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SOME RESULTS OF ASTRONOMICAL WORK DURING 1919

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(*Retiring President's Address, January* 26, 1920)

THIS evening it is alike my duty and my privilege to address you as retiring President of the Royal Astronomical Society of Canada, and after consideration I have taken for my subject, *Some Results of Astronomical Work during 1919*. Astronomy has become such a vast and complex science, reaching out towards, and resting upon other sciences, with which not very long ago it seemed to be quite unconnected, that I felt, and feel, it might have been wiser to confine my remarks to a single department of the subject. However, I could not justify to myself the adoption of that course unless prepared to speak, to some extent at least, of work with which I have had experience, preferably of some line of research in which I had at least taken a part. Unfortunately, subject to that restriction, nothing was possible to me; therefore I concluded to follow the course generally adopted in addresses of this kind delivered before the Society, and speak, so far as the time at my disposal will permit, on astronomical matters of greatest

general interest, most deserving of your attention, and suited to bring before those not in close touch with recent progress some information of happenings in our own immediate environment, the solar system, and, at least an outline of the new knowledge gained during the past year relative to that vast universe of stars and nebulae, compared with which our sun, and its family of planetary worlds, form but a minute unimportant point.

But first I turn for a moment to review the conditions under which astronomers were obliged to carry on their work during 1919. The world-war was indeed happily brought to a conclusion ere the year began, but the awful and titanic struggle left social wounds which centuries will scarcely obliterate, bringing also into existence conditions which still react adversely upon the whole civilized world, and will continue indefinitely to affect future generations. For the strife of nations has ceased, only to be succeeded by the strife of classes, by world-wide unrest and discontent, and by a development of individual selfishness heretofore unparalleled. Now, of all men, he who is restless, discontented, self-centred, is least inclined to look abroad and find pleasure in the study of nature, or to aid in the advancement of science, unless indeed science can be commercialized and utilized as a means of gain, in which respect astronomy neither claims, nor seeks, to stand in the front rank, and therefore is relegated to the background. These depressing conditions were obviously most effective in the countries nearest to the scenes of actual hostilities. News received from many European observatories tells of stress and hardship, the effects of the war making themselves painfully felt after its actual conclusion. Astronomers and other workers were wanting; some dead on the field of battle, others incapacitated by wounds or health impaired through the strenuous conditions of military service; still others detained to discharge duties different to those for which their special training had been designed to qualify them. Observatories near the actual seat of war, in which the large instruments had been practically dismantled for security's sake could not speedily resume work with full efficiency. The state of affairs in Russia renders at least dubious the condition of the world-famed astronomical centres located there. In curious contrast we notice that the directorates of some German observatories have declared, with

characteristic boastfulness and self-complacency, that not merely have they gone on uninterruptedly and efficiently with their work but that their equipments have acquired important instrumental additions. In which connection it is enlightening to recall a letter addressed to a prominent English scientific journal[1] by Professor R. Jonckheere, director of the Observatory of Lille, the only first-class French observatory (fortunately), which fell under the power of the Hun marauder. Returning from his exile in England, he relates to his confrères a heart-breaking story of the utter devastation and ruin wrought during the German occupation of the place. All the smaller instruments stolen, along with such parts of the larger as could by any possibility be made use of by the captors; and what they could not carry off, ruthlessly and systematically destroyed, or ruined beyond repair: The axes of the equatorial bent or broken; the circle graduations defaced and obliterated with a sharp-pointed tool; the dome wrenched out of circularity so as to be incapable of turning; all the clocks purloined, save one, and that one ruined by a corrosive fluid poured into the movement. The whole work of robbery and destruction carried out with such minute and systematic ingenuity of devilish spite as to demonstrate only too clearly that it had been perpetrated by persons perfectly familiar with astronomical and scientific instruments. Other instances of like character might be readily cited, but let the one suffice. Can we then wonder that scientists of the allied nations, honourable and kindly men as they are, feel repugnance when the suggestion is made that fraternal relations in matters of science be resumed with the perpetrators of such abominable and contemptible acts? A few, indeed, seem inclined to condone the offences committed *against others*, but happily, those so minded are greatly in the minority. Permit me to quote a few words uttered, not by a Frenchman, naturally embittered by the misery and loss brought upon his native land; not even by an Englishman, who had begun to realize what the savageries of the Hun have entailed upon his nation and empire. The speaker is an American, distinguished for scientific attainment and for qualities of mind and character which place him in the foremost rank among men. Speaking with reference to the establishment of the

[1] *The Observatory*, July 1919.

