TRANSACTIONS

OF THE

Astronomical and Physical Society of Toronto

FOR THE YEAR 1890-91,

INCLUDING FIRST ANNUAL REPORT.

PRICE, FIFTY CENTS.

TORONTO, CANADA:
PRINTED BY BROUGH & CASWELL
Printers to the Society.

The Astronomical and Physical Society of Toronto.

OFFICERS, 1890-91.

President:

CHARLES CARPMAEL, M.A., F.R.S.C., F.R.A.S.,
Director of the Observatory, Queen's Park, Toronto.

Vice-President:

ANDREW ELVINS.

Treasurer:

G. G. PURSEY.

Corresponding-Secretary:

G. E. LUMSDEN.

Recording-Secretary:

D. J. HOWELL.

Librarian:

A. F. MILLER.

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Director of the Observatory, Queen's Park, Toronto.

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ANDREW ELVINS, Yonge St. Arcade.

Treasurer:

D. J. HOWELL, No. 218 Bleeker Street.

Corresponding-Secretary:

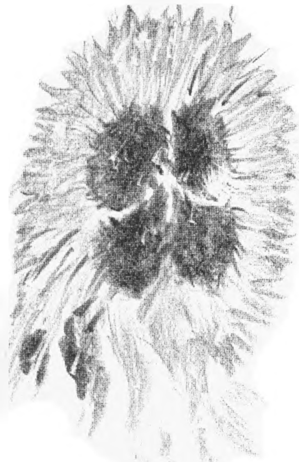
G. E. LUMSDEN, Parliament Buildings.

Recording-Secretary:

THOMAS LINDSAY, No. 38 King Street East.

Librarian:

A. F. MILLER, No. 280 Carlton Street.



Sun Spot
1890 Nov. 30.

Hydrogen flame
1890 Aug 3. $7^h 30^m$

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OF

The Astronomical and Physical Society,

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During the year 1890-91.

FIRST MEETING.

The first meeting of the Astronomical and Physical Society of Toronto, under its new Constitution and By-laws, was held on the evening of the 25th of February, 1890, Mr. Charles Carpmael, M.A., F.R.S.C.,F.R.A.S., Director of the Toronto Observatory, in the chair.

After some discussion, the final report of the special committee appointed to draft the new Constitution and By-laws was adopted.

The election of officers for the year 1890-91 was then proceeded with and resulted as follows: President, Mr. Charles Carpmael, M.A., F.R.S.C.,F.R.A.S., etc.; Vice-President, Mr. Andrew Elvins; Treasurer, Mr. G. G. Pursey; Corresponding-Secretary, Mr. G. E. Lumsden; Recording-Secretary, Mr. D. J. Howell; Librarian, Mr. A. F. Miller. These officers also constitute the Council.

A special committee, consisting of Mr. Miller and Mr. Lumsden, was appointed and authorized to take the steps necessary to secure the incorporation of the Society, under the provisions of the Revised Statute of Ontario, 1887, Chapter 172.

The Recording-Secretary read a letter from Professor Holden, Director of the Lick Observatory, Mount Hamilton, California, written in reply to an enquiry as to the best means of obtaining copies of the photographs of the moon taken at the Observatory. Having given the information desired, Professor Holden wished the Society success, and asked its acceptance of a copy of the proceedings of The Astronomical Society of the Pacific for 1889, and also of the Eclipse Report of 1889, published by the Observatory. The books, which had arrived, were thereupon presented to the Society, which directed that its thanks be conveyed to Professor Holden.

A portion of a meteorite showing the Widmannsttatten figures was exhibited by Mr. Joseph Townsend, who offered to share the specimen with the Society, provided it could be cut, as it had resisted the efforts of himself and others to divide it.

Mr. Elvins read a paper on "The Probability of Great Discoveries in Astronomy during the next Decade."

SECOND MEETING.

The second regular meeting of the Society was held on the 11th of March, the President in the chair.

The Librarian reported that he had received a manuscript copy of "A Method of Computation of Eclipse Projection" from the author, Mr. Thomas Lindsay, of Toronto; also a diffraction apparatus, some magnets, photographs, and a copy of an Almanac for 1769.

The special committee on incorporation reported that all the steps required by the statute had been taken; that His Honour the County Judge had approved of the papers, which had been drawn up in duplicate, and that, according to law, one of the duplicate-originals had been deposited in the office of the Registrar-General of Ontario.

The President read from *The Sidereal Messenger* a paper, by Professor Pickering, on "The Great Nebula in Orion," and from *Knowledge* an article, by Mr. A. Cowper Ranyard, descriptive of "A Photograph of the Sun's Surface," by Jannsen.

During some discussion respecting meteorites, Mr. Carpmael said that a magnificent meteor was seen by him on the 3rd July, 1884, at 8.27 p.m. standard time. It passed from south of east towards the north-west. Its apparent diameter was about one-fourth of that of the moon. About five and a quarter minutes from the time the meteor was visible, there was a deep sound something like the distant sound of heavy ordnance. He estimated the distance of the meteor as about sixty miles and that it was about thirty miles above the surface of the earth. The meteor was seen at Listowel, Hastings, Beatrice, Belleville, Lakefield, Pembroke, Peterborough, Kingston, Lindsay, Ottawa, Montreal, Huntington, and many other places. It passed a few miles south of Belleville, and about as much north of Lindsay.

THIRD MEETING.

Third meeting, 25th of March, the President in the chair.

Seven candidates for active membership were proposed. The report of the committee on printing was adopted. The committee was authorized to procure five-hundred copies of the Constitution and By-laws, and three-hundred circulars to be distributed for the purpose of supplying information respecting the Society. On motion, it was ordered that Cosmic Time be used in the Society's proceedings.

Mr. C. Gordon Richardson, Professor of Chemistry, read a paper on "The Fractionating Process in Inorganic Chemistry."

FOURTH MEETING.

Fourth meeting, 8th of April, the President in the chair.

Messrs. Garnet H. Meldrum, John Phillips, D. George Ross, C. Gordon Richardson, John G. Ridout, Thomas Lindsay, and G. H. Robinson, were elected active members, and two candidates were proposed.

The first of a series of papers, entitled "An Introduction to the Use of the Spectroscope," was read by Mr. A. F. Miller. It was shown that radiated or reflected light is often capable of revealing much as to the composition and physical condition of the body whence it comes. To render possible investigations of this kind, the desirability of possessing means for the analysis of light was made obvious. The experiments and observations of Grimaldi and Newton were referred to, and these early researches were followed down to the epoch when, by the association of a slit and other accessories, the simple prism merged into the spectroscope in its modern form. Fraunhofer's discoveries were described, and spectra rendered discontinuous by selective absorption were shown. The first general principles laid down by Kirchoff were quoted, and illustrated by the production of the continuous spectrum of incandescent solids and liquids and the bright line spectra of glowing gases and metallic vapors.

FIFTH MEETING.

The fifth meeting of the Society was held on the 22nd of April at the Observatory, the President (and Director of the Observatory) in the chair.

After routine, Mr. R. F. Stupart, of the Observatory staff, and Mr. J. Linden, were elected active members.

Early in the evening, upon the invitation of the President, the members repaired to the dome and were shown the fine six-inch equatorial by Cooke & Sons, of York, England, and the manner in which it is mounted and worked. This telescope was purchased by the Dominion Government to be used at Toronto during the transit of Venus on the 6th of December, 1882, and was placed in position under the supervision of the Director, who introduced some improvements in the construction and working of the dome. As the sky was clear and the seeing very fair, the evening was spent by the members in observing the moon, then three days old, and Saturn, then well placed. They were afterwards conducted to the Transit and Clock Rooms, where the methods of time correction and of telegraphic time signals with distant points were carefully explained and practically illustrated. The Director also exhibited Rowland's photographs of the normal solar spectrum. The visit to the Observatory proved to be alike enjoyable and instructive, and the courtesy of the Director was suitably acknowledged.

SIXTH MEETING.

Sixth meeting, 6th of May, the President in the chair.

Mr. T. S. H. Shearmen, of Brantford, Ont., was elected a corresponding member. Several candidates for active and corresponding membership were proposed. The Librarian reported that the proof-sheets of a paper by Professor Daniel Kirkwood, LL.D., and published in *The Danville Review* in 1861, had been presented to the Society by Mr. Elvins.

By request of the Society, Mr. A. F. Miller read portions of a correspondence conducted by him in 1885 with Mr. Shearmen, of Brantford, descriptive of that observer's earlier attempts in the direction of coronal photography in full sunshine. The Society expressed approbation of Mr. Shearmen's work, and a hope that he would contribute a paper on the subject at an early day.

