appear on or near the 15th day of the month and similarly for other months; for if it be remembered in any year, on what day of the first month of that year the new Moon appeared, it may be immediately known when it would occur in any succeeding month, especially when the months are numbered. (12) The convenience of computation would be greatly enhanced in all processes which involve the element of time, the ease with which the lapse of days may be computed is almost self-evident ; thus, if it be desired to know how many days elapse from the 13th of 3rd month to the 26th of 10th month, the problem at once takes shape as follows: 7x28+13. By our present method, the problem would take the following form. How many days from the 11th of March to the 6th of October? A comparison of the work involved shows how great a saving of time would be effected. All financial offices would thus be relieved of much drudgery in the computation of rents, interest, discounts, etc. ; indeed, no intelligent person of all Earth's millions could fail to reap the happy results of such a change in the very first year of its universal adoption. (13) It would, perhaps, not be one of the least advantages of the proposed simplification that the lines so well-known to all as a relief in times of doubt and perplexity, which run as follows—"Thirty days hath September, April, June and November," etc.—would cease to be one of the chief of English classics; its doggerel days would be numbered. (14) Intercalation would be limited to the last day of the year instead of being introduced into the second month, as at present.

It will be urged that there are

DISADVANTAGES

to be pointed out in the proposed changes, and there should be no disposition to shirk the issue of such a claim.

(1) One alleged disadvantage will be named as referring to the fact of change itself. Any disturbance of existing institutions will be resented by the more conservative class as unwarrantable. It can be said in answer to this objection that change in itself is not objectionable. It is only when change brings with it such inconvenience as to render it unwarrantable that it is to be avoided. Indeed, there are many facts lying on the surface of physical science which tend to show that change is desirable, and this is especially true where the change is an improvement. (2) The disturbance of statistical work in the almanac may be urged, but it may be said in reply that there would be no change of this kind which a school-boy could not efficiently manage. Besides, if the change be made as proposed at the close of the century, the new calendar era

would be easily remembered by all, and thus no great confusion would result. (3) Others would object that the new system would displace the dates of anniversaries. This is true, and there is a sense in which every man who is born in any month after the 28th of that month would have no more birthdays, but this would be easily arranged, for every day would still have its place and would be readily ascertained. Thus, in our ordinary year the equinoxes occur on or about the 80th and 264th days of the year, and these, according to the proposed system, would be on the 23rd of 3rd month and 11th of 10th month in every year. Usually, however, there would be no necessity for any change, besides those who attach importance to anniversaries, generally have leisure for such calculations. (4) Another class of persons will urge as an objection that this plan involves the displacement of Sunday, and while we all regard that day, there will be few, I think, and they chiefly of the uninformed, who will regard the displacement of Sunday by New Year's Day as a very serious matter. It is always claimed by discerning minds, as it was by the Founder of Christianity Himself, that the reason for the institution of the seventh day rest is found in the necessities of man's nature; hence, if these necessities are satisfied as well or better by the new system than by the old, the objection is answered. I have, however, recommended the adoption of the proposed calendar in a year which begins on Saturday, in order that persons who have conscientious objections to the displacement of the week, may enjoy the conveniences of the new calendar for a whole year before any displacement of days occurs, when probably their scruples will have vanished. (5) Akin to the last two points is the claim that it would interfere with the dates of the ecclesiastical festivals. In answer to this objection it may be said that just as the Church has in the past adjusted its calendar independently of the civil register, not even Pope Gregory himself hesitating to change dates in the latter, so will they continue to do so without any interference with the popular convenience. Indeed, the Hebrew race has done this in Christian lands from time immemorial.

And now I believe all the objections which have occurred to me have been noted. It remains with those interested in such matters—and who is not interested?—to say whether we shall adopt a simple, symmetrical and convenient system, such as is herein proposed, or continue to use a complex, confused and confusing system, which had its origin in a superstitious age, and developed under influences which were innocent, to a large extent, of scientific motives.

TWENTIETH MEETING.

October 13th; the President, Mr. John A. Paterson, M.A., occupied the chair.

Letters were read from Dr. G. W. Hill, of West Nyack, N.Y., and from Miss Annie McGregor, Secretary of the Tavistock Astronomical Society.

On motion of Mr. G. E. Lumsden, seconded by Mr. T. Lindsay, the Tavistock Astronomical Society was duly elected an affiliated body. The motion was carried unanimously, the members expressing pleasure at learning of the continually spreading desire to popularize the study of astronomy and physics.

The Corresponding Secretary then addressed the meeting, conveying the sad information that another death was to be recorded among the active members of the Society. Since the last meeting, Mr. J. C. Donaldson, LL. D., of Fergus, had passed away—a gentleman personally known to many of the members and very widely known throughout Ontario as a most assiduous worker in observational astronomy. It was then moved by Mr. A. Elvins, seconded by Mr. G. E. Lumsden, and

Resolved, That this Society has learned with sincere regret of the untimely death of Mr. J. C. Donaldson, LL.D., of Fergus, Ont., its first non-resident member, and that it desires to place on record its high appreciation of the merits of the deceased, who, whether as amateur astronomer, as private citizen, as professional adviser, as educationist, as member of the Public Library Board, or as promoter in others of a love of the manly out-door games and pastimes in which he himself excelled, appears to have striven to discharge his duties faithfully; and that this Society regards the disappearance of Dr. Donaldson from the ranks of its well-equipped observers as a serious loss to Canadian observational astronomy, he having been an enthusiastic, painstaking and conscientious observer, and having for some years regularly contributed weekly reports of his work to be read at its meetings; and that a copy of this resolution be transmitted to Mrs. Crawford, the sister with whom he lived, and that she be assured of this Society's respectful sympathy and condolence.

The Chairman, in putting the resolution to the meeting, paid a high tribute to the deceased, as one ever anxious, even in the midst of professional work, to advance the cause of science. The members rose to signify their sympathy with the spirit of the resolution.

Mr. Arthur Harvey read a communication from the office of the *Berlin Jahrbuch*, to the effect that this Society would be placed upon the regular exchange list.

Mr. G. G. Pursey presented his quarterly report of sun-spot observations, together with the corresponding series of sketches. Mr. Harvey read some notes on the great sun-spot group of September, 1896, and presented a carefully executed drawing of the group. Mr. Elvins called attention to the fact that it had been spectroscopically determined that the rotation of the outer layers of the Sun's atmosphere was much more rapid than that of the inner layers. The paper for the evening was a fanciful sketch of a "Trip to Mars," by Mr. Pursey, in which supposed inhabitants of the planet were "interviewed" regarding their modes of living, etc.

TWENTY-FIRST MEETING.

October 27th; Mr. E. A. Meredith, LL.D., occupied the chair.

Letters were read—from the President, who announced that Prof. J. Loudon, President of University College, had kindly consented to deliver a lecture before the Society, on "Acoustics"; from Mr. David Boyle, in further reference to the phenomenon of the double rainbow recently observed by him; from Mr. T. Gwyn Elger, acknowledging notice of election to corresponding membership and giving some valuable suggestions in regard to drawings of the lunar surface; and from Rev. J. B. Mullan, of Fergus, giving a sketch of the life and work of the late Dr. J. C. Donaldson. After the reading of the correspondence the Chairman announced that Mr. T. Lindsay would read the second and third chapters of the historical sketch on which he was now engaged, and of which the introductory chapter appeared in the *Transactions* for 1896. Following is the full text:—

HISTORICAL SKETCH OF THE GREENWICH NAUTICAL ALMANAC.—*Continued.*

II. *The Admiralty Board—Other Almanacs.*

As already said, Maskelyne was the ringleader of the plot to raise England to the dignity of a nation having its own astronomical ephemeris, and to provide for the maintenance of at least a small coterie of computers. The Act of Parliament, dealing with the whole matter, was signed in 1765 under Grenville's administration, and an extract from the Act followed the title page in all the early issues of the Almanac.

The Commissioners of Longitude, that is, the Admiralty, were given full authority "to print, publish or cause to be," etc.,—the same old style we have yet—any almanacs or tables, "in order to facilitate *the* method of discovering the longitude at sea." The method so emphasized was by observing the Moon's place among the stars, more particulars of which we will learn as our sketch goes on, for this was the main object of the Almanac.

Any publications the Commissioners had in view were copyrighted before hand by the next clause in the Act which decreed, that no other person or persons, etc., unlicensed, should publish the Almanac or tables under a penalty of £20 for each and every copy. There was no sending delegates all over the Empire to arrange a copyright in those days; there we have it just about as plain as could be wished for, in effect: "you may reproduce the Almanac, if you please, at £20 a piece." The Admiralty Board got bravely over that little failing (for we may presume it was the Board suggested it to Parliament) in later years, and now-a-days every almanac in the British Empire, that publishes astronomical data at all, copies directly without question and without comment from the *Greenwich Nautical Almanac.* So that the handful of computers with Dr. Downing at their head, supply information regarding the solar system not alone for a few thousand navigators and explorers, but for some 300 millions of people. The Board of Commissioners appointed to see the ideas of Maskelyne carried out numbered 18, their signatures appearing as follows:—

Egmont,	John Forbes,	G. B. Rodney,
John Cust,	Morton,	T. Talvisbury,
Howe,	N. Maskelyne,	P. Stephens,
Hen. Osborne,	T. Hornsby,	G. Cokburne,
Ed. Hawke,	A. Shepherd,	R. Long,
Ch. Knowles,	E. Waring,	John Ibbetson (Secretary).

A good list, truly; peers of the realm, commoners, sailors, divines, astronomers, ably represented. Egmont (John Perceval), who signs first, was the second earl of the name, appointed first Lord of the Admiralty in 1763, and a man of great talents and executive ability. He seems to have been specially noted for a dislike to all new fangled ideas about war implements, gunpowder, etc., believing in the old fashioned way of fighting, nevertheless he had a genius for spending money on dockyard improvements, which his detractors said were useless. He was, of course, a great favourite with the shipwrights, etc. The Earl of Morton (James Douglas) was another peer of great ability, the intimate friend of Colin Maclaurin, the mathematician, and one of the most active in furthering the interests of science generally, and in fitting out the Transit expedition of 1769. Then Admiral Lord Howe (appointed first Lord in 1783), who has not read of him? He was the famous "Black Dick" of the navy, the idol of the fleet, forecastle and quarter-deck; a man of action, not words, happily described by Walpole "as undaunted as a rock, and as silent."

Admiral Sir Edward Hawke, another of England's greatest sailors, succeeded Egmont as first Lord in 1766, holding the office for five years, and was created a peer on his retirement. Admiral Sir Charles Knowles, the son of the fourth Earl of Banbury, was distinguished as a mathematician and practical mechanic, not less than as a gallant sailor. He bore the reputation of being the most accomplished scholar in the navy. Then we have Admiral John Forbes, second son of the Earl of Granard; he served under Admiral Byng, and was one who stubbornly refused to sign the death warrant of that most unfortunate man. Forbes succeeded Hawke as admiral of the fleet in 1781. In Admiral Sir George B. Rodney we have another, standing prominently out on the roll of great sailors, second only to Nelson. Thos. Hornsby was the Savilian professor of astronomy at Oxford, and the founder of the Radcliffe Observatory. Dr. Shepherd was another great teacher, the Plumian professor of astronomy. In Roger Long, D.D., we have an eminent divine, a distinguished classical scholar, and the first occupant of the Lowndean chair of astronomy and geometry at Cambridge. A noble list truly, and fitting associates for Nevil Maskelyne.

The warrant bearing the signs manual of the 18 Commissioners was handed to one Mr. William Richardson, who continued to print the Almanac until 1784, issuing each volume in the regulation blue cover, no doubt quite suiting the tastes of the sea dogs who sat upon the board. We may presume that Mr. Richardson felt highly honoured at being awarded the contract to print, under the protection of such a clearly expressed copyright. To print for the Admiralty was something, but his brothers in trade, though prohibited from using the tables prepared at the Greenwich Observatory, could freely use the results reached by astronomers engaged in observational work at various centres of science in Europe and they certainly had access to Newton's *Principia*. All the bright minds in England were not included in the list of the Admiralty Board and the staff of Greenwich Observatory. Educational institutions were sending out scholars, not perhaps so many as now, but well trained in the mathematical sciences, and anxious to bring into the stock of everyday knowledge some information regarding the solar system. We have already noted that almanacs were found close following upon the work of Kepler, who first announced the laws governing the planetary motions. But in those days astrology was still a science, Kepler, indeed, himself a believer in it, and so, apart from their usefulness every day in giving the calendar, the almanacs of his time were mostly in demand among the fortune-tellers; for the positions of the Sun and the members of his family were laid down with quite sufficient exactness for determining what would happen to a man, when he would break his neck, fall heir to a legacy, marry, and such like trifles. Then knowledge began to spread, works of this kind gradually died out until we find that the book-loving people of the early part of the 18th century were in possession of almanacs recording the more noticeable celestial phenomena, giving the places of the Sun and Moon with considerable accuracy, and generally forming very fair guide books for those possessing telescopes. We say book-loving people, for in those days one must needs have been very fond of books to pay the prices necessary to obtain them. Telescopes were still rarer, of a very humble kind, and the list of objects within their grasp was not a long one, so that on the whole, an almanac need not have been an elaborate production to give very great satisfaction.

It will, of course, be understood that prior to Kepler's time there was nothing like what we understand by an astronomical ephemeris—a correct daily record of astronomical events. Calendars there were, had been from very early ages; but such astronomical data as these gave, were compiled from observations of cycle periods, not from calculations based upon geometry; moreover, between Kepler and Newton, it was still impossible to compile an exact ephemeris, because the laws which governed the pull of one body upon another had not yet been given to the world. Precise astronomical work became possible only after the publication of the *Principia*, and we know that not immediately then did it become an accomplished fact. We have seen that the world was in possession of Newton's philosophy for eighty years prior to the institution of the *Nautical Almanac*, at first thought a long lapse of time to be spent in preparation. We have to remember, however, that pure mathematics was only one of the instruments required for the construction of an accurate plan of the heavens; data to be deduced from practical observation were wanted; skilled artificers, able to fashion instruments of extreme precision, had to be found; and not least, a national sentiment had to be evolved; so that even the great almanac of France, though ante-dating the British ephemeris by nearly a century, did not in its earlier years give accurate detail in the matter of planetary motions, and was not strictly an astronomical ephemeris. It may be noted here as worthy of remembrance that Picard, of France, whose determination of the Earth's radius supplied Newton with data for his final calculations on the subject of gravitation, was the astronomer who commenced the *Connaissance de Temps.*

If, then, we describe briefly one of the almanacs in common use among the English people during the eighteenth century, it is by no means for the purpose of drawing a comparison between such works and the production of Maskelyne's genius, but merely to show what the country was accustomed to, from which we may judge how ready it was to welcome a national work from the observatory at Greenwich.