International Astronomical Union, Professor W. W. Campbell[1] thus expresses his views:

"The scientists of the allied and associated nations were of opinion that personal relationship with the scientists of the central nations should not be renewed; at least until the offending governments and peoples shall have renounced their past, and apparently present, political methods."

I acknowledge that in referring to these maters I have digressed from my proper subject. However, I feel it incumbent on me as I retire from the presidency to point out to the Council and membership of the Royal Astronomical Society of Canada the impropriety, the unwisdom, of friendly intercourse on any ground with men such as the scientists of Germany have shown themselves to be. An old Greek poet long ago related, that, disgusted with the injustice, misrule, and vices of the Olympian deities, the brave, wise, loving, much-enduring titan Prometheus adopted as a guiding principle this rule: "Accept no gifts from the gods". With a slight, but significant alteration, we would do well to adopt it as ours: "Accept no gifts from—*the other parties*."

Though the last maximum of solar activity undoubtedly occurred towards the latter part of 1917, sun-spots continued to appear very frequently during the past year, there being relatively few days on which the solar disc was entirely spotless, and on several occasions the spots or spot-groups were of such large dimensions as to be visible to the unaided eye. This continuance of solar activity was often mentioned at the Society's meetings. Naturally such a very large amount of observational study and research in connection with solar physics has been accomplished during 1919, that it would be impossible for me to give even the briefest outline of all the results, I will therefore mention only one very important and deeply interesting investigation conducted under the direction of Prof. G. E. Hale, at the Mount Wilson Solar Observatory.[2] It will be necessary at the outset to remind you that, as far back as 1908, plates secured at that observatory by the photo-heliographic method demonstrated conclusively that sun-spots have a vortical structure. In hundreds of instances masses of hydrogen were

[1] *Publications, Astronomical Society of the Pacific*, Oct. 1919. p. 250.
[2] *Mount Wilson Solar Obs.*, No. 165.

shown in the act of being drawn towards the centre of spots as though sucked into a vortex. The photographs suggested the hypothesis that a sun-spot is a vortex in which electrified particles, resulting from ionization in the solar atmosphere, are whirled at high velocities. Search for the Zeeman effect resulted in its immediate discovery, along with abundant proof of the existence of a magnetic field in every sun spot observed. Subsequent investigation led to the view that two classes of vortices are involved: High-level vortices centering in sun-spots, revealed when monochromatic images of the sun are photographed with the light of the central part of the H_a line In these the motion of the hydrogen appears to be spirally inward and downward: Low-level electric vortices formed in the photosphere. These constitute the sun-spots themselves, and in them the motion of the gases appears to be spirally upward from within the photosphere, and outward along its surface. The magnetic classification of sun-spots based upon determination of their magnetic polarities seems to point to a division into three classes. Unipolar spots are single spots, or groups of small spots, having the same magnetic polarity: Bipolar spots, which in their simplest characteristic form consist of two spots of opposite polarity: Multipolar spots, which contain spots of both polarities so irregularly distributed as to prevent classification as bipolar groups. This class comprises only about one per cent. of the total spots observed.