Mr. Andrew F. Hunter, of Barrie, Ont., presented some notes of personal observation, and some local newspaper clippings respecting certain atmospheric phenomena at sunset noticed in the vicinity of Barrie and Orillia.

SEVENTH MEETING.

Seventh meeting, 20th of May, the Vice-President in the chair.

Mr. Robert Dewar was elected an active member. Mr. Andrew F. Hunter, B.A., of Barrie, and Mr. D. K. Winder, of Detroit, Michigan, were elected corresponding members. Candidates for honourary and corresponding membership were proposed.

A short criticism of Mr. J. H. Kedzie's book entitled "Gravitation, Solar Heat, and Sun's Spots," and prepared by Mr. Hunter, of Barrie, was read. There were also read from *Knowledge*, a paper on "Variable Stars," by Mr. A. Cowper Ranyard and Mr. C. E. Peek, and one by Mr. Royal Hill, on "The Eclipse of Algol."

EIGHTH MEETING.

Eighth meeting, 3rd of June, the Vice-President in the chair.

Professor Daniel Kirkwood, LL.D., of Riverside, California, and formerly Professor of Mathematics in the University of Indiana, was elected an honourary member. Two candidates for corresponding membership were proposed.

Among the communications read were interesting letters from Mr. Hunter and Mr. Shearmen.

Among the observations reported were the following:

By Mr. A. F. Milller: "1890, May 20, 23h. 32m. Observed a very brilliant meteor, the course of which was directed towards Alpha Aquilæ, passing over the region between Alpha Lyræ and Alpha Cygni. Its color, when first seen, was reddish-white, rapidly changing to bluish-white as its brilliancy increased. It left behind it a train of ruddy-white detached streaks, which remained visible for a short time. The meteor was much brighter than Venus at maximum brilliancy when seen on a dark sky."

By Mr. G. E. Lumsden: "1890, April 29, 21h. 09m. Observed meteor, with radiant point near Vega, pass across the sky in a southwesterly direction, and when about fifteen degrees west of Arcturus suddenly, by a small but well-defined curve, divert its course to the southward and apparently upward, and fade out of sight. Motion—slow and steady; no darting and rushing. Lustre—that of a dull yellowish-green train of light, without very bright head, rather than that of blazing meteor. Tried to account for apparent erratic course by supposing the meteor to have been of discoid form and travelling with flattened surface presented to atmosphere, causing, as the stone fell into the heavier strata, a resistance to its progress sufficient to swerve it out of its direct path."

Mr. D. J. Howell reported that on the 1st of June, while observing the image of the sun projected upon a screen, he saw the well-marked apparition of the flight of birds across the sun's disc. The motion was such that he inferred that the birds passed at a considerable distance from his point of observation.

An animated discussion arose with respect to the desirability of having, in popular parlance, "A Night with Saturn," such of the public as might be interested to be invited. Ultimately, several of the members expressed their willingness to place their telescopes at the disposal of any persons desirous of seeing Saturn and other celestial objects.

A paper on "A New Type of Double Stars," being an account of the observations and conclusions of Professor E. C. Pickering, of Harvard Observatory, in connection with The Henry Draper Memorial, was read and commented upon.

NINTH MEETING.

Ninth meeting, 17th of June, the Vice-President in the chair.

Sandford Fleming, C.E.,C.M.G.,LL.D., Chancellor of Queen's University, Kingston, Ont., and initiator of Cosmic Time, was elected an honourary member. Mr. H. Pettit, of Belmont, and Mr. John Goldie, of Galt, were elected corresponding members.

Among the communications read were letters from Professor Frisby, of the United States Naval Observatory, a native of Toronto; from Mr. H. M. Paul, Librarian to the Observatory, Washington, D.C., and from Professor J. G. Porter, Director of the Cincinnati Observatory, Ohio, covering the transmission of thirty-nine volumes for the Society's library. The Librarian reported that he had received through the Smithsonian

Institution the thirty-three volumes referred to by Messrs. Frisby and Paul, and comprising as complete a set of the publications of the Washington Observatory as can now be supplied, besides a number of pamphlets of a valuable character; also from the Cincinnati Observatory six volumes, being all the Director could furnish; also Volume I. of the Lick Observatory. The Corresponding-Secretary was instructed to convey to the Directors of the several Observatories a due sense of the obligation under which, by their handsome donations, they had placed the Society.

By means of the Society's sciopticon, Mr. D. J. Howell showed a large number of views loaned by the Chicago Lantern Slide Club. These included photographs of the moon, one of which was taken by Mr. S. W. Burnham with the great Lick telescope.

On the evening of the 24th of June, an informal meeting was held for the purpose of inspecting a six-inch reflecting telescope made by Mr. Mungo Turnbull, of Toronto, and mounted on a parallactic stand; also some celestial globes constructed, by Mr. Turnbull, on a new principle.

TENTH MEETING.

Tenth meeting, the 15th of July, the Vice-President in the chair. It was announced that Mr. Carpmael, the President, was absent on a tour in the north-western portions of Canada, including British Columbia, for the purpose of inspecting meteorological stations and of establishing additional ones, and that, in all probability, his absence would extend over a period of several months.

The Librarian reported the receipt from Professor Pickering, of Harvard Observatory, of additional volumes, including four of the parts of The Henry Draper Memorial; also from Professor Holden, of the Lick Observatory, of Volume II. of the publications of The Astronomical Society of the Pacific.

Mr. A. F. Miller read his second introductory paper on "The Use of the Spectroscope." The effects of selective absorption in the production of colour phenomena were referred to, in which connection some description was given of experiments made by the writer in 1887, designed to study the results of introducing special predetermined selective absorption into a continuous spectrum received upon the surface of a concave silvered glass speculum and viewed when the rays were re-assembled upon a screen placed at its focus; whereby also the colour-effects attendant upon the re-union of any specified portions of the visible spectrum could readily be observed. Dealing with the joint effects of selective radiation and selective absorption, a description was given of the early experiments whereby the co-incidence of many bright lines in metallic spectra with Fraunhofer's lines was demonstrated, the simile of a photographic negative and positive being used to illustrate this point. The work of Kirchoff was described, and his experiments showing that a glowing vapour absorbs the identical radiations which it can emit, were repeated. The obvious bearing of these facts upon theories of solar physics was pointed out, and the confirmatory observations of Young and others in this connection were cited.

AN EXTRA MEETING.

On the 12th of August, during the holiday season, an informal meeting of the Society was held at the Observatory. Owing to the continued absence of the Director, Mr. F. L. Blake, D.L.S., of the Observatory staff, took charge of the members, and, in addition to other courtesies, placed the six-inch refractor at their disposal. The greater portion of the evening was spent in observing Venus, Mars, and Jupiter.

ELEVENTH MEETING.

Eleventh meeting, 26th of August, the Vice-President in the chair.

Among the communications read was one from Professor O. Tetens, Director of the Observatory at Bothkamp, Germany, who was so fortunate as to be able to take excellent negatives of the occultation of Jupiter by the moon on the 7th of August, 1889. The Professor requested the acceptance by the Society of a series of photographs and drawings of the phenomenon. The thanks of the Society were ordered to be conveyed to Herr Tetens. In a letter, Mr. S. E. Roberts, of Mimico, Ont., a corresponding member, described a remarkable lunar rainbow, exhibiting prismatic colours, recently observed by him.

Mr. Mungo Turnbull showed drawings of Jupiter and photographs of the last transit of Venus.