In 1704 a certain John Tipper, a schoolmaster of Coventry, conceived the idea of introducing an almanac especially for ladies, keeping clear of all the astrological nonsense that had formed the chief part of many other annuals, and instead, presenting for consideration, riddles, charades and mathematical and astronomical problems, together with household receipts, etc. He christened it the *Ladies' Diary*, and under this title the little book circulated until 1841, finally to become incorporated with another almanac. In its best days the *Diary* had a circulation of 30,000 copies, selling at ninepence per copy, about forty-eight pages. This, when it had passed into the hands of the Stationers' Company, a wealthy corporation that had published almanacs since the reign of James I., but of all kinds, astrological and otherwise.

A circulation of 30,000 was good in those days—it would not be poor now—but if that number passed out they were not all read, for one came to my hands recently with the leaves uncut. This copy of the *Diary* we have here, bears date 1769, and is dedicated in six very pretty lines to Queen Charlotte, who is held up, and no doubt justly so, as a bright example for all the other women of the time.

"Virtue and sense, with female softness joined,
(All that subdues and captivates mankind!)
In Britain's matchless fair, resplendent shine;
They rule Love's Empire by a right-divine,
Justly their charms the astonished world admires,
Whom Royal Charlotte's bright example fires."

Apart from the title page, one would hardly guess that the book was specially intended for ladies, but it is distinctly stated that the work contains "many entertaining particulars, designed for the use and diversion of the fair sex," and it is not for us—a century and a quarter later—to discredit what is there recorded, or to belittle the accomplishments of our maternal ancestors.

The *Diary* served as a calendar and gave the declination of the Sun to minutes, and time of its rising and setting; the Moon's age, phases, rising and setting, and the time when the Pleiades reached the meridian—that well-known group being referred to simply as the "seven stars." It was, therefore, somewhat like the common advertising almanac of to-day, but with that difference which we now understand: the astronomical columns were not copied from the *Nautical Almanac*. Nineteen guineas and threepence would have been rather too high a royalty to pay for that privilege. As the *Diary* indeed ante-dated the ephemeris by some sixty years, we may presume that the publishers had their own little staff of computers, capable at least of reaching the accuracy which a not too critical public would demand. In Chambers' "Book of Days," reference is made to Mr. Henry Andrews, who was a calculator employed by the Board of Longitude, and who also computed the columns for an almanac contemporary with the *Diary*. It may be worth while then to note here the names of three computers who worked on the book in question: W. Chapman, J. Coates and J. Metcalfe. These names are set against three sets of data for the transit of Venus in 1769.

If a book is to be an almanac at all—something more than a mere calendar—it must give some information regarding the solar system, whether intended for ladies or not; and we would also expect to find anniversaries, saints' days, etc., set down in their places. These we have in the *Diary*; for instance, among other interesting facts, it is set down that January 30th is the anniversary of the day when King Charles I. was, not "beheaded," or "executed," or any such vulgar expression, but "martyred." This compliment to the memory of poor

King Charles, who, I have no doubt, was not nearly so black as painted, was paid also by the Admiralty Board, and kept alive by their successors until so recently as 1862. Up to that year the 30th of January was among the special anniversaries as the day of "King Charles' martyrdom." Why they dropped it then I cannot, of course, say. An alien studying our history and character would judge that the unfortunate scion of the Stuarts was a martyr up to and including the year 1861; after that he was not a martyr, 1862 marking the year when he ceased to be so. What else could he think? There it is in black and white. And I can only hope that the Admiralty Board will again accord to King Charles I. the proud position he once occupied, and which was his due, if for no other reason than that he met his fate resignedly.

Anniversaries and the like would be interesting enough to ladies, and so too, no doubt, the information about the eclipses of the year, one of which, solar, was to be, in the language of that day very "formidable," in North America, Greenland and the "Hyperborean Ocean," the far north, the frozen sea, that had not yet began to gather in its fearful harvest of the world's best and bravest. Another was to be annular in what was then styled, and may truly yet be styled, the Terra Incognita, about the south pole. All this was interesting and useful. Then the "diversion" comes in by the way of answers to queries, riddles and problems in mathematics and astronomy that had been given the previous year. And when all that is digested, there is another set of questions for the next year, the prize mathematical problem being truly a perfect gem, "to find the solid contents of two conjugate hearts," which it was said "true lovers would have no difficulty in solving!"

If the ladies of that day were especially amused with the problems, then this higher education of women we hear so much about, is nothing new. As I said above, it would not be fair at this date to question the ability of the women of that time. But I hardly think that almanacs intended for ladies of the present age would sell very rapidly at ninepence each, the price of the *Diary*, if they were designed to bother fair heads with questions such as are in this book before us. One of them, the ladies must have considered themselves highly complimented at being presented with; this was one of the problems propounded by the famous Fermat in 1658, and according to the *Diary* had never been publicly answered: "On A B describe a semi-circle; from A and B draw A D and B C at right angles to A B and each equal to the chord of

90 degrees. Take any point E in the circumference and draw E D, cutting A B in O, and draw E C, cutting A B in V. Then the squares on A V and B O are together equal to the square on A B." I leave this problem just now, as the *Diary* did, for another year.

Then we have some questions in astronomy which could be solved by one familiar with the use of the globes, an accomplishment which, I understand, used to be taught in the old style young ladies' seminary, but which has somehow passed even outside the list of extras. Perhaps Dickens had something to do with that. He introduced the use of the globes into Mr. Squeer's curriculum, did he not? Then among the queries is a question which reminds us very much of the debating society of the present day: "Who strives the most eagerly—the good man in search of virtue, or the bad man in quest of vice?" And so on.

Such was the *Ladies' Diary*. It is really necessary to review this little book in connection with our present subject, for we wish, if possible, to get some insight into the taste of the reading public of the last century, and it is very satisfactory to find that publishers were making efforts to provide something substantial, though little at a time, and that their labors were appreciated, as they seem to have been in the case of the almanacs published by the Stationers' Company. The value of the little annual as an astronomical work was slight. The columns which gave the declination of the Sun—presumably very approximately correct—would enable one to determine the latitude of a place, using some instrument to measure meridian altitude. The Moon's phases and other phenomena were correct enough for the purposes of ordinary life; but this was all—just enough to create a demand for more.

While we cannot, of course, fix upon the very year or even decade when the desire for scientific knowledge became general in England, it is plain that it was becoming more and more pronounced all through the eighteenth century. The Commissioners of Longitude, therefore, in publishing an authoritative astronomical ephemeris, were not only providing data in convenient form for English explorers; they were laying before the educated classes at least a book, just what was wanted to appease the appetites of those who had learned that there were other intellectual pleasures than the study of Greek and Roman literature.

I hope there is no student of the natural sciences to-day who fails to see the beauty that lies crystalized in the written languages of twenty centuries past, or estimates the study of the classics at less than its real value. But we know that the English universities of a hundred years ago gave time to but little else than the study of what were truly enough styled the "humanities"; and those cultured minds, who began to yearn for something else, must have welcomed the seemingly dry pages of the *Nautical Almanac* and have experienced, as they looked upon this monument to the human intellect, just the faintest tinge of a suspicion that perhaps it was not altogether true that the "proper study of mankind is man." Perhaps the proper study of mankind was nature, and man was but an incident.

To those minds not specially interested in science, but still of sound judgment, it must have been readily apparent that pure mathematics, a science to many of meaningless symbols, had a mission, which indeed seemed about accomplished, to drag secrets from the very heart of nature. We do not mean to say that the *Nautical Almanac* itself circulated in anything like the numbers of the smaller almanacs of daily reference; but however little even it may have circulated, it became known by reputation at least, and, after its inception, books published in the interest of those seeking knowledge of astronomy fully recognized its usefulness and freely complimented the compilers on the accuracy of their work.

III. *Kepler's Problem—Gravitation.*

We are now nearly ready to take up the *Nautical Almanac* as it came from the hands of Maskelyne and proceed with description and history proper. But in order to save repetition in the descriptive part, I find it necessary to refer, once for all it may be, to a problem which, when understood, will make clear column after column of figures, and give to them, I hope, a living beauty. A recent writer on English literature, a critic of high rank says, that science is ever seeking to write in pure symbols, hence it is not comparable with what we understand by literary work. That is true, of course, in a certain sense; we cannot compare the written language of algebra, for instance, with written English. But there are symbols which convey truths to the mind in an instant which language of any other kind can never express. Such emotions as thrilled the soul of the immortal Newton in the moment when there was revealed to him the truth that every particle in the universe is linked to every other, poetry is powerless to describe; yet, what Newton looked at was the simplest of arithmetical expressions.

In the *Nautical Almanac* then science expresses itself in a language of pure symbols. You will permit me to make, at least, an effort to point out some of its beauties, while explaining the construction of the column which tells us where a planet will be to-morrow, next month, or a year hence.

We all know that the astronomers of the old world were far from correct in their notions of the system of the universe. The great Archimedes, the Newton of antiquity, knew nothing of celestial mechanics; Hipparchus, father of astronomy, an observer keen enough to note a motion so slight as the precession of the equinox, and with genius enough to invent the science of trigonometry, was widely astray in his ideas regarding the motion of the planets, and so it remained for Kepler, centuries later, to lay down the laws governing the motion of a body about the Sun. Simply, its path is an ellipse, of greater or less, or it may be no, eccentricity, and as the body wheels around, it closes in equal areas in equal times. If it moved in a circle, it is plain that equal areas would mean equal angles, but in an elliptical figure, while areas are equal, the angles differ considerably. A body then starts from some selected zero point referred to a point in space. We may imagine ourselves standing in one focus of the figure, at the Sun; we see the body wheeling round, opening out such an angle in a day, another angle another day, and so on. If we could name these angles, we would be naming the place of the planet day by day as projected on the star sphere. Tabulated, these places would give the motion of a body in its own plane about the Sun. Referred to the fundamental plane, the ecliptic, the places are given in the column, "Heliocentric Longitude." This is the principal column in the ephemeris, and its construction involves a solution of Kepler's problem.

I do not propose to carry you through all the details of the problem; it is merely an outline of the method of solution that I wish to call your attention to.

[Illustrating by diagrams, Mr. Lindsay here briefly reviewed the chapter in Newcomb & Holden's Astronomy dealing with Kepler's problem and leading up to the equation :

$$u - e \sin u = 2 \pi \frac{t}{T}$$

where e is the eccentricity of the orbit; u the eccentric anomaly; π the ratio of circumference to diameter; T the periodic time, and t the time elapsed since perihelion passage. It was shown that this equation is transcendental, and references were made to various methods of solution, more or less rigorous. Continuing, the further analysis was sketched, leading up to the formula for the true anomaly, or angular distance from perihelion.

$$\tan f = \frac{\sqrt{1 - e^2} \sin u}{\cos u - e}.$$

It was added that the amateur would always be able to solve Kepler's equation by the method of successive approximations.]

Now, so far, we are dealing with geometric truths. This formula would be true if there never had been a figure drawn in illustration; if there never had been a hand to draw one, or a mind to conceive of one; if there had never existed space in which it might be drawn or conceived of; nay, further, if the whole universe lay, potential, in an atom, then bound up in that atom this truth would also be. Nothing we can conceive of could make it untrue—it stands before us as absolute truth symbolized. This is the nature of all geometric truths. They tell man nothing of his relation to the universe; nothing of arguments for or against design; nothing of destiny. The metaphysician may imagine a time when there was no eternity, a time when eternity will end; let him do so if it pleases him—he cannot imagine a time when geometric truths did not exist.

But look at this figure again. In the point marking the focus we find a massive body controlling the motion of another which moves upon the curve. This other obeys a law which bids it follow a certain path, and we are no longer dealing with the abstract truths of geometry, but with a physical reality. The figure now seems a thing of life. It is no more to be imagined as a geometric line—a concept only. It is the path of a body rushing through space, feeling and obeying the bond of gravitation; and there is forced upon us the sublime truth that here is will—some will—acting upon matter; some will decreeing that inert matter shall obey a certain law. We know it remained for Newton to prove that if the law of gravitation were true, then a body free to move about a centre of revolution would trace out this curve or one having the same properties, and must trace it out by equal areas in equal times. And thus we express the results of the law of gravitation—the will of the Creator—in a language of pure symbols. This is the language of the ephemeris.

On contemplating the mystery of gravitation itself, I feel drawn to the conclusion that a solution is not for man while his mind is encased in an earthly tenement. I am aware that a contrary idea is often enough expressed, justified apparently by the immense strides science has made in recent times. But on examining the evidence in favor of a possible final solution, we seem to see connecting problems continually increasing—problems that must first be solved as introductory.

I will never forget a simple expression which fell from Mr. Elvin's lips on one occasion when we were discussing the admittedly beautiful vortex ring theory of the constitution of matter, as enunciated, hypothetically of course, by Lord Kelvin: "Vortex rings they may be, but vortex rings of what?" And I believe that the discoveries of Röentgen, now known all over the civilized world, and giving a remarkable impetus to scientific investigation, have only thrown another barrier in the way of advance to a knowledge of the ultimate. This idea is beautifully expressed in a recent number of *Science* by the editor, Prof. Cattell: "The more we enlarge our little sphere, the greater is the surface at which our knowledge touches our ignorance. The more we learn, the greater is the area immediately awaiting exploration."