The magnetic polarity of sun-spots was determined by observations of their spectra under very high dispersion, the components of a Zeeman "triplet" being studied by means of a Nicol polarizing prism, which shows different relative intensities in the *n* components. It is further pointed out that the lines of force in sun-spots can be measured with considerable precision. About 60 per cent. of the groups observed are binary groups, the members of which are of opposite magnetic polarities. It must be noticed as a remarkable fact that before the last sun-spot minimum, the magnetic polarity of unipolar spots, and the preceding members of bipolar spots, was positive in the southern, and negative in the northern, hemispheres of the sun. But immediately after, and since, the minimum, (which occurred in 1912), these signs have been reversed. It may reasonably be hoped that the results just summed up will greatly aid

in the discovery of the cause of sun-spots, periodicity, as well as terrestrial magnetism, undoubtedly connected therewith. I might further call attention to the curious fact that frequently dark masses have appeared in the Mount Wilson photographs of the solar disc, which on their arrival at the limb recorded themselves as true solar prominences. Before terminating this notice of work done at Mount Wilson I may just remind you that the great reflecting telescope of 100 inches aperture, the largest telescope ever constructed, was successfully put in operation there in 1919.

In connection with solar physics I would much like to speak of several investigations relative to the spectrum; however time forbids me to say more than a few words. Within recent years the improvements in laboratory methods and apparatus have been turned to such good account that at the present time relatively but few of the many thousands of lines in the solar spectrum remain unidentified with the spectral lines of metals or other terrestrial substances. It is not a little curious to learn that quite recently a number of fine narrow bands in the ultra-violet region, previously of unknown origin, have been found identical with bands in the spectrum of ammonia when that gas is injected into an electric arc formed between copper poles. Some time ago, as you may remember, bands due to water vapour were found to exist in the sun's atmosphere.

At this point I think reference should be made to the total solar eclipse of May 29, 1919, on which date the cone of the lunar shadow traversed broad regions of the South American and African continents. This eclipse is of particular interest because of observations undertaken, and successfully carried out, to test the correctness of one, probably the most important, of three predictions made by Albert Einstein, a Swiss physicist residing in Prague, in connection with what is termed his "relativity hypothesis". Einstein evolved his theory through mathematical reasoning of so abstruse a character as to be quite beyond the possibility of a popular exposition; in fact very able mathematicians fully admit their inability to follow his reasoning and formulae to the ultimate conclusion. However, as the outcome of his research, Einstein felt justified in stating that his hypotheses fully accounts for the anomalous shifting of the major axis of the orbit of Mercury, for which the previously

accepted, though not entirely satisfactory, explanations demanded the existence of an inter-Mercurial planet, never detected, or the presence of ponderable matter in the vicinity of the sun, a theory rendered improbable by the near perihelion passages of many comets. Einstein further showed that light from stars passing through a powerful gravitational field must suffer deflection towards the body producing the field, to an extent which should be measurable, the quantity of which deflection he computed as 1.75 seconds of arc for a star (apparently) at the sun's limb. A third conclusion from the hypothesis was, that a slight shift towards the red should be found to prevail in the lines of the solar spectrum. The completeness with which the relativity hypothesis explains the shifting of Mercury's perihelion point, aroused general and deep interest among astronomers, particularly on the part of those specially occupied with the theory of gravity, for which they demand, and can only rest satisfied with, absolute accuracy. Therefore a very general desire was felt to test the hypothesis by actual observations, which could only be made during a total solar eclipse, since then only would it be possible to photograph stars in very close proximity to the sun's apparent place in the sky. Attempts were made on the occasion of the eclipse of June 8, 1918, to achieve this result, but proved unsuccessful. Consequently it was decided by the British Eclipse Association to renew the effort during the eclipse of May 29, 1919, which offered the special advantages of an unusually long totality at a time when the sun would be projected on a background of the sky occupied by the bright group of the Hyades and the brilliant star Aldebaran. Accordingly two expeditions or observing parties were dispatched, each having two highly competent trained observers, to secure the desired observational results in the form of photographs of the eclipsed sun together with the stars near its place during the period of totality. One of the parties consisting of Dr. Crommelin of Greenwich Observatory and Mr. Davidson, was dispatched to Sobral in northern Brazil. The other, comprising Prof. Eddington of the University of Cambridge, and Mr. Cottingham, went to the island of Principe on the west coast of Africa. The state of the sky at the first-named station during totality was all that could be desired, and several satisfactory plates were secured. At Principe,