A paper on "Coronal Photography in Full Sunshine," contributed by Mr. T. S H. Shearmen, of Brantford, Ont., a corresponding member, was read by Mr. A. F. Miller, as follows: "The photographs of the spectrum of the solar corona obtained at the total eclipse of May, 1882, showed it to be very rich in blue and violet rays. This discovery led Dr. Huggins in England and myself in Canada to devise methods of photographing the corona in the absence of an eclipse. As the difference between the brightness of the illumination of our atmosphere and that of the atmospheric illumination and corona combined is very slight, optical and photographic expedients of great delicacy must be resorted to in order to detect it. We must, in the first place, have an image quite free from false light. This secured, we must, by a series of photographic expedients, give the brighter parts of the image a prominence over the the other. Dr. Huggins showed how this could be done by giving the plate an exposure just long enough to catch the illumination of our atmosphere where that illumination is intensified by the light from the corona and by using a well-restrained developer. Intensification after development gave still greater contrast to the chloride of silver plates used by Dr. Huggins. These plates are highly sensitive to the ultra-violet rays (in which the corona is rich) and respond readily to the process of 'heightening contrast.' The optical means employed by Dr. Huggins to form the image is a speculum metal reflector. No secondary reflector is used, nor is the speculum tilted as in the ordinary Herschellian instrument. It has a working aperture of three inches and a focal length of about six feet. The total length of the instrument is, however, nearly twelve feet, the incident rays passing down a tube containing a number of diaphragms placed a few inches apart. The solar image is formed near the centre of the instrument, where a rapidly moving shutter passes close to the plate. Sometimes a a disc is used to screen the plate from the sun's image, the shutter passing between the disc and the sensitive plate. This shutter is larger than the sun's image in order to prevent diffraction effects. The interior of the apparatus is well blacked and the outside wrapped in folds of flannel and swan's down calico to prevent convection currents inside. The developer used is a solution of ferrous citro-oxalate. The plates are backed with a solution of asphaltum in benzole, thereby preventing reflections from the back of the plate. This method had been put to a practical test during the last few years by Dr. Huggins and others under his direction, and is now being tried at the Athens Observatory. When the sky is very clear and transparent, it is believed traces of the corona have been obtained. My method of forming the solar image is very simple. No lens or speculum is used, the duty of forming the image being delegated to a minute hole. In other words, I make use of what is commonly called 'pin-hole photography.' My attention was first called to this method of forming an image of the sun for scientific purposes about ten years ago, when I detected sun-spots in an image formed by the solar rays entering a small hole in a Venetian blind and falling on the whitened wall of the apartment. Believing such an image to be free from scattered light, I determined when the question of photographing the corona without an eclipse came up, to put it to a practical test. In order to guard against irregularities, the plate containing the hole is sometimes made to revolve, the sensitive plate of course remaining fixed. In the photographic process employed, I have used paper instead of glass plates. On several occasions, when the air has been very transparent, I have obtained corona-like markings around the solar image; but the experiments being still in progress, I will not refer to my results at present. In conclusion, I would say that the possibility of photographing the corona in full sunshine has been called in question because it requires us to detect the difference in the intensities of two lights having the proportion, according to Professor Holden, of 1000 : 1002. Against this, I would cite the observation of the moon, Mercury, and Venus, projected on the corona. These objects have been seen as black discs before they reached the sun, proving that the corona must have a sensible brightness compared with the atmospheric illumination."

The interest of the Society in Mr. Shearmen's work was evinced by a vote of thanks for his paper and by the expression of the hope that he would succeed in his investigations, so patiently conducted.

TWELFTH MEETING.

Twelfth meeting, 9th of September, the Vice-President in the chair. Among the visitors were several ladies, who apparently took a deep interest in the proceedings.

The Librarian reported the receipt from the Washington Observatory of a copy of "Washington Observations, 1884"; also for 1885; also Appendix I., "The International Astro.-Photographic Congress"; also Appendix II., "Saturn and his Rings—1875-1889," by Asaph Hall.

The observations reported included a memorandum by Mr. A. F. Miller respecting the sun-spot group of the 25th of August which he had observed telescopically and spectroscopically, the latter method revealing several peculiarities, notably the widening of many lines. Mr. G. E. Lumsden stated that on the night of the 11th of August, and within the hour and three-quarters commencing at 22 o'clock, he counted in the north-eastern sky ninety-two meteors apparently having their radiant points in Perseus and in Auriga. Some of them were noteworthy. One that, as he thought, must have moved in the line of sight appeared for an instant simply as a ball, larger than Jupiter, of liquid yellow light, without motion. Glowing out as it did against the black sky, it formed for the observer a singularly beautiful and uncommon object. Three fine Aurigids, travelling in parallel lines about half a degree apart and at intervals of a second, passed southward directly below Beta Andromedæ. Several fine meteors, with short paths, appeared nearly overhead. Many of the shooting-stars, however, were very pale and visible only as the merest threads of light.

A paper by Mr. J. E. Gore, F.R.A.S., on "Binary Stars," was read from *Knowledge*.

THIRTEENTH MEETING.

Thirteenth meeting, 23rd of September. The earlier part of the evening was spent in observing the moon, Jupiter, and Mars, with portable telescopes, provided for the purpose. The air being steady and very clear, some excellent views were obtained. The chair having been taken by the Vice-President, some routine business was transacted. A candidate for active membership was proposed.

Among the communications read was one from Mr. J. A. Brashear, of Alleghany, Pennsylvania, the eminent optical instrument manufacturer who, on account of a previous letter addressed by him to the Society, had been consulted with reference to the durability of Jena glass objectives, which he makes. In the course of his letter, Mr. Brashear stated that the whole difficulty about Jena glass came from the deterioration of their boro-silicate flints and kali crowns, with which such fine corrections were obtained. He added: "We made some very careful studies of these glasses and found that Crown 14 and Flint 27 of the Jena Catalogue gave the finest corrections ever obtained; but alas! the crown was seriously hygroscopic, and reluctantly we had to abandon this glass. . . . The chromatic corrections were so fine that the penumbral tints were neutral and the image superb. Professor D. B. Brace, of the University of Nebraska, has my glass now, using it for some critical studies of the action of a powerful magnet on a beam of light. . . . Well, we selected more Jena glass that does not deteriorate, but gives a large percentage of value, and have made over fifty objectives from 3 to 8 inches, and we are soon to commence the 16-inch for the Carleton College Observatory. This, however, is to be made of Jena flint and a special crown made for us by Mantois. We are also making a 12-inch of 17 feet focus and one of 15 feet focus. . . . All crown glass that has potash in it will for a while become slightly hygroscopic (especially in damp weather), but it seems to wear away and does no harm, but it was the borate flints of the Jena glass that caused the lively talk about its deterioration, and it came almost altogether from the microscopists."

Observations of the sun by Mr. Miller and of the moon by Mr. Lumsden were reported. The subject of occultations being under discussion, Mr. Elvins mentioned that some years ago he had observed an occultation by the moon of the Pleiades, the disappearance being instantaneous in the case of all the stars save one, which appeared for a brief time to be projected on the moon's disc. Selections from the last edition of Chambers' Descriptive Astronomy bearing upon the subject were read.

A portion of a paper in *Knowledge* by Mr. A. Cowper Ranyard, on "Some Recent Advances in Mapping the Solar Spectrum," was read, and, after discussion, Mr. Howell promised a paper, to be practically treated, on "Ortho-chromatic Photography," having special regard to the manufacture of plates sensitive to the less refrangible rays of the spectrum.

FOURTEENTH MEETING.

Fourteenth meeting, 7th of October, the Vice-President in the chair.

Mr. Clarence Bell was elected an active member, and a candidate was proposed.

Among the communications read was one from Joseph Morrison, M.A., M.D., Ph.D., F.R.A.S., Assistant at the American Nautical Almanac Office, Washington, U.S.A., desiring the Society to accept a copy of the American Ephemeris and Nautical Almanac for 1890, 1891, and 1892, and of The Almanac for 1893; also of the Report of the Observations of the Total Eclipse of the Sun, 1889. The thanks of the Society were voted to Dr. Morrison, who, it was announced, was a native of Toronto.

One of the subjects discussed was the expediency of subscribing, as a Society, to a guarantee-fund, proposed to be raised by a member of the Senate of the University of Toronto, for the purpose of securing compensation for certain of the professors who, it was understood, were willing to deliver in the evenings a course of popular lectures on mathematical and physical subjects. While it was not deemed to be advisable to commit the Society to such a fund, it was decided to encourage its members and others to avail themselves of the advantages to be derived from the intended lectures, should the scheme be carried into effect.

A committee was appointed to consider and to report upon the best means for promoting the objects for which the Society became incorporated.

Not having had time to prepare his paper, which was, however, promised for a subsequent meeting, Mr. D. J. Howell, in the meantime, gave a brief account of the ortho-chromatic method in photography and exhibited samples of ordinary and of stained plates, as well as some negatives taken with both kinds and the resultant prints.

FIFTEENTH MEETING.

Fifteenth meeting, 21st October, the President in the chair.

The Honourable Sir Adam Wilson, Knight, was elected an active member and a candidate was proposed.

Included among the communications read were interesting letters from J. J. Wadsworth, M.A., M.B., of Simcoe, and Mr. R. J. McLellan, of Dundas, Ont. A Report was presented by the Committee appointed to consider the best means of promoting the objects of the Society. It was adopted, and the Committee was instructed to consider several other cognate matters which were referred to it.

Several observations of solar spots made by Mr. T. S. H. Shearmen, of Brantford, were read. They were supplemented by Mr. A. F. Miller. Mr. A. Elvins stated that on the 17th of October he had observed an aurora, and that he had been informed that considerable magnetic disturbance on the same evening had been registered at the Observatory. He called attention to the co-incidence that existed between the aurora and the appearance of the group of sun-spots observed by Mr. Miller and by Mr. Shearmen.