Then the question: Are we ever to know? Is the mind ever to be freed from its gross environment, to pass into the presence of the Infinite, the source of all knowledge, or must it perish with the clay that imprisons it? Is the mind that reaches out to the very confines of space to read what is written there, at the mercy of a sudden chill on a wintry night, a slight cough, neglected, worse, and all is over? The glorious dead—the uttering of whose very names thrills us with emotion—do they now revel in the glories of the unseen universe, knowing now truly whence the great First Cause? or, have they ceased to be?

"If all is silence, darkness—yet 'tis rest."

"Darkness!" What vision is here conjured up? We have no words in our language to describe, no power of imagination to conceive of a future so black as that. Rather than believe that the great minds, whose work we love to dwell upon, have passed into nothingness, I would believe that they are literally with us yet. You will remember our Vice-President addressing us once on the Pythagorean astronomy and closing thus quaintly: "Who knows but that Pythagoras redivivus is our secretary to-night?" Rather than believe in annihilation, I would borrow that quaint conceit and cling to it as a tenet of faith; and believe that, wherever there may be a gathering of the humblest lovers of nature, the President's call to order is an incantation, summoning some great spirit—it may be of the immortal Newton himself—to scenes such as he had loved so well.

Calmly, dispassionately, we must impeach the honesty of the one, professing to be a student of nature, who would draw a picture of blackness beyond; or if honest he be, then he has failed to read aright the tokens that surround him—the chord that should respond to the voice of nature either is in him tuneless, or exists not. We have looked upon pretty pictures and attractive modellings, freely admiring, but soon forgetting; then some day we see the touch of a master hand—we cannot describe it, but now we know the meaning of the words, "genius in art." We have enjoyed the tuneful rhythm of elegant verses and admired their faultless style, only to forget. Then one day we hear the simple trilling of some poet, appealing to the soul, and we know it is the heart that sings. And is there not something like this in the world of science, in the realm of pure symbols? Is there not a soul in philosophy, passing out and into nature's laboratory, and conscious of its oneness with the beauties there revealed? Even Byron, misanthrope perhaps, out of the depths of his saddened soul could sing, in contemplating the beautiful around him:—

> "I love not man the less, but Nature more,
> From these our interviews, in which I steal
> From all I may be, or have been before,
> To mingle with the Universe, and feel
> What I can ne'er express, yet cannot all conceal."

TWENTY-SECOND MEETING.

November 10th; the President, Mr. John A. Paterson, M.A., occupied the chair.

Cordial letters were read from Dr. J. A. Brashear and from Dr. G. W. Hill.

Mrs. Warren and Mr. S. D. Caswell, of Toronto, were duly elected active members of the Society.

Mr. Arthur Harvey and Mr. G. G. Pursey reported their observations in solar work, the latter presenting sketches of some of the more noticeable sun-spots. Mr. R. F. Stupart, in the course of a discussion regarding the significance of solar phenomena, stated that during his recent visit to England he had learned that the observers at Greenwich attach less importance to the position of sun-spots than to the total area covered by them. Mr. A. F. Miller remarked that he had frequently noted, when there was a great outbreak in one hemisphere of the Sun, an almost immediately following outburst in the other hemisphere. Mr. J. G. Ridout read some notes of the positions of the planets during November, and called the attention of observers to the minimum of Algol, to occur on November 30th at 9h. 16m.

Mrs. Savigny stated that several friends had asked for copies of the calendar, illustrating the reforms proposed by Dr. A. D. Watson, and which had met with very great favour.

The Chairman then announced that Mr. A. F. Hunter, M.A., of Barrie, would read a paper on

APPLICATIONS OF THE POLARIZATION OF LIGHT.

The paper was illustrated by successful experiments with microscope and polariscope. The text of Mr. Hunter's remarks follows :—

The epoch-making experiments of Hertz on electrical waves, the phenomena of X-rays, the discovery a few months ago by M. Becquerel of another kind of invisible radiation, and other interesting advances in the domain of radiant energy, have recently increased the value of polarization as a means of research. It is necessary, therefore, that we should keep its principles well in the front rank of our working methods.

The word " polarization " is a legacy from the old emission theory of light, whose disciples believed that each light corpuscle had poles and could thereby be rotated almost at will. Under the wave theory, however, this word has a very different meaning, not suggested by its literal sense.

Definition of Plane-Polarized Light.—In ordinary light, the ether particles vibrate in elliptic paths transversely to the line of propagation, the motion being transmitted from one particle to another by means of their mutual attractions. This elliptic motion of an ether particle can be resolved into its component motions in two rectangular directions. (The illustration generally used is that of the pendulum. The driving-wheel of any steam-engine is also a familiar example of compound motion.) If we could separate these two rectilinear motions in any way, each of them would produce plane-polarized light; that is, all ether particles would vibrate parallel to a fixed plane. A large number of crystals are capable of thus separating these two motions of the ether particles, thereby producing double refractions, which are the resulting phenomena. Each motion is competent to excite vision, such that neither can be distinguished from ordinary light by the eye without the aid of instruments.

Double Refraction.—There are two methods generally used to obtain polarized light; double refraction and ordinary reflexion. Crystalline substances, or anything which has not uniform structure in all directions, have the property just mentioned of separating a compound motion of the ether particles into two simple, rectangular motions. Of the latter class, unannealed glass, and most organic substances, in which the grouping of the atoms causes the ether within them to have different densities in different directions, are double-refracting.

There are two important changes effected by sending a ray of ordinary parallel light through a crystal of Iceland spar or any double-refracting substance:

1. Two images are produced, on account of the change of velocity of the light in two directions.
2. In the two new rays thus produced, called the *ordinary* and the *extraordinary*, the ether particles vibrate in different directions, both rays consisting of plane-polarized light, instead of the elliptical light of the original ray.

As to the first of these results, viz., the production of two images, the amount of refraction which the parallel light undergoes depends entirely on its change of velocity after entering the crystal. And as in the crystal, whose molecular structure is not uniform in all directions, there are two capacities of transmitting the light, there will accordingly be two refractions and therefore two images.

The action of tourmaline affords an opportunity of studying the second change, viz., the direction of vibration of the ether particles in both rays.

Tourmalines were used for a long time with remarkable success, though defective for chromatic work on account of their green colouration, until they were superseded by Nicol's invention of the polarizing prism. This is constructed by cutting a crystal of Iceland spar in an angular direction, polishing the severed surfaces, and reuniting them again by Canada balsam.

The ordinary ray (index 1·65) strikes so obliquely upon the surface of the Canada balsam (index 1·53) that it cannot penetrate it, but undergoes complete reflexion. Two of these prisms form a polariscope, one being called the *polarizer*, the other the *analyzer*.

Tourmalines and Nicol prisms are used in general work because they get rid of one of the rays (the ordinary) thereby assuring freedom from confusion, which would certainly arise if we had four rays in our experiments. The single ray which *does* emerge from either prism is, however, plane-polarized.

Polarization by Reflexion.—When a beam of light is reflected from any surface except a metallic one, a portion of the reflected light is polarized. This method of polarization, however, cannot be dwelt upon in the time at our disposal. Suffice to say that under this heading falls the polarization of light by scattering from small particles. The blue of the sky is largely polarized light. The light emitted by the corona and from comets also contains a portion of polarized light, which a polariscope detects, showing that it is reflected.

Application to the Colours of Thin Crystals.—If a thin plate of selenite be introduced between the polarizer and the analyzer, two directions of vibration will be produced. One ray will fall behind the other, the selenite being double-refracting. When these directions of vibration correspond with the directions of vibration in both polarizer and analyzer, no light will pass through.

At all other times, when the directions of vibration produced by the selenite are oblique to the directions in the polarizer and analyzer, light *will* pass through. But in this case the light is coloured—a phenomenon which may be explained by the principle of interference.

What takes place is this: the beam of light is polarized by the first Nicol or polarizer; that is, the ether particles are made to vibrate parallel to a fixed plane. These rectilinear vibrations are resolved by the selenite into two other beams whose vibrations are at right angles to each other, and which also take a difference of phase depending on the nature and thickness of the crystal. In other words, one ray is retarded with respect to the other, and they emerge from the selenite in this condition. The second Nicol then resolves the vibrations into another plane, and in doing so combines them so as to produce colours by their interference, those rays interfering (when the analyzer is in a certain position) which are retarded by a whole wave-length, and likewise those interfering (when the analyzer is at right angles to its former position) which are retarded by half a wave-length.

What the analyzer does is to destroy certain waves of a particular length; that is, a certain colour; and the remaining colours of the spectrum are left to produce the composite colour which we see. If this coloured light which emerges from the analyzer be examined by a spectroscope, the spectrum would show a single dark band indicating an extinguished colour. For a complete revolution of the analyzer two colours will be twice produced, one being complementary to the other.

Other Applications of Polarization.—Nichols and Snow have recently found that the power of calcite to polarize light varies even within the range of the visible spectrum. In the Presidential address to the Mathematical and Physical section of the British Association last September, Prof. J. J. Thomson also laid stress on this feature of the relative powers of different polarizers. He pointed out that a bird cage will polarize long electrical waves. Mr. Chant showed this by means of a gridiron of copper wires in some interesting experiments on electrical waves before the Society last year. Rubens and Dubois made a wire polarizer for infra-red rays; while, on the other hand, tourmaline has hitherto proved too coarse to polarize the Röentgen rays. Notwithstanding this disability or limit to the range of any polarizer, the method of polarization is increasing in practical usefulness. It is now used to detect irregularities of strain in transparent substances such as telescopic lenses. It is also used extensively in the chemistry of sugars and other organic substances, and we have already referred to the use of the polariscope to examine the nature of the light from comets and the corona.

On the conclusion of the paper the cordial thanks of the meeting were tendered to Mr. Hunter, who had taken special pains to illustrate the subject. Mr. Miller recalled pleasant evenings spent with Mr. Hunter before the Society became incorporated, while it was merely a gathering of a few friends endeavouring to inculcate a love for the study of the physical sciences.

TWENTY-THIRD MEETING.

November 24th; the President, Mr. John A. Paterson, M.A., occupied the chair.

Mrs. Ireland, of Toronto, was duly elected an active member of the Society.

A communication was received from the Paris Observatory, announcing the death of Prof. Tisserand, one of the most distinguished of the world's astronomers. The Secretary was requested to forward to the relatives of the deceased an expression of the Society's sympathy.

A cordial letter was read from Prof. W. W. Payne, editor of *Popular Astronomy*, announcing his willingness to meet the views of some members of the Society, who had asked for certain additions to the already valuable matter contained in the journal. Mr. T. S. H. Shearman, of Brantford, wrote in reference to the reported views of the Greenwich astronomers regarding the significance of solar phenomena. Mr. Shearmen thought that position had much to do with the effect of sun-spots on terrestrial magnetic conditions. Dr. J. J. Wadsworth wrote encouragingly of progress in lunar work. He had induced two ladies to attempt drawing some of the ring-plains, etc.; they had tried Clavius, Straight Wall, and Sinus Iridium with promising success, considering the novelty of the work. Both the ladies were skilled in artistic drawing, and Dr. Wadsworth had hopes of good results; he thought sketching of this kind was a work for which ladies were specially adapted.

The Librarian reported having received from Mr. A. Elvins a complete set of the third edition of the *Encyclopedia Britannica*, a most valuable addition to the Library, containing as it does an epitome of all that was known of science just one hundred years ago. The thanks of the Society were specially due to Mr. Elvins.

Mr. G. G. Pursey reported observations of sun-spots and faculæ on 17th, 18th and 22nd of November. Mr. G. E. Lumsden presented a sketch of Aristarchus, made on a particularly favourable night.

Dr. A. D. Watson read some notes on the grading of the thermometer. He stated that physicists generally had expressed dissatisfaction with the present method of registration. The scale now proposed was one beginning with the boiling point of chlorine as the zero on both Fahrenheit and centigrade. The effect of this would be that minus readings would be rare, in meteorology very rare, as there are few centres of observation where the register is ever so low as 50 degrees below the centigrade zero, where chlorine boils. Corresponding to this point is 58 degrees below the Fahrenheit zero. In the changed scale the freezing point of water would be centigrade 100°, Fahrenheit 90°, and the boiling point of water respectively 300° and 270°; so that a degree of Fahrenheit would be nine-tenths of a degree centigrade, and the two, therefore, easily interchangeable, if both continued to be adopted. Dr. Watson's proposal was introduced for the purpose of simplification, and was intended to evoke discussion that might eventually lead to some change.

TWENTY-FOURTH MEETING.

December 8th; Mr. A. Elvins occupied the chair.

Communications were received from the Secretary of the Royal Astronomical Society; the Secretary of the War Department of the United States; the editor of *Popular Astronomy*, and the Secretary of the Paris Observatory.

The Librarian reported the receipt of the early volumes of the *Sidereal Messenger*, wanting to complete the set in the Society's Library. These volumes had been kindly donated by Prof. W. W. Payne, to whom the thanks of the Society were specially due. Mrs. J. Fletcher presented a copy of a magazine containing reproductions of figures produced by sound waves, and introduced the subject as one of very great interest. It was decided to devote an evening to the science of acoustics generally at the earliest opportunity.

At the request of several members the article on the planet Venus, as observed at the Lowell Observatory and published in *Popular Astronomy*, was read by the Secretary. Mr. Lumsden had drawn on the blackboard copies of the sketches which accompanied the article. A discussion followed, in which several members took part. Mr. D. G. Ross called attention to what seemed to him an insoluble mystery, namely, the fact that by one set of first-class observers, with a telescope of the highest excellence, certain conclusions are drawn from observation which are flatly contradicted by another set of observers, with even a more powerful telescope at their service. Mr. Lindsay thought that Mr.

Ross was right, more than right, in calling this state of affairs a mystery. Mr. Elvins, however, reminded the members of many instances where one observer, with full confidence in himself, had yet failed to see what another most certainly did see. Mr. Lindsay then asked a few minutes' indulgence, and briefly reviewed the mathematical work of the late Prof. Coakley, who had held it to be extremely unlikely that Venus did not rotate on its axis as the Earth does. The Lowell observers seemed to have determined that the rotation period was co-incident with the revolution about the Sun. It had been shown that the gravitational influence of the Sun on Venus, tending to elongate its diameter and retard its rotation, was very much less than the force exerted by the Earth on the Moon, and which had, according to the tidal action theory, slowed down the rotation of our satellite. Mr. Lindsay expressed himself as believing that the planet did rotate in short period, notwithstanding the reports from the Lowell Observatory.