unfortunately clouds interfered to some extent; in spite of which, however, five star-places were recorded. The observers at Sobral remained long enough after the eclipse to secure the requisite comparison on check plates, when the sun's ecliptic motion had made possible photography of the same star-field before sunrise. For the Principe plates another method of comparison was employed. Recently, when giving an account of the results achieved, Sir Frank Dyson, the Astronomer Royal, felt justified in stating that unquestionably the light from the stars photographed near the sun deviated, and did not come as directly in a straight line as it would had the sun with its powerful gravitational field not been there; that it was certainly deflected towards the sun, and as a matter of fact the amount of this deflection was practically in complete agreement with Einstein's prediction based on his relativity hypothesis. This remarkable verification of a prediction derived from a transcendental mathematical theory, is of the highest interest to astronomers the world over, and possibly may lead to important conclusions as to the cause of gravity and the nature of the medium through which it acts. I should add here that Einstein's third corollary as to the shifting of the solar spectrum toward the red, has not been verified, though looked for by Dr. St. John with the powerful appliances available for the purpose at Mount Wilson. However, the anticipated shift is very small, and its detection demands accurate allowance for other causes of displacement, by which the problem is affected and made more complex than might appear at first sight; therefore we may hope verification will be forthcoming later. Einstein himself would regard his hypothesis as untenable should his conclusion on this last point be disproved.

At the same eclipse other observations on the usual and more general lines of photography and spectroscopy were of course not neglected. The great brilliance of the corona was a marked feature; and a prominence remarkable for its vast size was observed visually and recorded photographically. Although not so fantastic an object as "The Heliosaurus" which astonished the observers of the 1918 total eclipse, the enormous hydrogen mass visible to those who had the good fortune to be within the shadow-path on May 29 last, far exceeded the other in actual dimensions and in brightness. And a further interesting fact is, that it had existed as a hydrogen

cloud on the sun's surface for a month prior to the eclipse, fortunately reaching the limb at the critical time. It seems to have been the only noticeable prominence form in evidence on that occasion.

I must not detain you with any detailed description of interesting experiments conducted, relative to the transmission of wireless signals through the shadow-cone between stations outside the line of totality. Our members, and probably others present, had the opportunity of hearing an interesting lecture by Prof. Bauer of the Carnegie Institute, who went to Liberia to observe the variation of terrestrial magnetism and atmospheric electricity during the total phase.

A very regrettable circumstance is, that French astronomers, even those engaged at Paris and Meudon, were prevented, because of financial stringency, from going abroad to make observations of the eclipse on May 29. It was then just one year more than half a century since Jansen made his ever-memorable discovery of the gaseous nature of the chromosphere and prominences. Two years later, to continue his investigations on the phenomena of another total eclipse, he was obliged to escape from beleagured Paris by means of a balloon.

There are a few matters relating to the sun's family of planetary worlds, to which I ought to make some reference. 1919 afforded very favourable opportunities for observation of the inner planets Mercury and Venus. The former I must pass, with only the brief reference already made in connection with Einstein's relativity hypothesis.

Regarding Venus, a good deal should be said, which I will sum up as concisely as I can. During 1919, several well-known and very competent observers drew attention to the existence, at the extremities of the crescent phase assumed by the planet when in its most favourable position, of brilliant white spots, presumably polar caps resembling those of Mars. Assuming the correctness of this opinion the axis of rotation would be practically perpendicular to the plane of the orbit, which favours the view first advanced by Schiaparelli, and since maintained by several astronomers of high standing, that the periods of the rotation and revolution of Venus are equal. It will be remembered, however, that nearly 150 years ago Schröter, after long and patient investigation, felt