The President referred to the greater brilliancy, as compared with this part of Canada, of the auroræ observed by him while recently on his tour of inspection in the North-western Territories. He also exhibited some very large maple leaves brought by him from the west. He explained that these leaves, which were four or five times larger than the normal maple leaf found in Ontario, had been plucked from second-growth maples.

Mr. John G. Ridout read a paper on "Solar and Lunar Parallax," or the method of determining the distance of the sun from the earth, having special reference to data furnished by the transits of Venus, the last of which it was his good fortune to observe at Winnipeg, Manitoba, where the conditions were very satisfactory. Solar parallax being the angle which the equatorial radius of the earth would subtend to an observer at the sun when the earth is at mean distance, Halley suggested that a transit of Venus, which was at that time about to take place, would afford a method of determining it. The first observed transit of Venus was in December, 1639; in June, 1761, there was a second transit, and a third in June, 1769, when the parallax of the sun was first determined in a satisfactory manner by Halley's method. In determining this problem, the relative distances of the earth and Venus have to be ascertained. The determination of this ratio between Venus, the earth, and the sun, is deduced from Kepler's second law, which was demonstrated in 1618 and first applied by Halley in 1761, namely, "The squares of the periodic times are proportional to the cubes of the mean distances,"

$$\text{Therefore } \frac{D^3}{d^3} = \frac{(1.62)^2}{1} = \frac{2.6244}{1}$$

$$\text{and } \frac{D}{d} = \frac{1.3795}{1} \text{ or } \frac{100}{72} \text{ nearly.}$$

That is, if 100 on the scale represents the mean distance of the earth from the sun, 72 represents that of Venus from the sun. To give the details of the problem would make this synopsis too long and necessitate diagrams, etc.; but in utilizing the transit of Venus, it may suffice to say that we measure a large angle in order to infer from it a small one, which makes this transit the most favored of all for obtaining an exact result. A transit of Mercury is inapplicable to the measure of the sun's distance, because the measured and the required angles are here in the proportion of 4 to 6—a small angle is measured to obtain a large one, which is unfavorable to accuracy. Having determined the relative distance of Venus and the earth from the sun, the problem is worked out mainly by the formula "that the sines of angles are proportional to the length of the opposite sides." The sources of possible error are still of such a character as to render a mathematical exactness of result an impossibility. Owing to a movement of the nodes of the planes of the earth and Venus analogous to the recession of the moon's nodes, the transits of Venus occur in groups of two, about eight years apart, which groups are separated by prolonged intervals of over a century. The next transits will occur on the 8th of June, 2004 and on the 6th of June, 2012. From the transit of 1769, the solar parallax was determined at 8.81″, 8.58″, 8.91″ and 8.70″—four different results; from the transit of 1874, 8.76″, 8.88″, and 8.85″, and from the transit of 1882, 8.95″, 8.96″—a result nearly similar to that of 1769. The solar parallax has also been determined from our knowledge of the velocity of light, the value of which first became approximately known to Roemer by his observations of the eclipse of Jupiter's satellites. By the retardation of the calculated times of eclipses, it is deduced, that it takes light sixteen and one-third minutes to traverse the diameter of the earth's orbit; hence, if the velocity of light can be determined, the diameter of the earth's orbit becomes known. By Fizeau's direct measurement, by means of a toothed rotating disc, the velocity of light has been determined at about 186,700 miles a second, which gives 182,928,660 miles for the diameter of the earth's orbit, about half of which would give the distance of the sun, and this agrees very approximately with the result arrived at from the solar parallax of 8.95″.

SIXTEENTH MEETING.

Sixteenth meeting, 4th of November, the President in the chair.

In the course of the evening, Mr. Carpmael, in reply to a question, stated that he had received from the Dominion Government permission to accept the nomination of the President of the United States National Academy of Sciences to attend, in his capacity as Chief of the Meteorological Service of Canada, a meeting of the Academy, to be held on the 12th of November at Boston, Massachusetts, for the purpose of formulating a plan for the successful determination of the position of the North Magnetic Pole, for which arrangements were being made under the auspices of The Smithsonian Institution. It was further announced that Mr. Carpmael would make a careful investigation of the results obtained at some of the United States' Tidal Observation Stations, with a view to utilizing the information, so gained, in improving the Canadian Service.

The President also referred briefly to efforts recently made on two occasions by the Toronto Observatory to exchange time with the Greenwich Observatory. For certain reasons these efforts had not been entirely satisfactory, but it was confidently hoped that a third attempt, intended to be made at an early day, would be crowned with success.

Mr. Stephen Huebner was elected an active member and a candidate was proposed. Several communications were read. One from a distant part of the United States requested information respecting the objects of the Society and the best means for forming a similar one. The Librarian reported the receipt of additional publications from The Astronomical Society of the Pacific. A second Report from the Committee charged with considering the means by which the objects of the Society may be promoted was received and adopted. Mr. A. F. Miller reported further telescopic and spectroscopic observations of sun-spots.

The following paper on "Observing the Solar Corona by Fluorescence," contributed by Mr. T. S. H. Shearmen, of Brantford, was read by Mr. A. F. Miller. "About eight years ago, Professor Wright, of Yale University, made an attempt to see the corona of the uneclipsed sun by the aid of fluorescence. He originated the method, and described it in a paper read before The National Academy of Sciences, in April, 1883. The eclipse of May, 1882, having shown the light of the corona to be very rich in violet and ultra-violet rays, he reasoned that it should be more brilliant to a fluorescent screen than to the unaided eye. He accordingly reflected the solar rays into a darkened room by a heliostat, and after passing them through an absorbing cell, which cut off all but the blue and violet radiations, brought the image to a focus on a sensitive fluorescent screen. The sun's disc was stopped out, leaving the eye better prepared to recognize minute differences of light and shade in the solar surroundings. In a letter received a few days ago from Professor Wright, he says: 'I obtained what I considered to be a visible image of the corona, and the results were very encouraging, but the experiments were interrupted by the effects of the Krakatoa eruption, which rendered further work for a long time impossible. I have recently made some trials of the method, and intend to pursue it further, as the work is still on my hands as an unfinished investigation, of which my paper was, in effect, a preliminary notice. The completed results would have been published long ago had it not been for the interruption mentioned above.' Although I have long had the method in view, I have only recently made a trial of it. For many years past the photographic method has engaged my attention to the exclusion of other plans. In my recent attempt, I made use of a speculum to form the image, and dispensed with the heliostat and absorbing-cell. I allow the solar rays to enter a darkened room through a short tube, and, after reflection from the speculum, to fall on the fluorescent screen placed slightly to one side of the tube. In the centre of the screen is a hole slightly larger than the sun's image. When the solar image is brought centrally over this hole only the surrounding sky is to be seen, and the eyes are not dazzled by the intense glare of the sun's disc. Fearing the stoppage of some of the blue and violet rays, I did not use a silvered glass speculum. A metal reflector not being at hand I used one of unsilvered glass, and in order to prevent reflections from the back, it is formed on one of the sides of a total reflection prism. I have not yet obtained many observations with this apparatus. On one occasion I fancied a corona-like ray was visible close to the western limb, but I could not hold it steadily. I am now waiting for a clear day to make further experiments. An experience of eight years in coronal work has shown me that there are very few days in a year clear enough for investigations of this kind. The sky must be of a blue-black colour, the slightest trace of haze instantly blotting out coronal forms. Brantford, 1890, November 1st."

"*Addendum.*—To prevent a possible misapprehension, I would say that the unsilvered speculum mentioned above is, of course, a first surface one. It is now replaced by a smaller metallic one. The latter will also be used in an attempt to photograph the corona by Dr. Huggins' Method. Brantford, 1891, February 5th."

Mr. A. Elvins read his first paper on "Moving Matter." The paper was an attempt to form conceptions of *matter*, its relation to *energy* and the *ether* of space. The view which regards matter as solid, impenetrable, indivisible *moving* particles, subject to the known laws of motion, was, Mr. Elvins thought, capable of explaining natural phenomena, and was accepted by him as true. Every such ultimate atom occupies space, and no two atoms can occupy the same space at the same time. That which we call *energy*, or *force*, is simply matter in motion, the word *force* representing the number of atoms and the rate of their motion. Mr. Elvins believes that a definite number of such moving atoms exists in the universe, the total sum of the *motion*, like that of the number of atoms, being a constant quantity. He holds, too, that masses are composed of moving atoms and that the vibration of the atoms, consequent on their collisions, is what we know as *heat;* any increase of atomic motion will lengthen the free path of the atoms, and hence must increase the size of the mass without affecting its weight; hence we see why we must have a *thermo-equivalent* of mechanical force and a *mechanical* equivalent of heat. Mr. Elvins regards the *ether* as matter in its atomic condition; as the free path would be comparatively long, the collisions would be few, but when they collide with masses they impart their motion to the atoms forming the mass, increasing their number of collisions. Thus, though space is cold, masses become hot.