By special request Mr. R. F. Stupart, Superintendent of the Meteorological Service of Canada, gave a brief but most interesting account of the International Meteorological Conference, which was held in Paris between 17th and 23rd September, 1896.

There were present at the Conference: MM. Angot, Paris; Anguiano, Mexico; Baillaud, Toulouse; von Bezold, Prussia; Biese, Finland; Billwiller, Switzerland; Ellis, Greenwich; Erk, Bavaria; Finea, Perpignan; Hepites, Roumania; Hergesell, Alsace-Lorraine; Hildebrandsson, Sweden; Jaubert, Paris; Kesslitz, Pola; Konkoly, Hungary; Lancaster, Belgium; Mascart, France; Mohn, Norway; Moreaux, Parc Saint Maur; Neumayer, Germany; Paulsen, Denmark; Riggenbach, Bale; van Rijekevorsel, Netherlands; Rotch, Harvard and Blue Hill Observatories; Rykstcheff, Russia; Scott, Great Britain; Schmitt, Stuttgart; Snellen, Netherlands; Stupart, Canada; Symons, London; Tacchini, Italy; Teiserenc de Bort, Paris; Thévenet, Algeria; Watzoff, Bulgaria; Wragge, Queensland, Australia. The following guests were admitted to the meeting as specialists: MM. Dufour, Lausanne; Page, United States Hydrographic Office, Washington; Tolnay, Budapest; Rücker, London; Becquerel, Fron, Chauveau, Mathias, and de Fonville, Paris.

A programme of questions had been prepared for the meeting, and sub-committees were appointed to consider the various questions relating to cloud observations, terrestrial magnetism, atmospheric electricity, etc., and report to the Conference. Amongst questions considered was one which Mr. Stupart thought would particularly interest members of the Society, as it related to Earth currents. The following resolution was passed, that "It is important to develop the study of Earth currents. This investigation, like that of magnetic phenomena, should only be taken in the open country, distant from industrial electric installations."

Mr. Stupart described the Bureau Central Meteorologique, the meteorological and magnetical observatory at Parc Saint Maur, and the private observatory of M. Teiserenc de Bort, near Versailles; also the municipal meteorological observing stations at Mont Souris and Tour St. Jacques. He considered the general equipment of meteorological observing stations on the Continent superior to that in Canada, inasmuch as many more self-recording instruments are used. He hoped, however, that this reproach would soon be a thing of the past, and in speaking of the general work performed by the Canadian Service, stated that the Canadian success in forecasting was greater than that obtained in Europe.

On returning to England several days were spent in visiting the observatories at Greenwich and Kew. The description given by Mr. Stupart of these famed observatories was particularly interesting to the members present. On the conclusion of his address, Mr. Stupart presented to the Library of the Society a portfolio of cloud photographs made at Zurich, and which were considered a most valuable addition to the Society's collection.

TWENTY-FIFTH MEETING.

December 22nd; the President, Mr. John A. Paterson, occupied the chair.

Letters were read from Dr. J. A. Brashear, of Allegheny, and from Mr. H. Harrison, of Jersey City.

It had been announced that the officers for the ensuing year would be nominated at this meeting. Mr. A. Elvins addressed the chair with special reference to this matter; he thought that the best interests of the Society would be served by making no change in the roll for 1897, and formally moved, seconded by Mr. Z. M. Collins, that the officers of 1896 be nominated for another year. This was carried.

The attendance being below the average, on account of the very severe weather, a paper prepared by Mr. G. E. Lumsden was postponed until the next meeting, and the evening was spent in a discussion of the various plans which had been from time to time proposed, for rendering the Society still more prosperous and its work still more effective.

SEVENTH ANNUAL MEETING.

The Seventh Annual Meeting was held January 5th, 1897. The Vice-President, Mr. Arthur Harvey, F.R.S.C., occupied the chair.

Miss M. T. Scott, of Toronto, was duly elected an active member; and Mr. Henry Harrison, of Jersey City, N.J., an associate member.

The Chairman declared the officers of 1896 elected to continue in office during 1897, there being no other nominations.

Mr. James Todhunter then read the following

TREASURER'S REPORT FOR YEAR ENDING 31ST DECEMBER, 1896.

Receipts:	
Balance on hand January 2, 1896	$351 59
Fees Collected	103 00
Interest, etc.	6 18
Provincial Grant	200 00
	$660 77
Disbursements:	
Publication Account	$204 70
Sundry Expenses	161 84
Cash in Bank	294 23
	$660 77

In submitting a statement of receipts and disbursements for the year just ended, the seventh of our history as an incorporated body, it has been deemed advisable to present to the members and friends interested in the progress of science in Canada a brief statement of our financial affairs. The Provincial Government has dealt with us in the same liberal way as in former years, but the growth of the Society has been such as to render the annual grant inadequate to permit of the effectively carrying out of our aims and objects. Amongst these are the possession of instrumental equipment for observations and for research in experimental science; the purchase of additions to the Library, and the creation of a fund which may eventually enable us to undertake the establishment of a popular observatory in Toronto.

While in the past our income from members' subscriptions has been sufficient to meet incidental and clerical expenses, the necessity of which latter the growth of the Society's work has necessitated, it is a matter of regret that the receipts from the same source have this year been inadequate to meet the demands, so that while the Government grant may cover the cost of publication for 1896, it is quite necessary that we make an effort in some way to increase our paying membership this year. We have had ten new members during the past year, and have now about 110 active members on the roll, many of whom, however, do not come to our meetings and are also allowing their fees to get into arrears. If we could have some way of reaching such either by circular or otherwise we might be able to induce them to take a greater interest in the Society and attend the meetings more regularly. We have had a number of very valuable books, etc., presented to the Library during the past year by members and friends, whose names have been recorded in the minutes of the Society from time to time.

JAMES TODHUNTER,

31st December, 1896. *Treasurer.*

The financial statement having been duly certified to by the Auditors, it was on motion adopted.

Mr. W. B. Musson then read the following

LIBRARIAN'S REPORT.

MR. PRESIDENT,—In presenting this annual report, I would draw attention to the fact that, not the least important work being done by this Society is the collection and preservation of a valuable and ever increasing library upon those subjects, the study of which, it is the special object of the Society to promote. For this Library we have been mainly indebted in the past to the generosity of friends and to the courtesy of those observatories and societies whose publications we have received. It is suggested, however, that in addition to this a certain proportion of the Society's funds should be annually appropriated for the purchase of such books or periodicals as may be deemed advisable, and I trust this matter may be taken into consideration. It is to be regretted that we are not yet in a position to incur the expense of a completely equipped reading room with an attendant in charge, but this difficulty has been overcome as far as possible by an arrangement allowing members, under certain conditions, access to the book shelves for purposes of reference, and I am glad to say that in the matter of accommodation we are in a much better position than formerly, a separate room having been secured for a Library and furnished with tables, chairs and writing materials.

A partial catalogue of books was prepared for use of members, and a limited number of copies distributed, in addition to which a subject index—as complete as circumstances would allow—has been placed in the Library for reference. It is regretted that, both in regard to indexing and printed catalogues, it has been impossible to make the work as complete as could be desired, but I trust this defect may be remedied with the growth of the Society.

Since the beginning of the year there have been bound some forty-three volumes, including such repairing as was found necessary. The Library now numbers over 300 volumes, consisting of works on physics, general and mathematical astronomy, and scientific instruments, in addition to the following publications:—

Greenwich Observations.
Washington Observations.
Publications of the Lick Observatory.
" " Harvard College Observatory.
" " Yerkes "
" " Yale College "
" " Columbia College "
" " Carlton " "
" " Cincinnati "
" " U. S. Naval "
" " Toronto Magnetic "
" " Paris "
The British Nautical Almanac.
The American " "
The Atlantic Coasters' Nautical Almanac.
The Pacific " " "
The Monthly Weather Review.
Iowa Weather and Crop Service.
Proceedings, British Astronomical Association.
" Royal Astronomical Society.
" Royal Society, London.

Proceedings Royal Society, Edinburgh.
" " " Canada.
Astronomical Society of the Pacific.
Astronomical Society, Wales.
Leeds Astronomical Society.
New York Academy Sciences.
Wisconsin Academy of Sciences.
Nova Scotia Institute.
Canadian Institute.
Hamilton Association.
Smithsonian Institution.
Italian Society of Spectroscopists.

Of periodical literature we have :—

The Sidereal Messenger.
Astronomy and Astro-Physics.
Astro-Physical Journal.
Astronomical Register.
Knowledge.
The Observer.
Science.
Science Siftings.

To the above should be added a large number of monographs on astronomical subjects.

The number of books and magazines borrowed during the year has been about 100.

Before closing this report, I desire to express my obligation to the Corresponding Secretary for the very willing assistance he has given me in regard to correspondence connected with Library matters ; and also to Mr. J. R. Collins, for assistance rendered in various ways.

W. B. Musson,
Librarian.

On motion, the Librarian's report was adopted.

The Corresponding Secretary then briefly reviewed the correspondence carried on during the year with friends of the Society in various parts of the world.

The business being concluded, reports of observational work were received from several members and correspondents, after which Mr. G. E. Lumsden presented a paper on "Scientific Terminology," which evoked a most interesting discusion. It was strongly held that it is not necessary to introduce into the language of science words which are almost purely Greek or Latin. Without in any way regarding lightly the studying of the classics, Mr. Lumsden still thought that the English language was rich enough to meet all the requirements of science. Some of the members were opposed to this view, but the paper had some strong supporters, especially when it touched upon the science of botany.

On the conclusion of the discussion it was announced that the next meeting would be specially convened for the purpose of hearing the annual address of the President, and the proceedings of the year 1896 were brought to a close by adjournment.

[*Address delivered before The Astronomical and Physical Society of Toronto in the Lecture Room of the Technical School, January 19th, 1897, by the President, Mr. John A. Paterson, M.A. Mr. Arthur Harvey, F.R.S.C., Vice-President, occupied the chair.*]

I stand here to acknowledge with pardonable pride your goodness in electing me to the Presidential chair for a second term. You have seen fit to express your appreciation of my interest in the welfare of this Society by again endowing me with the purple of office. Appreciation so gracefully expressed on your part deserves thanks as gracefully expressed on my part; my words should therefore be more than usually happy, and my feelings conveyed with more than usual expressiveness. Kindness, it is said, is a language which the dumb can speak and the deaf can understand; but when this language passes from you, who are not dumb, to me, who is not deaf, then the mutual expressiveness must be all the more intense. Let me say, in the words put by Shakespeare into the mouth of Sebastian in the "Twelfth Night":—

> "I can *no* other answer make but thanks,
> And thanks, and ever thanks! and oft' good turns
> Are shuffled off with such uncurrent pay,
> But were my worth, as is my conscience, firm
> You should find better dealing",

and with this let the personality of your President vanish. The gift of being eloquently silent is one rarely attained to, and still more rarely exercised.

Since last we reviewed the astronomical record of a year, scientific Truth has planted Her foot farther on, and has marked as Her conquest something more out of the vast infinitude of the problems that stand like an army of stony Sphinxes and erect a forbidding front to Her forward progress. But building splendid palaces of discovery from bricks fashioned from the sand sifted on the shore of that yet undiscovered Ocean of Truth, is long and laborious. Ptolemy built a complex theory of cycles and epicycles that the world believed for 1,400 years; but what seemed a palace turned out to be a mere house of cards, and the labours of years crumbled to pieces when Truth spoke through Copernicus. Kepler, the legislator of the sky, persevered for years, and after a most laborious analysis produced his famous laws, and thus reared a palace more brilliant than brass, and more enduring than marble, because Truth dwelt therein. The astronomers of this age are either Ptolemys or Keplers—they are building either on the sand or on the rock. Many mighty truths have been discovered by some happy accident; they have leaped like Minerva fully armed from Jove's head. Others have been dragged forth from their crypts by some reach of genius, while others—most others—have been worked out by laborious application from some small beginning. The discoveries of Newton, Laplace and Adams bear me witness of that. Discoverers have sometimes lighted on some tiny rill trickling along the barren expanses of years, and thinking it truth they have rejoiced; but ere long it has become lost in the sand and left them wondering much and wandering more. While some other tiny rill has become the happy tributary of the river of Truth, or mayhap itself, swollen by numerous tributaries, has become a very Danube or St. Lawrence—the proud highway of whole kingdoms and continents of knowledge and philosophy. In this age of astronomical and physical research how many vanishing rills do we follow, or how many broad and ever broadening tributaries? and how often does real discovery sweep on like some mighty Mississippi? A great painter was asked which he regarded as his greatest painting; he answered, "The one I am about to paint." He grew from more to more. I ask "Which is the greatest discovery of astronomy?" and I answer, "The discovery that is about to be made." This science grows, too, from more to more; the ocean of triumphant progress is illimitable. There stands no high terminating pillar marked "*ne plus ultra;*" discovery will never proclaim any proud period and her work accomplished. The Empire of Force has been—the Empire of Thought is now with us—the triumphs of the one vanish, they are only victories—the triumphs of the other endure, they are conquests. The ploughshare of physical force has been driven over this planet from the time of Xerxes to that of Bonaparte, and the Earth divisions they made have all been blotted out over and over again, and their throne-machinery and kingdom-making have vanished. Not so the work of the world's great thinkers, and scholars, and scientists—that still stands. The La Places, the Newtons, the Herschels, who by their mighty calculus conquered the problems of the heavens, live yet, and their works yet do praise them. I cannot forbear remembering how well and how beautifully Carlyle expresses this thought. "When Tamerlane," he says, "had finished building his pyramid of 70,000 human skulls, and was seen standing at the gate of Damascus, glittering in steel with his battle-axe on his shoulder, till his fierce hosts filed out to new victories and new carnage, the pale onlooker might have fancied that Nature was in her death throes, for havoc and despair had taken possession of the Earth, the sun of manhood seemed setting in blood. Yet it might be on that very gala-day of Tamerlane's, a little boy was playing nine-pins on the streets of Mentz whose history was more important to men than that of twenty Tamerlanes. The Tartar Khan with his shaggy demons of the wilderness passed away like a whirlwind, to be forgotten forever, but that German artizan has wrought a benefit which is yet immeasurably expanding itself and will continue to expand itself through all centuries and through all times. What are the conquests and expeditions of the whole corporation of captains from Walter the Penniless to Napoleon Bonaparte compared with these movable types of Johannes Faust? Truly it is a mortifying thing for your conqueror to reflect how perishable is the metal which he hammers with such violence, how the kind Earth will soon shroud up his bloody footprints, and all that he achieved and skilfully piled together will be but like his own canvas city of a camp—this evening loud with life—to-morrow all struck and vanished—a few earth pits and heaps of straw!"