justified in assigning to the planet a rotation period very similar to that of the earth, a result later confirmed by other excellent observers. Thus, although the later determination, arrived at by the aid of instruments much superior to those at the disposal of the older investigators, might be regarded as entitled to full confidence and unquestioned adoption, a strong element of doubt exists in many minds as to the propriety of accepting the later result in preference to the original one. Coincidence of the periods of rotation and revolution would seem to demand an effect of tidal retardation unauthorized by, and incompatible with, our knowledge of the planet's mass and distance from the sun, and the non-existence of a satellite; even if we place no weight whatsoever on the complete lack of analogy with the known rotation periods of other major planets. Our members will recollect that at two of the Society's meetings last autumn I invited discussion on that point, taking the grounds just mentioned. Those present had the privilege of examining a spectrogram of Venus secured at the Lowell Observatory by Prof. Slipher, who maintains that lack of inclination in the lines of the spectrum negatives the possibility of a short rotation period. However I then felt, and still believe, a period of about 24 hours would hardly involve an equatorial velocity sufficient to evidence itself by the test of inclination. Therefore I was both interested and gratified through meeting with a mathematical investigation of this subject by the Rev. Luis Rodés, S.J., director Observatorio del Ebro,[1] which to me appears to demonstrate conclusively that an axial rotation period of, say, 24 hours would be insufficient to produce a deviation from the vertical in the spectral lines distinguishable from the slight deformation due to unavoidable inaccuracy in guiding. I commend the Reverend Padre's very important paper to the careful consideration of every one interested in the study of our nearest neighbour among the major planets. It is hardly necessary to say that the axial inclination relative to the plane of the orbit need not be regarded as in any way affecting the rotation period. Did time permit I would like to refer at greater length to some very important experiments conducted at Arcadia, California, for the Smithsonian Astrophysical Observatory by Mr. L. B. Aldrich, who, by employ-

[1] *The Observatory*, August, 1919, p. 308.

ing very delicate heat-measuring instruments elevated by a military balloon above a layer of cloud and fog, has demonstrated that a planet completely enveloped in a mantle of cloud would be screened from 78 per cent. of the direct solar radiations; that quantity being radiated back into space from the surface of the cloud-screen. The fitness of planets other than our own to be the abodes of life (not necessarily intelligent), has from time to time come under discussion, the affirmative being maintained by men eminent in the world of science, though at present the subject is seldom mentioned, and sometimes with a sort of contemptuous indifference. I see no reason why it should be less deserving of consideration than some of the many recondite problems with which astronomers are occupied. Curiously enough, a statement just made by Marconi as to wireless signals of unexplained origin, which for some reason he supposes may come from Mars, has attracted popular attention to a surprising extent. Other sources for those electric waves have been suggested, as for example active solar spots. For my own part I believe they are simply results of electric disturbances in our own atmosphere; induction effects occasioned by lightning-storms occurring probably at no very great distances from wireless apparatus which happened to be tuned to respond to certain ether waves occurring as secondary results of great flashes.

Mars having been to all intents and purposes invisible during 1919, I will only remind our members that during the ensuing spring and early summer this interesting miniature of our own world will be well placed for observation, in which work, telescopes of 3-inches aperture and upwards may be turned to good account. The depicting of the Martian features on the surface of a small globe seems to be growing in favour among areographers, professional and amateur. That the Royal Astronomical Society of Canada should not be accused of lagging entirely behind the prevalent fashion, a slight effort in the line of globe construction was made in its behalf by an old member.

I spare you any reference to the Jovian planet, although the largest member of our system next after the sun.

Regarding Saturn, the remarkable albedo of the ring-system, especially Ring B, is well known to all observers. An attempt to

explain this fact has been made, on the supposition that the two outer rings are mainly composed of extremely minute particles, since almost every substance when reduced to fine powder appears much whiter than in larger masses. The singular bright spot which I saw on the eastern extremity of the outer ring during several hours on the evening of May 13, 1919, and subsequently mentioned at a meeting of the Society, was noticed by other observers on the same date. Its anomalous behaviour has not been satisfactorily explained. Despite his ill repute as the devourer of his children, Saturn maintains a family of nine satellites; the ninth having been named "Phoebe".

I have nothing of interest to mention relative to Uranus. As for Neptune, everyone is aware that owing to detection of a very slight perturbation effect whereby its actual position differs from the predicted place to the extent of 2″, the existence of a still more distant planet is considered certain; its position, mass, distance from the sun, and other elements having all been computed, and its opposition predicted as occurring about the end of December, though I have not learned that it was actually observed then, or since; which is not surprising in view of its faintness and the many small stars among which its orbit now lies.