SEVENTEENTH MEETING.

Seventeenth meeting, 28th of November, the Vice-President in the chair.

A candidate for membership was proposed. Among the communications was one from Mr. A. Cowper Ranyard, editor of *Knowledge*, respecting the publication of that magazine on an earlier day in the month and the predictions given of astronomical phenomena.

The Librarian reported the receipt, through the Smithsonian Institution, of a large number of valuable publications upon meteorological and astronomical subjects. The thanks of the Society were voted.

Predictions of occultations and minima of Algol were announced, and members, notwithstanding the prevalence of unsuitable weather, were requested to observe them, if possible, and report. Among the observations reported was the passage from a point near Alpha Arietis towards Alpha Aquarii, at 21.18 on the 17th on the month, of a very large and very slowly-moving meteor. The star was notable by reason of its dull red colour and a train of red colour visible during some seconds.

Mr. G. G. Pursey tendered his resignation as Treasurer.

A paper on "The Latest Astronomical News," by Professor Charles A. Young, and published in *The Forum*, was read and commented upon.

EIGHTEENTH MEETING.

Eighteenth meeting, 2nd of December, the Vice-President in the chair.

Mr. William H. Seyler and Mr. John A. Paterson, M.A., were elected active members.

Mr. A. F. Miller and Mr. A. Elvins made special reports upon and displayed drawings made at their telescopes of a remarkable group of spots which passed across the sun's disc between the 21st and the 30th of November. Among other reports made was one of an occultation by the moon of a star and another of a minimum of Algol, both by junior members. The interest taken in practical work by the younger members was regarded as highly encouraging and the results creditable.

A paper on "The Identity of Light and Electricity," by Hertz, was read from *The Popular Science Monthly*, and occasioned an animated discussion.

NINETEENTH MEETING.

The nineteenth meeting of the Society was, by request, held at the residence of Sir Adam Wilson, who, having purchased and placed in position a six-inch telescope, was desirous that the members should test it. The night, however, proved to be unsuitable for observation. The Vice-President accordingly took the chair at 20 o'clock.

Two candidates for active and one for corresponding membership were proposed.

Among the observations reported was one respecting a small but active group of sun-spots. Attention was drawn to a remarkable article in *The American Journal of Science and Art*, in which Professor Langley described his spectroscopic researches upon the light emitted by certain insects. Mr. John A. Paterson referred to recent spectroscopic determinations of celestial motions wherein the results have been verified by comparison with effects of the known orbital motions of the planets. In the course of the discussion, the chairman cited an article by Mr. Parkhurst, in *The Sidereal Messenger*, which, he said, would throw light upon that subject.

Mr. Thomas Lindsay read a paper on "Astronomical Predictions." Mr. Lindsay's object was to show that some very close approximations may be reached by simple processes, aided by tables of elements of the solar system and the ephemeris for any one year. Examples were given of the method of finding for any epoch the sun's longitude and longitude of moon's node and perigee point. In the case of the sun, the position is taken from the ephemeris for the moment when an integral number of sidereal revolutions of the earth are completed, reckoning from the epoch. Applying to this the correction for precession, the error resulting will be well within 10 seconds of arc. An error slightly greater in calculating the place of the node, still enables us to trace the moon's path in any lunation with sufficient accuracy for naming the occulted stars. The accuracy in naming the moon's place in longitude for any epoch depends upon the correctness with which we name the perigee point, and for this we should use the period between successive returns of the sun to the lunar perigee. An example was given of the following method of determining the moon's longitude. Take from the ephemeris the configuration between the sun and moon for the moment, between which and the epoch there are an integral number of synodic revolutions. Take the date about the same time of the year as that in which the epoch falls. Several inequalities in the moon's motion are thus accounted for. Then, remembering that the synodic revolution refers to the mean motion of the moon with respect to the mean motion of the sun, the true arc is to be reduced to the arc between the mean places. Then the configuration between the mean places at the epoch will be the same as on the date selected. The mean configuration at the epoch is then to be reduced to the arc between the true places. The sun's correction is easily found, and the accuracy of the final result will be according to the placing of the lunar perigee. Examples were shown of tables giving the moon's correction for different positions of the perigee and different distances of the moon from it. An error of a few degrees in naming the perigee point will not involve a greater error than one-quarter of the moon's diameter in finding her longitude at the epoch. The above calculations require the processes of arithmetic only.

TWENTIETH MEETING.

Twentieth meeting, 30th December, the President in the chair.

Mr. Arthur W. Morphy and Mr. J. A. Livingston were elected active members, and a candidate was proposed. Mr. J. H. Kedzie, of Chicago, Illinois, was elected a corresponding member.

Among the communications read were one from Dr. Morrison, Assistant at the American Nautical Almanac Office, Washington, covering the transmission of additional publications, and of a paper on "The Disappearance of Saturn's Rings"; and a second from Mr. J. W. Crouter, of Sudbury, Ontario, asking the Society to advance funds to enable him to publish a work respecting certain views he entertains regarding several astronomical questions.

A Committee, consisting of the Vice-President and the two Secretaries, was appointed to prepare the matter to form the first Annual Report of the Society and to take charge of the printing of the same.

With the assistance of several diagrams and a series of formulæ, in large, Mr. Thomas Lindsay, read the following paper on "The Disappearance of Saturn's Rings," contributed by Dr. Morrison.

"Among the numerous celestial objects which claim the attention of astronomers, none possesses a greater charm than the planet Saturn. Surrounded by its magnificent and graceful rings and attended by its family of eight satellites, it presents in the field of view of a powerful telescope a gorgeous spectacle—one never to be forgotten. The rings, though circular or very nearly so, are always seen obliquely; their apparent figure is therefore an ellipse, with the planet occupying the centre; and when observed from year to year, it is soon discovered that their aspect is subject to very great variations.

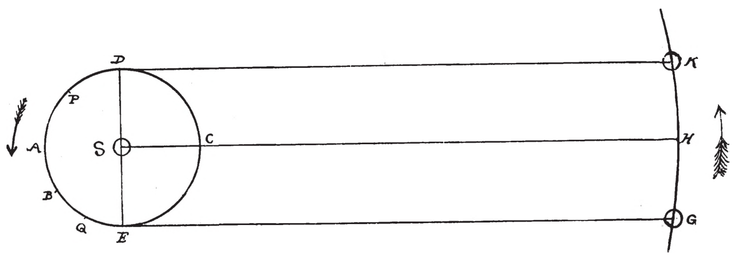
"When viewed under the most favorable circumstances, the minor axis of the apparent ellipse is about equal to half the major axis, after which the former decreases until, at the end of about seven and a half years, the rings appear as a very slender straight but rough line extending out on opposite sides of the planet, and finally disappearing from our view altogether. Galileo was the first to observe this phenomenon, but not having command of sufficient optical power, he was unable to explain it. In his telescope, Saturn appeared as a large globe with two oval appendages affixed to it on opposite sides. After observing it for two or three years, he was greatly astonished and perplexed to see the appendages gradually fading away and finally becoming invisible, and, after a short interval, again reappearing. Unable to account for this extraordinary and unexpected phenomenon, he was led to suspect some optical illusion connected with his telescope, and it is related that his chagrin and disappointment were so great that he never afterwards looked at Saturn. The plane of Saturn's rings is inclined to the plane of the earth's orbit at an angle of 28° 10′; and as the planet moves round the sun, its axis, as well as the plane of the rings, preserve the same absolute direction in space, just as the axis of the earth and the plane of our equator do. As seen from Saturn, the earth's orbit subtends an angle of 12° 2′; and since the planet completes a revolution round the sun in 10759.219 days, it will pass over this angle in about 360 days, or about 5½ days less than a year, during which period there will be one or two disappearances of the rings, according to the position the earth may occupy in its orbit at the moment when the plane of the rings extended first becomes tangent to the earth's orbit. The rings may become invisible from the earth for the following reasons:

"(1) When the plane of the rings passes through the earth, their edge being quite too thin to be seen except in the most powerful telescopes.

"(2) When the plane of the rings passes through the sun, their edge, though illumined, being invisible in ordinary telescopes, since it subtends no appreciable angle.

"(3) When the plane of the rings passes between the earth and sun, in which case the dark or unillumined surface of the rings is turned toward us, when they become absolutely invisible.