And thus it is, that although the corridors of time may re-echo with the clang and clash of broils and battles, and the men of that neighbourhood and of that epoch may hear them, yet not by material, but by mental and moral power are worlds governed and nations moulded. Thought is noiseless and moral power is gentle, but oh! how mighty and how all pervading. It is the dynamics of the intellect and of the heart that after all moves, and compels and lives.

We are here assembled to-night to search for and to gather together what the servants and handmaidens of astronomy—this gentle Queen of the Sciences—have done for her during the year just closed,—what progress has been made, what victory achieved, what error unmasked and what truth revealed—and not only all that, but more—what problems remain yet to be solved.

But before reaching far, let me speak of our own Society, not because it is the most important, for it is indeed far from that; both modesty and truthfulness compel me to that statement—but simply because it is our own—in Homeric phraseology, it is, though a little one, yet a dear one—ολιγον τε φιλον τε.

The Royal Astronomical Society of London publishes this notice in its *Transactions:* "The attention of Fellows is called to the fact that ladies are only admitted to the ordinary evening meetings of the Society *by special invitation of the President, sanctioned by the Council.* The invitations are issued at the commencement of each session." I am happy to say that we, in this Toronto Society, have no such haughty rule of exclusiveness. This Society is open to both gentlemen and ladies. We require no test of erudition, no scientific reputation, but only a sincere love for Urania, and an earnest desire to know her better and offer some devout acknowledgment at her shrine. None of us are professionals; we are at the best merely humble seekers for Truth; we feel honoured by touching the hem of Her garment, and it must not be supposed that what we do here is to attract the attention of astronomers, but it is rather to instruct each other, to make the rough places smooth and the high places low. Therefore do not let us be backward in preparing and reading papers; you need not know the calculus, not even quadratics, and what you write or say may be for that reason all the more interesting and useful.

The Astronomical Society of the Pacific is a very famous Society. It comprehends in its 398 members such eminent astronomers as Holden, Schaeberle, Perrine and Campbell (who have made the Lick Observatory famous), Garrett P. Serviss, Burchkalter, Prof. Weiner of the Imperial Observatory, Prague, the Earl of Rosse, E. P. Crossley, and Miss E. Brown, the Directrix of the Sun-section of the British Astronomical Association, and even a gentleman of our own Ottawa. But notwithstanding this magnificent roll call, I find that its President did, on the occasion of his last annual address, gently chide the members in not being sufficiently active and co-operative in the work and purpose of this great Society. It may be some comfort to know that the votaries of science in the great Golden State are so unobtrusive and shrink so much from the fierce sunlight of publicity that they creep within the shadow of Mount Hamilton and the great observatory that crowns its crest, and for so doing attract the criticism of their President. They may be resting on the splendid reputation of their observatory, the greatest and most splendidly equipped in the world; but bear in mind that we have yet to lay the foundations of our observatory, and do not, therefore, lag or faint in the preparation for that building yet to be. If it ever is to be, it will lie with this Society and its friends to stimulate the public mind and prompt the public and private purse to take some forward step that Ontario may hold her proper place in the ranks of that glorious battalion of astronomers and physicists that ever battle for the conquest of those secrets that our good Mother Nature so jealously hides. Now what work have we ourselves done? Surveyor-General Deville, in the prosecution of the great work of fixing the boundary line in the far North-West, devised an instrument to largely reduce the work of triangulation and lay off the country with more accuracy. The execution of this design he intrusted to one of our members, Mr. James Foster, which he executed with remarkable success. The Collins brothers have proved their ability in the figuring and polishing of parabolic mirrors for reflecting telescopes, and recently they have invented a telescope of an entirely new design, which will attain a maximum result at a minimum cost, measuring only half the length of the ordinary design, bearing at the same time the same magnifying power and possessing the virtue of achromatism by the use of two lenses, both of crown glass. By changing the relative position of the chief lenses the achromatism can be under-corrected or over-corrected. A short achromatic telescope with two lenses of the same material sounds like an impossibility. We have three members, Messrs. Elvins, Lumsden and Dr. Wadsworth, who map out most sedulously and systematically certain portions of the Moon's disc; while another, Mr. Pursey, watches and most carefully records day by day the wonderful panorama of sun-spots with the attendant phenomena. Others too numerous to mention contribute most valuable matter to astronomical journals, English and American, or bring to us at our fortnightly meetings valuable papers, or enliven with point and value our order of business, entitled "Notes and Queries," and not the least distinguished of these, Mr. Chairman, is yourself. While another of our officers of daring ambition has, in the city or in Provincial towns, been actually caught open-mouthed in the hazardous performance of delivering addresses on astronomy.

The study of Earth currents of electricity under the charge of our Vice-President, R. F. Stupart, the Superintendent of the observatory, is still continued. Its object is to discern what connection (if any) exists between Earth currents and magnetic currents. Each week during the past year reports of the Earth currents registered at the Commercial

Cable Company's station at Canso, N. S., have been forwarded to the Toronto Magnetic Observatory. A curve has been regularly plotted with the curves showing changes in the magnetic values at Toronto, and at times, at least, there is a striking similarity between the Earth current curves and the horizontal force curves. It is proposed to request the Cable Company, in lieu of sending in reports of the Earth currents as measured at a certain hour each day, to note the times of the beginning and ending of Earth current disturbances on the paper ribbon, tear off the disturbed portion, and forward it for comparison. It is to be regretted that the Electric Railway system in Toronto makes it impossible to satisfactorily study Earth current changes at this observatory. At Greenwich, what promised to be a most valuable and interesting Earth current record, has within the past few years been ruined by the building of an electric railway in East London. This railway is not at any point nearer than one and a half miles to the Earth current wire, and yet the vibrations of the galvanometer magnet, caused by the passage of the trains, are greater than any ordinary Earth current changes. The Meteorological Conference held in Paris in September last, which Mr. Stupart attended, passed the following resolution: "It is important to develop the study of Earth currents. This investigation, like that of the magnetic phenomena, should only be undertaken in an open country distant from the industrial electric installations." Some of us know somewhat of actions being brought against Electric Railways for grave and manifest breaches of the law, but down to date there is no action for an injunction against the Toronto Railway Company for its grave and manifest interference with the study of Earth currents at our observatory. This would present a very curious electrical-legal problem. Industrial necessities often disturb scientific pursuits. But all this painstaking series of observation and comparisons may bring us on to some very great discovery. Is it possible that the Earth acts as the armature of a great dynamo, and by revolving in the Sun's magnetic field, generates the so-called Earth currents of electricity?

We are also indebted to the Lick Observatory for lunar photographs and for other most valuable gifts, and to many eminent astronomers from all parts of the world for most useful papers and much information most courteously rendered.

As a year of astronomical history, 1896 has its remarkable features—

it is the year of two jubilees and of two centenaries. Fifty years ago Adams discovered Neptune, and fifty years ago the University of Glasgow discovered plain William Thomson, now Lord Kelvin. The jubilee year of Neptune's discovery reminds us of the history of that famous problem which the French Le Verrier and the English Adams grappled almost simultaneously, and calculated the place of an unknown planet from the known perturbations of the planet Uranus in longitude. This was the solution of a series of simultaneous partial differential equations with nine unknown quantities, namely, the mass, mean distance, eccentricity, epoch, and perihelion longitude of the great unknown, and the correction to the mean distance, eccentricity, epoch and perihelion longitude of Uranus. The old and known weapons of mathematical discovery were foiled and blunted in attacking this stony Sphinx when wielded by even the trained gladiators of analytical combat, and so new weapons had to be invented for every stage of the battle, until at length victory crowned the struggle, and the great Northumberland Refractor at Cambridge Observatory caught Neptune in its field of vision just where he ought to have been. On the 15th June, 1896, about two thousand guests assembled at a soiree, held in the great suite of rooms of Glasgow University, to celebrate the jubilee of Kelvin, the Glasgow Scotchman born at Belfast. It was a brilliant gathering of the titled and the learned and the mighty—not of one land, but of many lands. Beautiful maid and stately matron graced the function; the belted soldier bowed his head, and the son of a hundred earls doffed his coronet before the foremost physicist of his day; even H. R. H. the Prince of Wales paid congratulatory court to this man, a subject of his royal mother, but a prince and potentate in the domain of natural philosophy. One hundred years ago James Lick was born, and one hundred years ago the nebular hypothesis was born. James Lick, the millionaire who established the grandest and most magnificently furnished observatory in the world, and thus consecrated his wealth and made it tributary and a handmaid to Benign Science. All honor be to him! and may the gold of many other men like him and Earl Rosse, and Lowell, and Crossley, and Yerkes, be sublimized by being laid on the altar of Urania!

But what shall we say of La Place? One hundred years ago he gave to the world the "nebular hypothesis" as a postscript to "*Système du Monde*," the grandest and most magnificent speculation that ever entered the heart of man to conceive. As briefly and poetically summarized in the "*Princess*"

> "This world was once a fluid haze of light,
> Till towards the centre set the starry tides
> And eddied into suns, that wheeling cast the planets."

We are thus taken back into the unfathomable ages of past eternity when the Spirit of God brooded on the face of the waters, and even before the beginning when the world-stuff of solar systems and astral systems suffered birth pangs and, by movements over countless ages, generated worlds. During the last decade this hypothesis has undergone some modifications, but all reaching and focusing in the great principle of developmental change and evolutionary creation. Milton's reading of Moses' Genesis will no longer do; something more scientific, equally poetic and more orthodox must take its place. Heresy is oft but truth in the making. There is not only evolution of star-systems and world-systems, but an evolution in the interpretation of the Scriptural records of cosmogony. The more deeply and the more reverently we study these records, the more we wonder how much the authors of Job, and Genesis and the Psalms knew of astronomy and astrophysics; had they been left to grope in the darkness of the barbarism that surrounded them, their references to scientific knowledge could never have been so accurate. But they were not so left, and being divinely guided they have not lapsed into one scientific inaccuracy. They lived a thousand years before Hesiod wrote or Homer sang, and though earlier they were accurate, and the later literature was fabulous. What would modern reviewers say if Job had given such a view of cosmogony as this which is declared by Hesiod?:—

> "From the high heaven a brazen anvil cast
> Nine days and nights in rapid whirl would last,
> And reach the Earth the tenth; whence strongly hurled
> The same the passage to the infernal world."

Verily, one class would shoot out the tongue at poor Job, while another with more scholastic elegance, and therefore all the more to be watched, would, with pessimistic smoothness, affirm that the Old Testament Scriptures were not indeed one millstone, but two of them—an upper and lower—between which the whole system of Christianity is ground to powder.

During the last year observational astronomy was more than usually busy, and more than usually successful. We find Herr Leo Brenner in May last eagerly watching the swift-footed Mercury, the Benjamin or youngest son of Sol, our fiery parent. The astronomer of Lussinpiccolo confirmed the view of Flammarion—he not only saw the wonderful markings, but even when the planet was gibbons he saw the dark limb surrounded by an aureole similar to Venus, as seen in July, 1895. The dark side was darker than the sky. He records his astonishment as bordering on scepticism, suspected optical illusion, tried eye-pieces of powers from 146 to 410, changed the position of the planet in the field, and at length tried to exorcise the demon—if demon there was—by rudely shaking the telescope. But there Mercury still shone on with his dark side darker than the sky and surrounded by his glory like the gloomy ghostly pilot that he is to Acherontian shades holding his brightly gleaming *caduceus* as a flashing oriflamme.

The phosphorescence of the dark side of Venus has come under the study of observers, and has attracted more attention than usual. Not only the illuminated portion of her disk, but the whole of her disk has been seen in broad day-light at four o'clock on a July afternoon. This phosphorescence has been accounted for as being objective, being the effect of refraction of the Sun's rays through the planet's atmosphere. But it is argued that the visibility of this aureole when the illumined part of the disk is gibbous does not consist with the refraction or twilight theory. The planetary details and her much disputed rotation period have attracted the attention of Percival Lowell, of Flagstaff Observatory, who certainly is one of the most remarkable observers of these later years. Professor Mascari, from the high mountain observatory of Ætna has studied the displacement of the markings during an interval of two hours, and his results negative the theory of the 24 hour rotation, and favour the longer period of Schiaperelli as between 180 and 280 days. Percival Lowell, with his usual daring, says it is perfectly and conspicuously evident that the rotation and orbital period of 225 days coincide. Lowell further affirms that the markings are invariably visible, and there are no clouds on the fair features of this Queen of Beauty, that a bright veil is drawn over the whole disk, and that that is unquestionably atmosphere; that there appears no sign of water or vegetation; there is no colour, and that compared with the beautiful tints of Mars, Venus is a "very drab-like thing." And so she is no beauty after all, and her atmospheric veil is not worn to make her modest loveliness more tantalizing, but to hide her hideousness. Furthermore, that the sun-lit side being in a perpetual blaze of heat and light, all the water is driven to the dark side, where it is heaped in vast bergs of never melting ice. All this and much more is as positively affirmed with a "*Quod erat demonstrandum*" as if the proof were as clear as that the three angles of a triangle are together equal to two right angles.