Passing now in thought far beyond the narrow confines of the solar system, we come to the stars properly so called. The vast canopy of the starry heavens, which from the earliest times excited the wonder and admiration of the human race, though now less admired, often scarcely noticed, by the "finished and finite clods" who unfortunately constitute so large a proportion of the world's present population, is becoming more wonderful, more attractive, more mysterious even, to the astronomer, who as his knowledge grows and his means of investigation develop, still finds the problems with which he is confronted ever increasing in magnitude and complexity, but also in importance. Therefore he resolutely confronts the difficulties which hinder his work of investigation and research, with a settled determination to penetrate the secrets, unravel the mysteries, of the sidereal universe.

It would be impossible in several addresses such as this to give an adequate account of all the results arrived at through the investigations carried on during 1919 relative to the stars, the galaxy,

the nebulae and star clusters. Therefore I can only refer to a very few of them. In a general way I may say at the outset that our knowledge of stellar parallaxes has been very materially extended, thus vastly enlarging our conception of the distances of the stars; and to a certain extent the same holds good for a moderate number of nebulae, though naturally with a larger proportion of uncertainty. Besides what is known as the trigonometrical method, use was freely made of the spectroscopic method which I attempted to explain when addressing the Society a year ago, of the method based on absolute magnitudes, and other means more or less inferential. All the conclusions reached have tended to enlarge our comprehension of that portion of the universe accessible with our present means, and there comes also a conception of universes still vaster lying far beyond; for space does not appear to be dark, but glowing with a faint, yet definite, luminosity, which more than hints at the existence of other galaxies so distant that the light from their myriads of stars reaches us only as a dim, almost imperceptable, glimmer.

One of the questions debated among astronomers during a considerable period is, the true classification of the stars, and the arranging of these in what should be regarded as a rational evolutionay series. Clearly a star must have had a beginning at *some time*, no matter how remote, and the view long accepted, following Laplace, has been, that a star was formed through the gradual condensation of a nebulous structure by the action of gravity, and possibly other forces, though the process has never been seen in operation; but our period of observation is so brief compared with that required for the development of a star that lack of such an instance is but to be naturally expected. It being then assumed that the nebular hypothesis accounts for the formation of stars, these would naturally exist in different stages of development, dependent on the age, the mass, the chemical and physical condition of every individual body. Reasoning on these lines a classification was made, the brightest and whitest stars being assumed to be the hottest, the temperature being supposed to have declined through definite degrees in the yellowish-white, yellow, and orange stars, and to have fallen very considerably in the ruddy and red stars. But spectroscopic study, and investigation on other lines,

have demonstrated the necessity for a revision of that arrangement; it having become evident that *all* those termed "red stars" are not declining, but many actually rising, in temperature. In that way we now have the hypothesis of "giants" and "dwarfs" among the stars; the former, on the up-grade as it were, the latter, going down. This hypothesis, besides other merits, helps to obviate the acknowledged difficulty that, according to the earlier view, *all* stars must be regarded as on the decline.

An immense assistance to investigations such as the foregoing is afforded by that great and truly wonderful work, *The Draper Memorial Catalogue of Star Spectra*, an additional volume of which was bestowed on the scientific world in 1919. Over 200,000, star-spectra have already been photographed, measured, studied, classified, and recorded in this monumental catalogue, which is still in progress; and though it by no means supersedes the detailed spectroscopic study of individual stars, it vastly aids every department of astrophysical research, and also forms an invaluable record of the physical and chemical condition, at definite times, of each of the stars included within its range.