"Two disappearances usually occur during the year in which the plane of the rings traverses the earth's orbit. This will be easily understood from a consideration of the following diagram, in which *S* represents the sun; *ABC* the earth's orbit; *GHK* a portion of Saturn's orbit; and *H* the position of the planet when the plane of the rings passes through the sun. Draw the tangents *EG* and *DK* parallel to *SH*; then, since the rings always preserve their parallelism, *G* and *K* will be the positions of the planet when the plane of the rings (extended) is tangent to the earth's orbit, and therefore no disappearance can take place unless the planet is between these points. Suppose now that when Saturn is at *G*, the earth is at *D*, or that the earth's heliocentric longitude exceeds that of Saturn by about 96°; then, as the earth proceeds in its orbit, it will meet the advancing plane of the rings somewhere in the vicinity of the point *B* in the quadrant *AE*, when the



rings will disappear, and the disappearance will continue until the planet arrives at *H*, when the plane of the rings passes through the sun; for after that time the illumined side will be turned toward the earth. A disappearance under these circumstances will last about 60 days. While the earth proceeds from *B* through *E* and *C* to *D*, the point from which it started when Saturn was at *G*, the plane of the rings will pass from *HS* to *KD*, and will pass through the latter position about 5½ days before the earth arrives at *D*, and therefore in this supposed case there can be only *one* disappearance during the time the plane passes over the earth's orbit. If, however, when Saturn is at *G*, the earth is some degrees farther advanced in its orbit, as at *P* in the quadrant *DA*, the latter will meet the advancing plane of the rings somewhere in the quadrant *AE*, as at *Q*, after which the dark side will be turned toward the earth and the disappearance will continue until the plane passes through the sun, the earth being then somewhere in the quadrant *EC*. The earth, however, will overtake the plane in the quadrant *CD*, when the rings will again become invisible and continue so until the earth recrosses the plane somewhere in the quadrant *DA*. There will thus be two disappearances, and the earth and Saturn may be so adjusted at the commencement that these two disappearances may unite in a single one of about eight months' duration. This will happen when the plane of the rings passes through the earth and sun at the same instant; that is, at the time of opposition, when the earth and planet occupy the positions *C* and *H* respectively, for then the plane passes between the earth and sun both before and after opposition. Again, if the earth is at *A* when the planet is at *H*, the illumined side of the rings must have been turned toward the earth while the planet was moving from *G* to *H*, and the illumined surface will also be presented to the earth while the planet moves from *H* to *K*; therefore the disappearance can only last for a moment, and even this cannot be observed, since the planet is in conjunction with the sun, and is lost to view in the splendor of his rays. Recapitulating, then, we have, in general: during the year the plane of the rings crosses the earth's orbit *two* disappearances arising from the third cause, each of which begins and ends with a disappearance from the first or second cause. In the disappearance of September and October, 1891, the plane of the rings will first pass through the earth on September 22—ten days after the conjunction of Saturn with the sun—after which the earth will be on the dark side of the rings until their plane passes through the sun on October 30, an interval of 38 days. This disappearance occurs under conditions not very favorable for observation, Saturn being a morning star. The best time to observe the planet will be in the early mornings a few days before the reappearance of the rings, when Saturn will have advanced some 30° or more from the sun. The next disappearance will of course take place when the planet will have completed half a revolution round the sun; and the planet's period being 29.458 years, half of this, or 14.729 years, is the average interval between two consecutive disappearances; hence the next will happen in 1906, and will be under more favorable conditions for observation.

"The times of disappearance and reappearance are thus determined: Let θ denote the angle which the line of sight makes with the plane of the ring; N the right ascension of the ascending node of the rings on the equator; i the inclination of the plane of the rings to the *equator*, and a and δ the right ascension and declination of the planet respectively, then in the spherical triangle formed at the planet by joining the earth and the poles of the rings and the equator, we shall have :

$$\text{Sin}\ \theta = -\cos i \sin \delta + \sin i \cos \delta \sin (a - \text{N}),^*$$

θ to be taken always between $+ 90°$ and $-90°$, the positive sign indicating that the earth is on the north side of the rings and the negative sign on the south side. This formula may be easily computed by Zech's Addition and Subtraction Logarithms, or it may be readily adapted for common logarithmic computation as follows :

$$\text{put}\quad \text{c} \sin \text{C} = \cos i$$
$$\text{and}\quad \text{c} \cos \text{C} = \sin i \sin (a - \text{N})$$
$$\text{then}\quad \sin \theta = \text{c} \cos (\text{C} + \delta).$$

As an example, let us take the date 1891—September 17, Greenwich mean noon. From the Nautical Almanac, we have : $a = 172° 25'.8$, $\delta = + 5° 20' 46''$; and from the elements of the Saturnian system : $\text{N} = 126° 45' 4''$ and $i = 6° 59'.8$. With these data, we find $\text{C} = 84° 58'.9$, $\log \text{c} = 9.99843$, $\sin \theta = 7.75662n$ and $\theta = - 0° 19' 38''$, which indicates that the earth is still on the south side of the rings. In a similar manner, we find on October 7, Greenwich mean noon : $\theta = + 0° 48' 23''$, from which we see that the earth has passed to the north side of the rings. A simple interpolation gives September 22, 21h., Greenwich mean time, as the exact date when the earth is in the plane. In a similar manner, we find when the sun is in the plane of the rings, in which case the planet and rings must be referred to the plane of the ecliptic. Thus on November 16, Greenwich mean noon, the longitude of Saturn $= \lambda = 172° 38'.6$; latitude of Saturn $= \beta = + 2° 9' 21''$; longitude of node of rings on ecliptic $= n = 168° 4' 9''$; inclination of rings to plane of ecliptic $= i = 28° 10' 13''$. Whence by the preceding formula we get $\text{C} = 87° 33' 16''$, $\log \text{c} = 9.94565$, and $\sin \theta = 7.64951$ or $\theta = + 0° 15' 21''$, therefore, the sun is on the north side. On October 27, the sun was on the south side—the exact date of disappearance being October 30, 10h., Greenwich mean time. See *Am. Ephem.*, p. 477."

Mr. John Phillips read a paper entitled, "How our Moon Found Her Orbit," being a discussion of the projectile theory. He said the nebular hypothesis supposed the moon to have been formed at the

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* For a demonstration of this and other formulæ connected with this subject, see my paper in Vol. 44, No. 8, June, 1884, of the Monthly Notices of the Royal Astronomical Society, London, Eng., a copy of which is herewith forwarded to the library of the Society.

same distance from the earth's centre as she is at present, and at a time when the matter now forming the earth filled the sphere now enclosed by the moon's orbit. Professor Darwin supposes the moon to have been removed to her present position by tidal action, the moon passing outward slowly from the earth. The author ventured to formulate a third theory, namely, that the moon was shot off from the earth, and that she is still moving off from her primary. In support of his theory of projection, Mr. Phillips said there was but one satisfactory explanation, and that was this: "That the earth in the early stages of her history was in a molten state, revolving around the sun, rotating on her axis, unaccompanied by a satellite, and surrounded by an atmosphere extending beyond the lunar orbit; that the atmosphere was condensing and settling down upon the embryotic planet within, and that the mass composing the planet was in a state of great physical agitation much of the time; that during that period, by reason of a tremendous eruption, one-eightieth of the entire mass of matter was projected at an inclination to the perpendicular, owing to the rotation of the mass on its axis, and with force enough to penetrate the atmosphere and carry it a million of miles or so beyond; that the portion projected, on clearing the upper bounds of the air, took an elliptic course around the earth, the larger portion; that the place of leaving the appreciable limit of the atmosphere was the real point of projection, or place where the earth and moon actually separated; that the huge missile, first flying off to its greatest distance, or apogee, and returning earthward re-entered the atmosphere, swept through the upper portions thereof and left it again, as at first, on its second journey in its newly-found but variable orbit; that during its sweep through the air the missile met with resistance, which checked its speed or reduced its velocity; that it, therefore, broke through the air limit with less force than before and did not go so far; that the place of apogee consequently fell nearer, and its second trajectory was more circular than the first; that during each subsequent revolution this process was repeated, and that the orbit became gradually less and less eccentric, or more circular; and that by this means, in conjunction with the constant absorption of the atmosphere of the earth, our moon found her orbit."

TWENTY-FIRST MEETING.

Twenty-first meeting, 13th January, the Vice-President in the chair.

George B. Foster, M.D., was elected an active member. The Librarian presented a catalogue of the volumes in the library, and announced that upwards of one hundred books were ready for the use of the members. The resignation of Mr. G. G. Pursey as Treasurer was accepted, and a vote of thanks for the services rendered by him to the Society was passed.

Among the observations reported by junior members were occultations by the moon, and the fact that on the 7th of January, when near her greatest elongation west, Venus had been easily seen with the naked eye several hours after sunrise. The old moon, within a few degrees of the sun and reduced to a thin crescent, was also visible a little to the south-east of the planet. Information by a corresponding member was requested as to the place of Neptune in Taurus.