Jupiter, the monarch planet, continues to puzzle astronomers. A. Stanley Williams, in the *Monthly Notices* of the Royal Astronomical Society, writes most exhaustively on the drift of surface material of Jupiter in different latitudes. He divides the planet's surface into nine different zones, and he then shows that the rotation period of these zones are different among themselves for any one year, and that the periods of any selected zone differ in different years. These atmospheric currents, or whatever they are, circulate in a due east and west direction, and show little or no sign of polar movement. The great red spot, with its colour of human flesh as Brenner puts it, continues to vex observers. Mr. Maunder, the ex-President of the British Astronomical Association, traces its movement and compares it to the effect that would be produced if Australia could travel towards Africa at a speed of four knots an hour, and yet keep its shape. Fancy such a state of things in Terra, and what international complications would follow:—a sort of peripatetic continent. An English observer, whose eyes have been trained, as he says, by twenty-five years' experience, affirms that the red spot flutters and pulsates like the reflection of a big fire reflected in a dark cloud and dying out, and, moreover, this throbbing appears before the spot is on the disk, and warns him of its approach. The same observer tells us that the equatorial zone is filling in, and the north equatorial belt is being thinned out. And after all this, comes Flammarion and tells us that on the surface of Jupiter its atmosphere is seventeen million times as dense as platinum, and what must then be the surface heat of Jupiter under such an enormous pressure. What then, in fact, is Jupiter? A mass of blazing, whirling clouds, each being a law unto itself, more a miniature Sun than a planet, more a star than a light-reflecting body? A man of true scientific spirit will not often say "this or that must be so," or "this or that cannot be so." To another system our Sun may be a double star with Jupiter as a small and relatively faint companion. Schwabe did much for Sun-spots, more than he ever anticipated, and when his unstinted effort and elaborate observations began to bear noble fruit, he said, "I set out humbly like Saul, when he went forth to seek his father's asses, and lo! like him, I have discovered a kingdom." Jupiter's belts may, too, yet find their Schwabe, and the heart of Jove's mystery may yet be read. Before leaving Jupiter, let me note that on 30th March last, a member of the British Astronomical Association saw the second satellite grow dim, although not in the shadow of the planet, and there was reason to think that it was partially in the shadow of the third satellite. This phenomenon, the eclipse of a satellite by the shadow of another, is an exceedingly rare one, if not, in fact, unique as an observation.

MOON.

Selenographers, principally Herr Brenner and T. E. Elger, the Director of the Lunar section, British Astronomical Association, continue to demonstrate changes on the Lunar surface. The theory of our satellite being a burnt-out cinder will no longer hold. New minute clefts and crater cones are being formed, as it would appear, from the slow dissipation of the store of internal heat, radiated as it is into space, and the vapour falling condensed, forms these so-called "cones." They may, in fact, be formed daily. The floor of Plato has been especially observed, where a kind of rill has appeared on the north-west corner; but more astonishing still is the more than suspected circumstances recorded by two independent observers in different parts of England, who record various changes in the features of Plato on the same night between 6.30 and 11 o'clock. The Earl of Rosse has been carefully investigating the radiant heat from the Moon during an eclipse. This is an old problem and a very remarkable one. Twenty-two years ago, Lord Rosse, by the use of a very delicate thermopyle, made of alternate bars of bismuth and antimony, compelled the Moon to give up her secret. He observed the Moon from new to full and from full to new. As the Moon got full he found the needle moved, showing heat, and after the full it went back and showed zero again at new. At Greenwich Observatory, by an ingenious combination of two small thermopyles of about one-tenth of an inch across face, and a galvanometer, the temperature of the stars has been measured. It was found that the heat received from Arcturus when at an altitude of twenty-five degrees was just equal to that received from a cube of boiling water having three inches measurement each way at a distance of 400 yards, nearly a quarter of a mile. While Vega, which is brighter than Arcturus, gives less heat; for at an altitude of sixty degrees, when conditions are manifestly more favourable, the heat received is equal to that from the same cube at a distance of 600 yards.

The movements of the Moon continue to perplex the mathematical astronomer. The problem of two bodies, their mutual attractions and relative motions and positions, can be calculated and tabulated on the basis of the well-known law of gravitation most exactly—not the most infinitesimal tittle of difference can exist between the observed place and the calculated place. The problem of the three bodies, or, in other words, the Lunar problem, is by no means so easy; no complete solution has ever yet been offered for it; while in the case of a number of bodies more than three, no approximation to a solution has been made. This problem is too complex for the calculus that hitherto has been invented. The mathematician must forge some new weapon of attack to overcome the enemy, the intellect of man must bend itself to the task of discovering some yet more infinitesimal calculus which will reveal the mystery. Because, indeed, the forces which act upon the planets are dependent upon their motions, and these again are determined by the forces which act on them. The lunar tables are not exact. Her observed and calculated positions from 1750 to 1850 are accurate, but previous to 1750 and after 1850 discrepancies exist. The error in her longitude now amounts to about 20″ of arc, equal to about 1/100 of her apparent diameter. A similar difficulty occurs in the motions of the planet Mercury. No doubt discrepancies are found to exist as to other members of the solar system, but they can be accounted for by imperfections of instruments and of the human sight, for though the laws of the Creator are perfect, yet the best mechanism of the human artificer is not perfect. But the inequalities that exist in the movement of the Moon's perigee and of Mercury's perihelion, must be accounted for otherwise. We may, near the close of this century, be hovering on the confines of some great discovery. The law of gravity which we have heard from our school-days varies directly as the mass and inversely as the square of the distance, seems to have written across it lately an interrogation point. We thought Newton had settled that long ago, and whatever else was uncertain, yet that was bedded on the rock. Reverently be it said, we have believed that heaven and earth may pass away, but that word or law shall never pass away. It has been so long rooted and grounded in all astronomical science that we have been convinced that even the gates of hell shall not prevail against it.

And yet, we are now startled by Prof. Hall, followed by Prof. Newcombe, suggesting *that perhaps gravitation does not vary exactly as the inverse square of the distance.* If the law of gravitation has to go, we look round for some solid ground on which to rest, for we see the shattered wreck of many another theory struggling in a vast whirlpool. Another explanation which is offered, is that the length of the mean solar day is incorrect, and therefore, of course, the Earth's rotation period is not uniform. To test this, we must have a means of measuring time which is independent of the Earth's rotation, and that Newcombe points out, is furnished by transits of Mercury. And thus it seems that the Earth's rotation slackened between 1769 and 1789, also between 1840 and 1861, followed by a strong acceleration to 1870. And here again are we to give up that hitherto impregnable fortress, the uniformity of the Earth's rotation period—one of the astronomical constants. But Prof. Harzer has recently come to our relief as to the difficulty of Mercury's perihelion by attributing it to an irregular distribution of the Sun's mass within its surface admitted to be spherical, being denser in the parts near the solar equator, and it is suggested that that weird-like mystery, the Sun's corona, has somewhat to do with it. For his memoir on this subject he obtained the prize of the Jablonowski Society. We again breathe freely. Let the Sun's corona do what it likes, anything rather than reach out a rash hand and pluck the crown from the great Sir Isaac's head. But truth, whatever it be and whenever it comes, must prevail. Science has no idols which the onward march of discovery must not shatter if it can. If we have worshipped a mere Dagon, then let Dagon fall on his face, and if he is only clay, let him break, and let rainbow-vestured Truth triumph and stand strongly. But at the same time be it remembered that Truth must not have Her fair garments spoiled by mere theorists, who, for the sake of novelty, desire to alter their fashion. No doubt, as Madame de Stael wrote, "Search for truth is the noblest occupation of man; its publication a duty." But let not some mere puppet of a theory masquerade in Truth's robe. It is as impossible to soil Her as it is to soil the sunbeam. To Newton's theory of gravitation I purpose to fully and most unqualifiedly adhere.

MARS.

When I come to speak of this planet, I approach it with a feeling of great uncertainty. The *Edinburgh Review* of October last tells this story: "A lady of the inanely inquisitive type having met an eminent astronomer, implored permission to ask him *one* question. 'Certainly, madam,' he replied, 'if it isn't about Mars.'" It was about Mars. That was the time of the great Mars boom, when public imbecility and journalistic enterprise combined to flood the papers and society with news from Mars and queries concerning Mars, most exasperating to grave thinkers and hard workers in science. Mars, in the hands of sensational newspaper writers, has been almost degraded to the level of a mere Punch and Judy show. We have all heard of Schiaparelli's wonderful discoveries in 1877 of the "canals" and their mysterious gemination, and how for nine years no other mortal eye could discern what he so easily saw; and how Percival Lowell, of Flagstaff Observatory in Arizona, outstripped every other observer in his wonderful Martian discoveries and in his still more startling records of them, and moreover, in his most phenomenal conclusions from them. All that has been told often before, and nothing, as yet, of any real value can be added. Prof. Barnard, however, promises to publish a work on Mars, and we have to hear yet what success Lowell had with his new 24-inch refractor, by Alvan E. Clark, at the opposition of December, 1896, from a point near the city of Mexico, where Dr. T. J. J. See has been helping him. This telescope has already done some remarkable work, as Dr. See has with it redetected the long hidden companion of Sirius (first discovered by the maker of this telescope), and has also discovered faint companions of θ Scorpii, ε Sagittarii and others. The discussion, or rather, quarrel, between the Lick Observatory authorities and those of Flagstaff as to the accuracy of Mr. Lowell's observations and the value of his conclusions, still continues. The last surrebutter is from astronomer Douglass of Flagstaff; in speaking of the "Lick article," from Prof. Campbell, he says: "We should not have noticed an article like the one before us had it not been an attempt on the rights of property—rights at least as sacred in intellectual matters as in those more material ones which the law protects." Ordinary terrestrial feelings, it seems, cannot be separated from the loftiest pursuits. Mr. Lowell records that in the early morning of the 7th June, 1894, he saw two brilliant star points suddenly flash out from the

Polar ice-cap on Mars and soon die away. Just as on Earth, when travelling on a road at sunset, we may see a sunbeam flash back by reflection from a window in a house in some adjoining field. And so some stray sunbeam was flashed back from some crest of ice on the south Polar cap as the planet turned on its axis. Remember, that flash came nearly 200,000,000 miles and took nine minutes to cross the gulf, and it struck the eye of one solitary discoverer that happened to be watching from that observatory, overlooking a deep canyon in Arizona, on that early June morning. And now Sir Francis Galton (who is not, be it remembered, an astronomer), in the November number of the *Fortnightly*, spending a dreamy vacation at Wildbad, writes an amusing article on "Intelligible Signals between Neighbouring Stars," arguing, or rather imagining how it could be done if there were intelligent beings and if they had the means of erecting sufficiently large heliographs; because, indeed, if Lowell is right in his theory that the Polar ice-cap acted by mere accident as a heliograph on that particular morning, why could not a heliograph be set up and worked by design? provided, of course, that there were on Mars intelligent mechanics and as clever as Sir Francis in inventing an inter-stellar language by using "signals mathematic," and that they could hit the right places of the Earth with their flashes, and not the Atlantic ocean or the Sahara. If these so-called canals are the "labours hydrostatic" of Martian engineers, then one feels the "creeps" as if in the presence of some weird-like midnight mystery. Jamie Soutar of Drumtochty would say, "it's no canny"—as Robinson Crusoe of our early days started when he saw the footprints of human beings pressed on the sand of his desert island, so we look with wonder at these canals, and are filled with awe at the thought that mayhap here we see the product of human, or rather, Martian intelligence :—

"O'er all there comes a shadow and a fear,
A sense of mystery the spirit daunted
That says as plain as whisper in the ear,
The place is haunted."

But let us turn to something more serious, although "a little speculation now and then is relished by the wisest men"—and women too ; and be it remembered, that speculation as to Mars is not nearly so expensive an amusement or so heart-breaking as speculation in many terrestrial ways. Giving the rein to one's imagination does not exhaust the "grey matter" imbedded in the skull nearly as much as the calculation of the orbit of a binary, and it is therefore all the more popular.

THE SOLAR ECLIPSE.

The most notable event of the year of an observational character was the Sun's eclipse on the 9th August last. Most elaborate preparations were made; all that human skill, money and foresight could provide was provided. The British Astronomical Association sent a large expedition to Vadso by the "Norse King"—Mr. Maunder, the President in charge, had actually drilled a whole ship's company, and they and all the ladies and gentlemen who accompanied the astronomer had often rehearsed their different parts, so that no time would be lost and no confusion exist during the eventful ninety-five seconds of totality. Prof. Lockyer went to the Varringer Fjord; Prof. Schaeberle of the Lick Observatory and the Royal Astronomical Society planted their cœlostats on the island of Yezo, Japan, but at all these places there was a monotonous record of wet and cloudy skies, and all that these astronomers and their lady friends could do was to photograph their instruments and themselves instead of the Sun's corona. To which the British Astronomical Association added a great dinner at the Holborn Restaurant after they got home, where they held high carnival and made some very bad jokes about their disappointment, all of which is duly recorded in their *Journal*, wherein also are recorded calculations of the orbits of new double stars and "Notes on Photomicrographs of Gelatino-Bromide Plates." Astronomers are taught to endure disappointment—"'Tis better to have tried and lost than never to have tried at all." When they packed their instruments for the return voyage their minds were set on India and the time (January, 1898) when the next eclipse will happen—"The king is dead, long live the king"—and so back from the home of the north wind and the land of the midnight sun, where the old bare-serkers were cradled; back from the land of cloud and mist and snow, and forward to India's coral straud and her smiling skies. But all were not so unsuccessful. Sir George Baden Powell equipped an expedition at his own expense to Novaia Zemlia. His yacht, "Otaria," carried Dr. Stone of the Radcliffe Observatory, and Mr. Shackleton of the Solar Physics Observatory, South Kensington. The one hundred seconds of totality were well used in breathless silence—the company drilled before for rapid and accurate work sketched, and the dry plates did their magic work and most valuable spectroscopic and coronographic results were obtained, and are now being worked out. Success also attended the Russian expedition which went to the north of Finland under Baron Kaulbars, and another at Bodo and on the River Amur. Miss Proctor reported a complete success of the expedition from the deck of the American steamer Ohio. The sky was cloudless, the atmosphere clear and the coronal streamers and prominences well seen. The planets Jupiter, Mercury and Venus, were plainly seen during totality. And thus again the Sun wrote his own story and added another page to help the revelation of the secret of his constitution. Astronomy has added another weapon of attack to her arsenal—a contrivance invented by M. Zenger and called the Eclipsoscope. This consists of a cone of crown glass or quartz enclosed in a zinc cylinder, enclosed at the ends by glass plates, the intermediate space being filled with a mixture of anethol and oil of terebenthine; over the glass window at the apex of the cone is placed a sheet tin dish in which a circular annulus is cut. By this arrangement an infinite number of spectroscopes of sensibly direct vision is obtained, and free from prismatic aberration. A telescope with a Barlow lens is used, the image of the Sun is thrown on the window so that its diameter just overlaps the inner diameter of the annulus, then by interposing a mixture of violet with green all the rays, except the red ray of hydrogen, are absorbed and the prominences are seen in red light with the chromosphere, a view of all the prominences round the Sun being obtained by one observation. Before leaving the Sun I may add that Mr. Sykorn of Charkoff Observatory has made a new measurement of the diameter of the Sun when spots are on the edge of the limb and he finds that the diameter is increased, which rather startles the upholders of the Wilsonian theory of spots being depressions.