A vast amount of work and study has been devoted to the nebulae, regarding which many important, and frequently surprising, results have been arrived at, The definite connection of many of these extraordinary objects with the galaxy of stars seems not improbable, though many others are undoubtedly entirely separate and remote from it. The view that the spiral nebulae are located at much greater distances than those assigned to other classes, and that each spiral actually constitutes an individual galaxy, is being disputed, seemingly on good grounds. Various studies by different methods have led to the conclusion that at least a million spirals are within reach of the great reflecting telescope at Mount Wilson. Globular clusters are now regarded as at least as distant as the spiral nebulae, and therefore would seem to be star-universes of inconceivable vastness. Planetary nebulae may all have originated as novae or temporary stars. Some of those known to have had their origin, in that way, appear to be returning to a stellar condition. Our ideas as to the distance and actual dimensions of the galaxy itself are being greatly enlarged in view of evidence which is being accumulated by several investigators.

Since almost all the temporary stars, or Novae, so far recorded, have appeared in, or on the borders of, the galaxy, I will now say a few words relative to two of these objects. The Nova which blazed out in the constellation Aquila on June 8th, 1918, was visible as a small stellar body during the summer and autumn of 1919. When its emergence from daylight made observation possible it appeared to have changed little in brightness during the six months preceding, being about magnitude 6.5; but during the ensuing six months its light diminished gradually with slight evidences of fluctuation, till, at the end of November it was only a little above the 8th magnitude. It will in all likelihood have sunk to invisibility, except in large telescopes, by June next. Observers have differed considerably in their estimates of its magnitude since the object became faint. I am inclined to believe that two small stars preceding the Nova, distant from it about 9′ have also sensibly declined, which may indicate they have some sort of physical connection with it. The visual spectrum underwent a gradual change, the hydrogen and helium lines fading to invisibility, till practically all the light, except a faint continuous spectrum emitted by the nucleus, was that of nebulium. The rapid decline in brightness of the Nova, especially during its earlier stages, appears to me more difficult to explain rationally than its almost instantaneous outbursts. As to this latter, I think the most reasonable explanation of several suggested, is, that a rapidly moving stellar body encountered a resisting medium, probably a cosmic cloud, whereby its motion was retarded and as a consequence its superficial temperature enormously increased within a very short period. In attributing its decline to the effects of radiation and expansion only, the difficulty arises, that as we are evidently considering a stellar body of large size it must be apparent that such a mass of incandescent matter would not cool by these processes alone, with the rapidity the observed phenomena demand. Consequently a theory has suggested itself to me whereby radiation and expansion are supplemented by a process of disintegration or dissociation of elementary materials, the operation demanding, and rendering latent, as the expression is, an enormous amount of the energy existing in the forms of heat and electricity. A brief review of the spectroscopic phenomena exhibited by the star during its earlier stages is necessary to render my meaning intelligible. The

spectrum of the Nova immediately after its outburst was continuous with some absorption lines as in an ordinary star. Obviously this was the effect of a sudden and great exaltation of temperature, on a body possessing a considerable degree of density. Then some bright lines and bands gradually superposed themselves on the continuous spectrum, the hydrogen series first becoming conspicuous, along with fainter lines due to helium, and some other elements. But though those persisted, there soon developed, with steadily growing intensity, the characteristic spectrum lines (in this case they were broad bands) of nebulium, a gas sought for vainly among the elements known to chemists; but familiar to astronomers as the chief constituent of gaseous nebulae. Simultaneously with the appearance of nebulium, the Nova rapidly declined in brightness, and a decline in temperature also became evident, the continuous spectrum fading, particularly toward the violet. I believe this diminution of the light and heat to have been closely associated with a development of nebulium in enormous quantity; I therefore think we would be justified in assuming that this gas originated through the disintegration or dissociation of the ordinary elementary forms of matter, metals, or others, existing as such in the star up to the time when the cataclysmic event occasioned an inconceivable augmentation of temperature, accompanied by electric phenomena on a scale of which we can have no conception. The theory I offer assumes nebulium to be one of the primordial constituents from which the so-called chemical elements are built up, though its existence cannot be made evident by any means at our disposal, the forces at our command being inadequate to overcome the bonds by which primordial atoms are bound together into the metallic, or other form with which we have to do. The terrific cataclysm attendant on the retardation of a stellar motion would, and did, give rise to stupendous forces, among which we only know to a limited degree, heat and e ectricity, but energy would doubtless be developed in other forms with which we are unacquainted. And then the *mere shock* of such a collision would almost certainly have a disruptive effect capable of upsetting the atomic structure of matter as we know it. If bombardment by the particles discharged continuously from a minute quantity of radium be sufficient to disintegrate nitrogen, how much greater effect may we attribute to the bom-