The following paper on the "Rotation Period of Mercury and Venus," contributed by Professor Kirkwood, of Riverside, California, an honourary member, was read by Mr. Elvins: "Few discoveries of recent times can compare in interest and importance with that of Schiaparelli, fixing the rotation periods of Mercury and Venus. The observations and discussions of this distinguished astronomer leave scarcely a doubt that each of these planets completes its rotation in the same time with its orbital revolution. Accepting this conclusion as demonstrated, the following remarkable facts remain to be discussed: 1. Every planet, primary and secondary, having no dependents, has equal periods of rotation and revolution. This class includes Mercury, Venus, and the secondary planets. 2. Equality of motions is not found in any *other* bodies connected with our system. In other words, it is wanting in the earth, Mars, Jupiter, and Saturn, and probably also in Uranus and Jupiter. These striking facts open to us at once a wide field of physical research. The failure of Mercury and Venus to have developed satellites; the relation between secondaries and the final rate of axis rotation; the effects of tidal friction in modifying ancient changes in the primitive system—all are questions of absorbing interest and fraught with the promise of ever-widening discoveries. The secondary planets have an alternate succession of day and night, the day being approximately equal to one-half the periodic time. This is all changed, however, in the case of Mercury and Venus. The hemisphere sunward has perpetual day, the other endless night. In each planet the only zone apparently tolerable would be that of twilight. As each planet has an atmosphere—that of Venus more extensive than the earth's—their meteoric phenomena must be frequent and varied. On their dark hemispheres the displays of lightning in the storm-cloud may afford the only mitigation of their perpetual midnight."

TWENTY-SECOND MEETING.

Twenty-second meeting, 27th of January, the Vice-President in the chair.

Joseph Morrison, M.A., M.D., Ph.D., F.R.A.S., etc., of Washington, U.S.A., was elected an honourary member, and a candidate for active membership was proposed.

Among the communications read was one from Mr. Mungo Turnbull, of Toronto, urging the Society to take the initiative in erecting a first-class telescope in Toronto, to be used by the public on certain conditions. The Recording Secretary was instructed to acquaint Mr. Turnbull with the fact that, at present, the Society was not in possession of funds sufficient to warrant the undertaking of a step of such importance. It was, however, hoped that the day would soon come when, by private munificence or otherwise, the Society might be instrumental in placing within the reach of students and others, not only in Toronto but elsewhere in the Province, optical instruments of a high class. The Librarian reported the receipt of additional publications from Washington.

Among the observations reported were several respecting sun-spots, which, in the opinion of the observers, were characteristic of the approach of the maximum period.

In a paper on "Constellation Study," the first of a series of an elementary character, Mr. G. E. Lumsden, after dealing with the subject generally, counselled beginners to be on their guard against temptations to take up in a desultory and unsystematic manner so charming a branch of observational astronomy. As in everything else, much greater progress would, in a given time, be made along lines wisely laid down. He did not presume to criticise the methods of study prescribed by the text-books, but it had appeared to him possible, and therefore expedient, so to clear the ground before the student that, in his practical work, he should not be hampered by misconceptions of the causes to which are due the apparent motions of the star-sphere as a whole, and of the constellations as portions of it. One of the first lessons given should, he thought, be devoted to acquainting the pupil with all the conditions local to his station of observation. The effects of the diurnal and orbital motions of the earth should be comprehended, as well as the diversity that exists between the movements of the sphere as seen (1) from a station on the equator; (2) from a station at the north pole; and (3) from a station like Toronto, for instance, about half-way between the equator and the pole. Possessed of this knowledge the beginner would, on commencing his work upon individual star-groups, be prepared for those apparent changes in their relative positions and otherwise which take place between the hours of rising and setting. Another preparatory lesson deemed prudent by the writer consisted of training the eye to judge distances upon the celestial arc. Ability to do this would prove to be valuable when the student came to compare with the constellations themselves the drawings made from maps and globes, and to pick up stars not readily distinguishable by brightness. As a rough method of accustoming the unskilled eye to estimate such distances, the use of a straight-edge, held out in front of the observer at arm's length, was recommended. Such an instrument of measure might be graduated by means of fundamental points marked upon it when held towards "The Pointers," which subtend an angle at the eye of about five degrees. By its use, some idea could be formed of the angles subtended by stars. The moon has an apparent diameter of about thirty minutes, and on the black ground of the night sky seems to be a very striking object, but if her disc be measured as suggested it will be found that lines drawn from her limbs to the eye pass across the stick only about one-quarter of an inch apart. An observation like this enables one to form some conception of the angles formed by objects several minutes or less apart. Having gained a conception of motions and distances, the pupil might, in the usual manner, make plans of the constellations and identify them and their individual parts on the star-sphere itself.

TWENTY-THIRD MEETING.

Twenty-third meeting, 10th of February, the Vice-President in the chair.

Among the reports were observations made by Mr. A. F. Miller respecting sun-spots, and drawings by Mr. G. H. Robinson of a group of spots visible on the 18th of January. The communications read included a letter of enquiry from Mr. P. R. Jarvis, of Stratford, Ontario, regarding the very bright object seen by him and others rising before the sun in the months of December and January, and its identity with the Star of Bethlehem. The Corresponding Secretary was instructed to inform Mr. Jarvis that the star seen was the planet Venus, then nearing her greatest elongation west.

Mr. A. Elvins read an interesting paper describing with some detail the very satisfactory observations made by him during twenty-four hours, one day and night last July. The seeing being unusually good, he was able to do very satisfactory work with Jupiter and Mars at night and with the sun in the day.

Mr. George B. Abrey, C.E., D.L.S., read a paper descriptive of the instruments for astronomical and other purposes used by him while in charge of Government surveying parties in the North-West Territories. The instruments, which were on view, included (*a*) A reiterating transit made by Troughton & Sims, of London, and designed for the survey of the standard lines in the Dominion of Canada Land Surveys. The telescope, which is of about eleven inches focal length and has one and one-half inches clear aperture, has sufficient power for observations of Polaris within three or four hours of noon. (*b*) A German universal instrument, made by Ertel & Son., Munich, and exhibiting workmanship of the highest class. The telescope is of the prismatic form, the rays entering the object-glass being reflected by a prism at the centre of the cross-axis to the eye-piece. (*c*) A time, or meridian, transit with 24-inch telescope, finder, etc. (*d*) A nautical sextant, eight inches radius, of best English construction, reading to 10″ of arc. (*e*) A box sextant, with supplementary arc. (*f*) A Frodsham watch, or chronometer, one of those used on the 49th Parallel Boundary Survey. (*g*) A rolling integrator, or planimeter, for measuring areas of irregular figures. (*h*) A transit made principally of aluminium. This instrument, in addition to being as complete as skill and money can make it, has two telescopes, one of which, with its attachments, is said to be entirely novel and to merit being somewhat fully described. It consists of a telescope proper, adjustable for focus at the eye-end, but in front of the object-glass is a small reflector which may be revolved on its axis placed at right-angles to the collimation of the telescope. To this axis is attached an arm carrying a vernier moving on an arc attached to the tube of the telescope, and reading to 20″ of arc. This attachment of reflector and arc is for setting to the declination of a celestial body. At the eye-end, behind the eye-piece and attached to it, is an eccentric disc having three openings in it. One of these holes is open, the second one has a dark plane lens, and the third a quarter-inch prism attached for right-angle sighting. By revolving this disc any one of the three openings may be brought before the eye-lens. The telescope has two cylindrical rings turned on the tube similar to a Y level telescope. The cross-axis for this telescope has a large circular ring in its centre, with bar and Ys similar to the Y level. The cross-axis with ring and Y bar are cast in one piece. The Ys for the tube of the telescope are adjustable laterally, so that the telescope may be placed at right-angles to the cross-axis, and in the centre over the verticle spindle. The telescope, when in place, occupies the centre of the cross-axis, and can be reversed end-for-end in its tube Ys as well as the cross-axis over the standards. The faces of the cross-axis ring are graduated for hour-angles, and time is read by an index attached to the telescope by revolving the telescope in its tube Ys. The telescope transits at its eye-end. It is also provided with a long diagonal eye-piece, and, with the aid of this in connection with the reflector in front of the object-glass, may be placed in and adjusted to a vertical position. Most of this instrument's adjustments, both ordinary and equatorial, may be effected with the telescope in a vertical position. This telescope and its attachments were designed especially for finding the meridian by observations on the sun, and the adjustments required are fewer and more accurately and substantially made than by any other arrangement known to the writer. All parts of the instrument are symmetrical and balanced; all observations taken on the sun may be made in pairs with all arcs reversed and a mean obtained for meridian. The telescope may be reversed in its Y tubes, and a second independent pair of observations and a mean obtained for meridian. It is to be noted that the error of all the arcs, namely, latitude, declination, hour and azimuth and collimation, are obtained by a reversal; that a single pair of observations eliminates the instrumental error in all, and that the cross-axis level may be read at the observation and error of level calculated. A similar construction might be adopted for equatorial mountings for observations of celestial objects other than the sun.