METEORS.

Dr. Stoney has lately warned us of the approach of the great swarm of Leonids, the meteors about which astronomers know most. These meteors are invisible dark bodies which become visible and blaze when they strike the Earth's atmosphere They pursue an immense oval orbit, stretching from the path of Uranus to the path of the Earth, which they complete in about thirty-three years. They travel, when near the Earth, at the rate of twenty-seven miles a second, are about

100,000 miles thick, and are stretched out at such length that they take two years to pass a point. The front of this great host will reach our orbit in the spring of 1899, but the Earth will then be in a distant part of her orbit. In the following November, and in November, 1900, she will plunge into them and will be bombarded on her advancing side for five hours with a never ceasing rain of brilliant stars. The history of the Leonids has been traced back by Le Verrier who demonstrated that this swarm was caught by the strong gravitating arms of the planet Uranus in the year A.D. 126, and was thus swung from the path it was then pursuing into the immense orbit the swarm now follows, and that a comet moved in the track of these meteors. The solution of their problem was completely worked out by the late Prof. Couch Adams, the discoverer of Neptune, and by Prof. Hubert A. Newton of Yale, who died only in September last. The *avant-couriers* of this great company will reach us next November, but the Earth will not encounter the thick of the battalions till 1898 or 1899, and then if this continent, during those eventful five hours, be turned from the Sun, or, in other words, be in darkness, the spectacle will be the sublimest that the mind of man can conceive. The whole sky will coruscate with blazing inter-stellar matter.

Some very remarkable individual meteors struck the Earth during 1896, notably the great Madrid meteor; this fell on the 10th February last at about half-past nine in the morning. The day was magnificent, blue sky and radiant sun—when at the zenith a white spot like smoke, about twenty miles in height and 6° in length and 1° in breadth, appeared, that is, about twelve times the apparent size of the full Moon long, and twice the same broad. It was semicircular in form, the centre of a reddish colour. A deep and very strong detonation was heard, followed by many others not so intense. All the buildings in Madrid were shaken and many windows shattered; many injuries resulted from panic in escaping from factories and schools. A cloud of smoke and dust remained, dissolving gradually until three in the afternoon, a period of six hours from its first appearance. A fragment fell—it was of a black metallic aspect with some brilliant points like nickle. Another meteor fell on the 13th April in Belgium. It weighed four and a half pounds and sunk about twenty inches in the Earth. Another fell in the Atlantic ocean about two miles in front of the steamer Wilkommen on 17th November. Brooks records a unique observation—on the 21st July, while observing the Moon, he saw a dark round object move slowly across the disk; its flight occupied three or four seconds. He believes it to have been a meteor outside of the Earth's atmosphere, and therefore not luminous.

ASTEROIDS.

The roll-call of the Asteroids, the pigmy children of the Sun, continues to increase. They now number four hundred and forty, of which nineteen have been discovered in 1896. Of these, Charlois discovered five; Wolff caught five all in the same plate on the 7th September last. Their nomenclature has been very perplexing. They are now numbered with a circle around the number. Such names as the following distinguish the older ones: Elsa, Lamberta, Martha, Isabella, Bianca, Stephania, Lucia, Rosa, Henrietta, Barbara, Carolina, Ida, Bettina, Clementina, Augusta, Alma, Antonia, Elvira, Paulina, Lucretia, Clorinda, Clarissa, Katharina, etc.—they read marvellously like the register of a girls' school, although such other names as Chicago, Ilmatar, Ingeborg, seem to indicate that girls' names had been exhausted. They are, moreover, like children in a crowded street, perpetually getting lost and after the lapse of years turning up in the grasp of some astronomer who has been fishing after them with a photographic plate in space, and then being put down in the star catalogue again. One, for instance, Menippe, discovered in 1878 wandering about in the zone between Mars and Jupiter, was rediscovered in 1896, because, perhaps, it was leap year. The poor little thing, I presume, was too little to stay where she ought to have been; but now, with eighteen years' more experience of life, she has come back to the catalogue. I cannot blame her for giddy youth, because she left the cradle of the Sun ages before our mother Earth did, but she must have got mixed up among her numerous small sisters or perhaps loitered on the way with some brother bearing a Russian name.

COMETS.

To the year 1896 belong seven new comets, although one of them, Brook's comet C. is recognized as an old friend of 1889. This wanderer has had rather a remarkable history. It came within observation in 1886 and afterwards got tangled up among the satellites of Jupiter and a disruption of it by the fifth satellite was more than suspected. Another one, being 1896 A. called Perrine-Lamp by reason of its double discovery, was discovered by an observation made arising from the mistranslation of a telegram received at Lick Observatory, from Boston, referring to comet C., of 1895. Of the remaining five Perrine discovered two, Swift one, Giacobini one, and Sperra one. All were discovered by American observers. Nothing has been added to cometary theory ; whether the Sun has a repulsive effect on the tails still remains one of the unsolved problems.

OBSERVATORIES.

New observatories continue to be built. During last year four State Universities have established observatories, namely, Pennsylvania, Ohio, Minnesota and Illinois. Brashear, Alvan Clark, Warner and Swazey, all have large contracts. Of the Province of Ontario there is yet no mention. Sixty-thousand dollars have been expended on the construction and equipment of a great observatory, and a number of years of valuable time of two noted astronomers and their assistants will be devoted to what may prove to be the most important astronomical expedition of the century. Percival Lowell has built this movable observatory and telescope, and he and Dr. T. J. J. See, of Chicago, are the two astronomers. It has been set up, meanwhile, near the city of Mexico, and will move thence forward. The planet Mars and double stars are the objects of this great quest. The Yerkes Observatory, seventy-five miles from Chicago, approaches completion ; the lens alone, the largest in the world, 40 inches across, which cost $60,000, has been tested by Professor Keeler, who reports its definition equal to that of the Lick telescope, and its light gathering power much greater. The great tube is seventy-five feet long, and its movable floor travels twenty-two feet upwards. The whole is governed by a new system of electric motors. A giant telescope has been erected at Berlin upon an entirely new principle, which dispenses with the usual dome, and gives to the observer a stationary seat in the general axis of the telescope. The new Royal Observatory at Edinburgh, has been opened by Lord Balfour, of Burleigh, Secretary for Scotland. The buildings cost $180,000, the library has 30,000 volumes ; the instruments are not large, being a 15-inch refractor and a 24-inch reflector.

On the 16th April, 1887, a convention of astronomers from seventeen different countries met at Paris, and decided to carry out a great astro-photographic survey of the heavens of all the stars down to the 14th magnitude. These plates will, when completed, exhibit 20,000,000 stars. Twenty-two thousand plates will be necessary. This work has been going on at eighteen observatories. During last year, three South American observatories stopped work on account of political revolutions, and the Sicilian Observatory put up its shutters and closed its dome for want of funds. It is astonishing how such sublunary matters as a presence of rifles where they are not wanted, and an absence of dollars where they are wanted, will affect the study of extra mundane phenomena, and clog the wheels of scientific progress.

THE DEATH ROLL.

In the year 1896 Death put his sickle into the ranks of scientists whose names "are written high on the dusty roll the ages keep," and reaped many of the noblest and best. They have ceased here to listen to those rhymes of the universe that nature sang to them by night and by day. Krueger, a pupil of the great Argelander, who did so much for star catalogues has fallen from the ranks of the living. Hubert A. Newton, of Yale, was not spared to verify by observation here his theory of the meteoric orbit of the Leonids; Fizeau, who calculated the velocity of light, and who also discovered the means of determining by the alteration of the wave-lengths as revealed through the spectroscope the direction and velocity of motion of bodies advancing or receding along the line of vision, and Tisserand, the great Parisian astronomer who wrote on "Celestial Mechanics," were both taken away for other work. We also mourn the loss of Prof. Benjamin Gould, of Cambridge, Mass. From 250,000 observations made by him or under his direction, at the Observatory of Cordova, Argentine Republic, he tabulated upwards of 107,000 stars, which was far in advance of any star-catalogue that had been till that time constructed.

Time forbids me to do more than mention a host of others such as G. P. Bidder, Q.C., a distinguished member of the R. A. S., General Walker, Gylden of Stockholm, and our own Dr. J. C. Donaldson, a barrister, of Fergus, Ontario, whose observations of double stars were so exhaustive, and whose contributions to the meetings of our Society were so valuable. We cannot easily forget our good benefactor, the late John Goldie, of Galt, whose contributions to our Library testified a kindly heart, and whose personal devotion to astronomy as an observer, evinced a wise head and cultured mind. For all these "the golden key that opes the palace of eternity" has turned. And so the years roll round, and scientific discovery closes one volume to open another and yet another. We see, at the best, in a glass darkly, and most things we cannot see, and little that we do see can we truly interpret. Eclipses may be calculated, orbits of double stars may be measured, and intellectual conquests of a very high order can be achieved, but when we consider the vast problems of physics and astronomy, the masters of science are at the best, but

> "Children crying in the night,
> Children crying for the light,
> And with no language but a cry."

And if we, students of astronomy, are not lifted from nature up to nature's God, unless the book and volume of the firmament does not reveal to us much more than mere stellar points, then, indeed, we fail in our pursuit. A Swiss scientist whose name I do not presently remember, heard a sermon in a French Cathedral from a Bishop who inveighed fiercely against science and scientific men. The poor man was troubled with the nebular hypothesis, or with the six literal Genesis days, or something of that kind, and with a repetition of that condemnatory vigour that launched Galileo into prison, he thundered away. At the close of the service the Swiss astronomer went to him and said, "Monseigneur, as-tu jamais vu Dieu?" "No," said the startled churchman, "I never did." "Then, Monseigneur, I have," was the reply. "I have seen Him in the great cathedral of the universe, I have felt Him in the movements of creation, I have witnessed His workings from nebula to star and from star to planet, I have read those Scriptures of the sky which you have not, I have touched His robe and know Him as a visible Being." Our intellects were given us to use them, to cope with lofty difficulties and to surmount them; let us, as humble students, use what mind and gift and opportunity that we have.

> "God did anoint thee with his odorous oil
> To wrestle not to reign."

It is the oil of the *palœstra* that we have and not the chrism of a king. Let us wrestle here, valiantly and earnestly and honestly,—no matter whether successfully or not,—and we will reign there.

THE LUNAR SECTION.

1896.

The work of the Lunar section during 1896 was maintained fairly well. It consisted partly of the individual observations made by some of the older members at their residences, and partly of a series of open-air meetings held every fourth Tuesday evening during the pleasant summer weather. The regular meetings of the Society and of the Stellar section fell on the intervening Tuesdays, so that it may be claimed that the members of the Society and of the sections collectively, had opportunities for practical work during every Tuesday night suitable for out-of-door observation. These meetings were well attended and, with a few exceptions, were held on the spacious lawns of Mr. John A. Paterson, M.A., President of the Society, at No. 23 Walmer Road, where the 6-inch reflecting telescope, presented by the late Hon. Sir Adam Wilson, had been set up. The interest in these meetings was well sustained by the members. The duties of those who were in charge were lightened by the spirited manner in which assistance was rendered. Several excellent papers were contributed by Mr. Elvins and others, and read on evenings when the skies were not clear. Among those who brought 6-inch, 4-inch, 3-inch and smaller telescopes, were Dr. A. D. Watson and Messrs. A. Elvins, G. G. Pursey, J. R. Collins, Z. M. Collins, C. T. Gilbert, W. L. Gilbert and T. Lindsay. On one occasion, a 10¼-inch With-Browning reflector and an excellent 3-inch Dollond —the latter loaned by Mr. R. F. Stupart, Director of the Observatory— were on the ground. The thanks of the section are due and are tendered to Mr. Paterson for many courtesies; and also to Mr. Stupart, who was always ready to place the 6-inch Cooke telescope of the Observatory at the service of members. It is worthy of note that the reflecting telescopes brought from time to time by the Messrs. Collins were entirely of their own construction.