bardment of a sun by cosmic dust in a cloud dense enough to retard, or even halt, its tremendous stellar velocity, thereby raising its temperature 100,000-fold in a period of a few hours? The vast supply of energy absorbed and rendered latent through the work accomplished on the atoms would disappear for the time being, but would not be lost, and must reappear as sensible heat if later, under more normal conditions the primordial elements should re-combine. This would result in a great elevation of temperature throughout the nebula. A high temperature for the nebulae is demanded by the hypothesis of Laplace though he assigned no cause for their acquiring a heated condition. Before leaving the subject I should mention that during 1919 Nova Aquilae expanded into a nebula having a measurable diamenter of about one second of arc.

In August last there was found on the Draper Memorial plates at Harvard Observatory a small star irregularly variable between magnitudes 7 and 9, and having a spectrum resembling that of η Carinae. It is located in the constellation Ophiuchus not far distant from Nova Auqilae 3. Information of this discovery reached us too late to admit of observations being made here. The existence of an analogy between Novae and such irregular variables as η Argus can hardly be doubted.

During 1919 astronomy suffered a great loss through the death of Prof. Edward Charles Pickering, director of Harvard Observatory. The invaluable work he accomplished during many years will always remain an enduring monument to one whose genius, energy, and devotion cannot be too highly extoled.

Death also removed Jerome Coggia, remembered chiefly as the discoverer of a periodic comet named after him.

J. A. Repsold, renowned as a maker of meridian circles of the highest accuracy, died at the age of 83 years.

The whole scientific world deplores the decease of Sir William Crooks whose great discoveries in chemistry and physics have also had an important bearing on astronomy.

I desire to mention with most respectful and sincere regret the decease of Madame Flammarion, the wife of M. Camille Flammarion the veteran astronomer and scientific writer, whose name is familiar as a household word to astronomers, professional or

amateur, the world over. I think no more eloquent tribute to a deceased wife was ever spoken than that uttered by her husband, when, referring to her, he said: "Sa mort est la première peine qu'elle me cause".

During 1919 our Society lost two old and valued members; George G. Pursey, and Angus Sinclair, M.A. The former, though not an astronomer in the strict sense, felt a genuine interest in the science, and was one of the small body of men whose steady devotion led to the establishment of this Society in its incorporate form. Mr. Sinclair did excellent service as the Society's librarian during several years. Both gentlemen were highly respected by all who knewthem.

I regret very much that during 1919 means could not be found for mounting in some permanent way so as to be available for the members' use, two excellent telescopes belonging to the Society. The difficulty has been to find a suitable location near our headquarters whereon a small observatory could be erected to house the instruments. I trust that during 1920 the Council will not overlook the great benefits which would accrue through carrying out this project.

The matter of popular ignorance relative to astronomy was brought forward for consideration at several meetings of the Council during 1919, a suggestion being made that the Minister of Education be asked to have astronomy added to the list of school studies. There is at present a strong tendency to diminish, rather than extend, the number of subjects to be studied by pupils in the public schools and the collegiate institutes. My own feeling is, that astronomy might well be put forward rather as a recreation than as a strict study, this being encouraged by the introduction of suitable books into the school libraries throughout the Province, to be read alike by teachers and pupils. By thus arousing interest in what is really a fascinating subject teachers and pupils would be induced to learn and to work together. They would soon be able to recognize the principal constellations and the larger planets, after which further knowledge would be gained very rapidly. An elementary acquaintance with optics would render easy the construction of a few simple instruments by means of which very interesting and instructive observations might be made. I feel satisfied such a plan would work out successfully, especially in the rural schools where pupils have relatively few amusements to occupy their leisure time in the evenings.