ANNUAL MEETING.

The twenty-fourth and annual meeting of the Society was held on the 24th of February, the President in the chair.

Several communications were received and read. The Committee on Publication presented a draft of the annual volume, which was ordered to be printed.

The Secretary in his report reviewed the history of the Society during its first year, and stated that there was every reason for congratulation in the steady growth of the members, in the increasing interest, and the practical work accomplished. The outlook for the future was bright and promising.

The Treasurer's statement showed a substantial surplus.

The Librarian with his report presented a catalogue of over one hundred volumes in the library of the Society, many of which are of great value, received as donations from Observatories and kindred Societies.

The following officers were elected for the year 1891-92: President, Charles Carpmael, M.A., F.R.S.C., F.R.A.S.; Vice-President, Andrew Elvins; Treasurer, D. J. Howell; Corresponding Secretary, G. E. Lumsden; Recording Secretary, Thomas Lindsay; Librarian, A. F. Miller.

The President then delivered his first annual address to the Society. He referred to the work which had been done during the past year, noticing particularly the discovery by Prof. Pickering of a class of binary stars too near each other to be separated by the most powerful telescopes in existence, or which we can ever hope to construct. This had been accomplished by photographing the spectra of the stars. Some stars had been found to show the lines of the spectrum double and single alternately, and at equal periods of time. The explanation of this fact was that two stars revolve around a common centre of gravity, and lie nearly in the plane of the line of sight. One must be approaching when the other is receding, and thus the wave-length of light coming from the two stars is increased in one case and diminished in the other, whilst when both are on the line of sight the lines are not displaced at all, as the wave-length of both are in that case unchanged by the motion. Vogel, in Europe, had arrived at the same conclusion, and the mass of the components, their distance and rate of motion, had been determined. Schiaparelli, the well-known observer in Italy, who has been observing the inferior planets, Mercury and Venus, during the last ten years, had arrived at the startling conclusion that both rotated on their axes and revolved in their orbits in the same period of time. This, the President thought *a priori* likely in the case of Mercury, but gave reasons for thinking it unlikely in that of Venus. Duner had been applying the spectroscope to the sun, and his results confirmed the observations of Carrington and others in relation to the more rapid motion of the sun's equatorial regions than towards the poles. He used the atmospheric lines as points of comparison, as their wave-length is not affected by the sun's rotation, and thus overcame the chief difficulty which the other observers have had to encounter. During the year, fourteen planetoids had been discovered. The planetoids are now so numerous that it is not easy to keep track of them. Six comets had been discovered, but none of them were large enough to be objects of much interest to the general public. Langley had been engaged in getting observations of the temperature of the moon's surface, and had concluded that the temperature of its hottest period is not above zero centigrade, or the freezing point of water, which gives a show of color to the possibility of the theory of Mr. Peal, of India, that the lunar surface is covered with snow and ice. The President referred to the growth of the Society as most encouraging, and spoke of its future as being one full of promise and hope.

During a conversation which followed, Mr. Elvins stated that Mr. Peal's theory was not new, as he (Mr. Elvins) had published the same views in a paper on "The Moon, its Motion and Physical Constitution," in the *Astronomical Register* in 1869.

The proceedings of the Society for the first year of its existence, were then brought to a close by adjournment.

ADDITIONS TO THE LIBRARY.

DONATIONS AND EXCHANGES RECEIVED DURING 1890-1.

The following donations and exchanges were received by the Librarian of the Society during the year 1890-1, and placed upon the shelves of the library :—

THE JOHN GOLDIE DONATION.

The New Astronomy, by Langley.

History of Physical Astronomy, by Grant.

Astronomy for Schools and Colleges, complete edition, Newcomb and Holden.

The Moon, by Neison.

Popular History of Astronomy during the Nineteenth Century, by Miss A. M. Clerke.

The System of the Stars, by Miss A. M. Clerke.

Proctor's Large Star Atlas.

THE UNITED STATES NAVAL OBSERVATORY DONATION AND EXCHANGES.

Publications.

Washington Zones, 1845-9.

"	Astronomical	Observations,	1851-2.
"	"	"	1863.
"	"	"	1864.
"	"	"	1868.
"	"	"	1872.
"	"	"	1873.
"	"	"	1875.
"	"	"	1876, Part I.
"	"	"	1876, Part II.
"	"	"	1877.
"	"	"	1878.
"	"	"	1879.
"	"	"	1880.
"	"	"	1881.
"	"	"	1882.

Washington Astronomical Observations, 1883.
" " " 1884.
Yarnall's Star Catalogue, 1860.
Reports of Total Eclipse, 1869.
" " " 1878.
American Ephemeris and Nautical Almanac, 1890.
" " " " " 1891.
" " " " " 1892.
" " " " " 1893.
" " " " " 1893.
Atlantic Coasters' Nautical Almanac, 1891.
Pacific " " " 1891.

Appendices.

Flexure of Meridian Instruments.
Comet of 1882.
Annular Eclipse, 1885.
Winterhalter's Report on Paris Congress, etc.
Telescopic Observations Trans. Mercury, 1875.
Saturn and its Ring.
Difference of Longitude, Washington and St. Louis.
" " " " Ogden.
Multiple Star Σ 748.
Equatorial Fundamental Stars.
Observations of Encke's Comet.
Value of Solar Parallax.
Double Star Observations.
Stellar Parallax.
Parallax of *a* Lyræ and 61 Cygni.
Hoogewerff's Magnetic Comparison Curves.
Solar Parallax and Related Constants.

SMITHSONIAN INSTITUTION DONATION AND EXCHANGES.

Aurora Borealis, by Loomis.
Psychrometric Tables, by Coffin.
Progress of Astronomy, 1879-80, by Holden.
" " 1881, "
" " 1882, "
" " 1884, "

Progress of Astronomy, 1885, by Winlock.
" " 1886, "
Bibliography of Astronomy, 1887, "
Astronomical Observations, 1886, by Boehmer.
Meteorological Subjects, 1878, by Abbe.
Progress of Meteorology, 1879-81.
" " 1882.
" " 1883.
" " 1884.
Tables of Precipitation, Rain and Snow.
Silvered-glass Telescope, by Draper.
Heat and Light of the Sun.
Astronomical Observations in Arctic Seas.
Orbit of Neptune.
Orbit of Uranus.
Orbits of Eight Principal Planets.
Planetary Motions.
Harmonies of the Solar System.
Atmospheric Temperature of the United States.
United States Charts of Rainfall and Temperature.

HARVARD COLLEGE OBSERVATORY DONATION AND EXCHANGES.

Henry Draper Memorial, 1887.
" " " 1888.
" " " 1889.
" " " 1890.
Annual Report of the Director, 1883.
" " " " 1884.
" " " " 1885.
" " " " 1886.
" " " " 1887.
" " " " 1888.
" " " " 1889.
Statement of Work, 1877 to 1882.

CINCINNATI, OHIO, OBSERVATORY DONATION.

Zone Catalogue of 4,050 Stars.
Micrometrical Measures of Double Stars.
" " " "
" " " "

Observations of Comets.

" "

LICK OBSERVATORY EXCHANGES.

Publications of the Lick Observatory, Vol. I.

Total Eclipse of the Sun, 1889, Jan. 1.

ASTRONOMICAL SOCIETY OF THE PACIFIC EXCHANGES.

Publications, Vol. I.

" Vol. II, Nos. 8, 9, and 11.

WARNER OBSERVATORY DONATION

History of the Warner Observatory, by Swift, two copies.

Simple Lesson in Astronomy, by Swift.

VARIOUS CONTRIBUTIONS.

Nautical Astronomy, by Kelly.

Meteoric " by Kirkwood.

Comets and Meteors, " two copies.

" " " " " "

Discussions on Current Science, by W. M. Williams.

Conservation of Energy, by Balfour Stewart.

Women's Almanac, 1769.

History of the Warner Observatory.

Eclipse Projection (MSS.), by Lindsay.

Gravitation, Solar Heat, Sunspots, by Kedzie.

Photographs and Lithographs of Occultation of Jupiter, August 7, 1879, by Professor Tetens, of Bothkamp.

Photograph of the Moon.

Photograph of Meteorite.

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PAPERS READ DURING 1890-91.

NOTE.—Authors are alone responsible for the views expressed, or for facts stated in the papers, or synopses of papers, in this Report.