Among the more active of the members of the section who kept up their work during the year, were J. J. Wadsworth, M.A., M.D., of Simcoe; J. C. Donaldson, LL.D., of Fergus, and the veteran Mr. A. Elvins, of Toronto. These gentlemen and the undersigned, early in the season, selected a series of special subjects for careful study and comparison as to results. Dr. Donaldson possessed a 3½-inch Cooke of the first quality, and had long sustained an enviable reputation as a successful observer of planetary detail, and of difficult double-stars, being gifted with excellent eyesight. Though new to him, he was becoming deeply interested in lunar work, and had begun to report useful observations and to make neat drawings, when he was stricken by the lingering illness of which he died on the 1st of October, greatly lamented for many good qualities. A careful observer of the Moon for a quarter of a century, Mr. Elvins naturally availed himself of every opportunity, and, with his accustomed industry, made a series of elaborate crayon sketches, some of which he presented to the society. Though many other objects were observed and drawn, particular attention was given to Messier, Messier A, the more or less demolished rings lying north of Lubiniezky and Albategnius and Cassini. The special objects selected by Dr. Wadsworth were Gassendi, Walter and Posidonius. These and others were drawn many times at his 12½-inch reflector, which was also used successfully to photograph the Moon. The images obtained were sharp enough to bear considerable enlargement, and copies were presented to members of the section. Dr. Wadsworth was able to attend one meeting and to read an encouraging paper on "Lunar Observation by Amateurs," in which, largely from his own experience, he gave much excellent advice as to the best means of becoming familiar with the names of objects on the Moon's surface, and of mapping, drawing and photographing them. The work of the undersigned was chiefly confined to Mädler and to other objects in and near Mare Nectaris in the eastern, and to the Aristarchus-Herodotus region in the western hemisphere. During the May, June, July, September, October, November and December lunations, many drawings were made of these and other objects. Happily, during the waxing and waning of the Moon, there occurred several series of three, five and six successive days when observation could be conducted throughout the night with satisfactory results, thus affording opportunity hour after hour for the study of some selected subject under gradually varying illumination. Some of the nights—especially in November and December, when the air was as balmy as in April—were very suitable for lunar work. Probably the best of all was that of October 18th, which succeeded very bad weather and two falls of snow on the 17th. The following is an extract from the note-book: "Seeing splendid; Moon high and near meridian; objects 'steady as a rock'; terminator cutting through Schiaparelli; *no tints whatever anywhere;* Herodotus clear and sharp; Aristarchus and Kepler actually without glow or dazzling glare; scarcely any shadow; crater in Herodotus clearly defined; central mountain in Aristarchus seems to be 'capped' and as if looming up through a mist low-lying about its base; Schröter's Valley shines like silver, and may be followed well towards Schiaparelli; minute objects, at other time seffaced, now easily seen; valley undoubtedly passes under cliff and into Herodotus (always doubted this before); as it approaches the mountain a central ridge of hills appears and continues up to the entrance. Is Aristarchus the newer formation, and when formed, was Schröter's Valley there squeezed together and a mound thrown up and shoved outward so as to dominate the valley? No smudge, and but the merest marginal shadow on south side of valley near Herodotus. As if it were further evidence of 'shoving,' the bed here seems to be considerably above the general level of the valley, both south and east of the 'squeeze'; valley seems to pass east through two hill-ranges and meet a broad shallow valley that trends south-eastward along the range running towards Mount Elvins (the persistently brilliant peak immediately north of the most northerly bend in the valley); seeing magnificent with powers up to 350 on a $10\frac{1}{4}$-inch With-Browning reflector; definition simply superb with powers of 150, 200, 260 and 300." Numerous observations in this region were made at the request of the late T. Gwyn Elger, F.R.A.S., whose untimely death the section deplores, and from whom some most interesting letters were received during the year. Mr. Elger's admirable book, "The Moon," has been adopted by the section for its work. It was hoped the section, during 1897, would have enjoyed his friendly assistance, which was promised. Other correspondents of the section were, Herr Leo Brenner, of Lussinpiccolo, Austria, and Mr. Henry Harrison, of Jersey City Heights, New Jersey, and it is anticipated that the report for 1897, will show evidence of the interest these gentlemen and others have been good enough to take in the welfare of the society.

G. E. Lumsden,
Director.

Toronto, 1897, January 29th.

THE MEAFORD ASTRONOMICAL SOCIETY.

(INSTITUTED NOVEMBER, 1893.)

Affiliated with The Astronomical and Physical Society of Toronto.

Officers:

President .... Rev. D. J. Caswell, B.D., Ph.B.
Vice-President .... Mrs. H. Manley.
Corresponding Secretary .... Mr. Geo. G. Albery, Town Clerk.
Recording Secretary .... Mrs. E. Kirton.
Assistant Secretary and Editor ...... Mrs. S. Huff.
Treasurer .... Mr. J. S. Wilson, M.A.
Librarian .... Miss Madeline Paul.

Active Members:

Mr. G. G. Albery.
Mrs. D. J. Caswell.
Mrs. E. Kirton.
Mrs. S. Huff.
Mr. A. Mowat, M.A.
Mr. W. T. Moore.
Miss L. McRae.
Miss M. Paul.
Mr. J. G. Sing, D.L.S.
Mrs. White.
Miss Shortt.
Rev. D. J. Caswell, B.D., Ph.B.
Miss M. Foster.
Mr. S. Huff.
Miss E. Layton.
Mrs. H. Manley.
Mrs. A. Mowat.
Mrs. W. T. Moore.
Dr. J. H. Parsons.
Mr. J. S. Wilson, M.A.
Mr. J. M. Magor.
Mr. R. E. Main.

Corresponding Members:

Mr. S. D. Caswell ....Molsons Bank, Toronto.
Mr. H. B. McCay ....Camperdown, Ont.
Mr. W. U. Latornell ....Molsons Bank, London, Ont.
Mrs. J. C. Saunders ....Ottawa.

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The Meaford Astronomical Society.

Transactions of 1896.

The first meeting of the year was held at the residence of Captain McRae, and was not largely attended, owing to the night being stormy and disagreeable. The list of members was revised, and it was found that twenty members were in good standing. Chapter V. of the Society's present text-book was read, followed by discussion. It may be stated that at all our meetings it has been customary to read and discuss a chapter from text-book when the time has not been taken up by original or selected papers. Meetings have been held with regularity throughout the year, alternately, at the Society's rooms in the office of the Town Clerk, and at the residences of members.

On February 10th, at a meeting held at residence of H. Manley, Esq., a paper was read by Miss Paul on the "February Skies," which was considered very interesting. A valuable paper was also read by J. G. Sing, D.L.S., on "Observations to establish the meridian," which drew forth discussion. By request, the President read a chapter from Motley's "Rise of the Dutch Republic," describing a phantom sky.

On February 24th, at the Society's rooms, after the usual routine, reading of minutes, correspondence, etc., a chapter of text-book was read and discussed, after which the President read a very interesting paper on "Chronological Cycles," which upon motion was sent to local paper for publication.

The fifty-fifth meeting of the Society met at the residence of Mrs. Manley on March 9th. Miss Paul read a selection on the "Dawn of the Twentieth Century." The President read a paper on the subject of "The Epact and Golden Number" (which, by request, was published in local newspaper). The subject of the new gas, "Acetylene," was introduced by Mr. Huff, science master in Meaford High School, which led to an interesting discussion. A communication was read from Mr. W. W. Payne, director of Goodsell Observatory, accompanied by a gift of three complete volumes of "Astronomy and Astro-Physics." This gift was gratefully acknowledged by a vote of thanks being passed, and the

Corresponding Secretary was requested to forward the same. A few of the members of the Society, oblivious of the fact that the mercury was nearly down to zero, went outside to look at Jupiter and his moons with the telescope, after which all dispersed to their homes.

The next meeting, March 23rd, was at the Society's rooms, at which we had a visitor, the Rev. C. E. Thomson, M.A., of Toronto Junction. Chapter X. of the text-book was read, and a discussion regarding comets and meteors followed. It was reported that a large meteor had been recently observed by Mr. Barber of this town. The President read a selected paper, by Mr. A. Elvins of Toronto, on the "Atmosphere of the Planets." A paper was also read by the President on the subject of calendars, entitled "Roman Indiction," which upon motion was sent to the printer.

On the 20th April the fifty-eighth meeting was held, at which, after routine, there was considerable discussion on the subject of taking observations, showing how, by an acquaintance with the sky, one could tell the time of night with sufficient accuracy. A selected paper was read from the Toronto Society's *Transactions*, on "The Greenwich Nautical Almanac," written by Mr. Thos. Lindsay of Toronto.

On May 5th the principal subject of discussion was regarding a paper read—kindly forwarded to us—on the subject of "Sun-spots," written by Mr. A. Harvey, F.R.S.C., of Toronto. The President also read an interesting selected article on "Double Stars."

The sixtieth meeting was held at the Society's rooms. A communication from Mr. T. Lindsay called attention to the approaching occultation of a fixed star by Jupiter on 22nd May. An interesting discussion took place on the suggestion of Dr. Watson of Toronto, who proposed a new division of the year into thirteen months.

On 1st June the Society met at the residence of the Recording Secretary, Mrs. Kirton, on Trowbridge street. Notice was taken of a pleasant paragraph in *Popular Astronomy*, alluding to the Meaford Astronomical Society. A resolution was passed that a copy of our *Transactions* be presented to the editor of the Meaford *Mirror*, who has been most obliging in inserting notices of our meetings and publishing papers written by members of the Society. Mrs. White read a selected paper on "Predictions of Phenomena," which was followed by discussion in which it was mentioned that the occultation of Jupiter as predicted had been observed in many places.

Fifteen members and three visitors were present at the meeting held on 15th June at the Society's rooms. The President gave a list of coming phenomena, chiefly relating to the changes of the moons of Jupiter, and advising all who could to take advantage of the opportunity of observing them at times mentioned. A selected paper, by Camille Flammarion, on the "Death of the Earth," was read and discussed, after which the President read, by request, the chapter in Proctor's *Other Worlds than Ours*, entitled "Supervision and Control."

At the sixty-fourth meeting, held at the residence of S. Huff, Esq., Science Master in the High School, Mr. J. S. Wilson, M.A., read an account of the fall of a meteorite in Mexico, which had caused destruction of life and property. Notice was taken of a poem written by one of the members of our Society, dedicated to the President, which had appeared during the week in one of the local newspapers, and which was highly spoken of. A letter from Wiarton was read, making enquiries and speaking of the formation of a similar Society which was proposed to be organized there.

The sixty-fifth meeting was held August 11th at residence of Miss Layton. Several newspaper items were read regarding the observations made in Norway and Japan of the recent solar eclipse (August 9th), all of which were regarded with interest, especially the account given by Miss Mary Proctor of the successful observations made on the steamer Ohio, off the island of Stott, Norway. Mr. G. G. Albery, Corresponding Secretary, read an interesting chapter from Prof. Young's book, *The Sun*, which assisted greatly in the discussion that followed.

On October 4th a special meeting was assembled at the house of Mrs. Manley, Trowbridge street, in order to meet the Rev. C. H. Shortt, M.A., a member of the Toronto Astronomical and Physical Society, and during the pleasant evening spent together a successful photograph was taken of the members present by the aid of a flash-light.

The sixty-seventh meeting was held, October 22nd, at the Society's rooms. A selected article of much interest was read on "Arcturus," by Mr. G. G. Albery, and, by request, the President gave an account of his recent visit to the Toronto Astronomical and Physical Society, the kind treatment he had received from the various members he had met, and the many opportunities he had of making observations with telescopes kindly offered for his use, especial mention being made of an evening with Mr. Blake at the Toronto Observatory; another with Mr. A. F.

Miller at his private observatory; a pleasant morning spent with Mr. A. Harvey, F.R.S.C., observing sun-spots, and a number of opportunities had in company with Mr. G. G. Pursey, seeing his method of following up the famous sun-spot of September, 1896, and observing the daily changes in its appearance.

At the meeting held, November 19th, in the Society's rooms, correspondence was read which had been received from Tavistock, informing us of the organization of a similar Society there, and desiring a copy of by-laws to assist in perfecting their plans. A copy of monthly publication was received from the Astronomical Society of the Pacific. Miss Paul read a very interesting selected article on the planet Mars. Mrs. Manley, by request, read an original poem on same planet, which was much appreciated, she being requested to allow it to appear in local newspaper. Mr. J. S. Wilson, M.A., read an interesting account of the construction and powers of the Yerkes telescope, which elicited considerable discussion on the subject of telescopes generally.

The last meeting of the year 1896, the 70th meeting of the Society since its origin, was held at the residence of Mrs. Kirton, Trowbridge street. It was reported that the new text-book adopted at a former meeting—Gillet & Rolfe's *Astronomy*—had arrived, and copies were available for the use of all the members who desired them. Among the reports of observations was one of a remarkable sun-dog seen on Tuesday, 30th November. It had been noticed by several members who reported having observed not only the colored line from the Sun itself, but also the colored marks in the sky at equal distances north and south of the setting Sun, which were more distinctly seen than on any former occasion in the memory of those who observed them. Miss Layton handed in an interesting newspaper clipping, and the President read an article from *Popular Astronomy*, entitled "Astronomy and Civilization;" after an interesting discussion, the Society adjourned to meet at the residence of Mrs. H. Manley, on the evening of January 7, 1897.

OBITUARY.

JOHN GOLDIE was the second son of John and Margaret Goldie of Ayr, Scotland, and was born on the banks of the Doon, in 1822. His father was a botanist by profession and took every opportunity of instilling into the minds of his children such knowledge as would be of use to them in after life.

John received his early education at the village school in Kilroy, near his home, being afterwards apprenticed to a millwright. The family coming to Canada in 1844, a new field was opened up for him, with the result that he became eventually known as one of the most successful manufacturers in the Dominion. His partnership with Mr. Hugh McCulloch, of Galt, was formed in 1859.

Mr. Goldie was at all times a deep reader, a careful student and an observer of more than ordinary ability, combining in himself the scholar and the man of business. He became a life member of the Astronomical and Physical Society of Toronto immediately after incorporation, and was always very closely identified with the practical work of the Society. His own observations were made in his private observatory, in Galt, Ontario.

Mr. Goldie's disposition was a most lovable one. In every station of life he exemplified in a high degree the characteristics of a true Christian gentleman. His death occurred after a lingering and painful illness, on March 26th, 1896, at his residence in Galt. His wife and two children, Alex. R. and Eleanor, survive him.

JAMES C. DONALDSON, LL.D., was born in Balinaclellan, Kircudbrightshire, Scotland, in 1843, and came to Canada in 1847, having the misfortune to lose his father on the ocean passage. The mother and children settled in Dundas, and subsequently Mr. Donaldson entered as a law student in a barrister's office in Fergus, Ont. On passing his examinations and being called to the bar, he first opened an office in Dundas, but finally settled in Fergus, where he had resided for 30 years prior to his death.

Dr. Donaldson became a member of the Astronomical and Physical Society in 1891, and was a regular correspondent, sending weekly reports of his work, which was mainly in the field of double-star observations. He possessed an excellent 3½-inch Cooke refractor, which he used to the utmost advantage.

Professionally, Dr. Donaldson stood very high; his wide knowledge, sound judgment and high standard of honour securing confidence and esteem wherever he was known. He was for many years a valued and useful member of the Fergus Board of Education, and took a deep interest, not only in local schools, but in everything pertaining to education.

Dr. Donaldson was never married; for some years past he had lived with his widowed sister, Mrs. Wm. Crawford.

His death occurred on October 1st, 1896, after a severe illness, borne with Christian fortitude.