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THE BIRTH OF CANADIAN ASTROPHYSICS: J. S. PLASKETT AT THE DOMINION OBSERVATORY

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ABSTRACT

J. S. Plaskett's technical and scientific work won him worldwide acclaim. Yet his importance to Canadian astronomy was more far-reaching, for he was largely responsible for ensuring the place of astrophysics in Canadian science. His efforts at the Dominion Observatory from 1905 to 1917 in instrumentation, stellar and solar research, building of an astrophysics staff, and efforts to obtain the 72-inch telescope all contributed towards making astrophysics the pre-eminent branch of Canadian astronomy. This remarkable feat was accomplished in just over a decade and was due to his research, organizing and leadership abilities.

Introduction. The development of Canadian astronomy shows many similarities to that of American astronomy, for the patterns of scientific growth in these two North American nations have many common features. In the nineteenth century, Canadian astronomy lagged behind its American counterpart. This can be explained in part by Canada's vastness, its thin settlement, meagre financial resources for science, and a reticence on the part of its universities to pursue astronomy. As a result, the orientation of Canadian astronomy was practical; the growing branch of astrophysics did not take root in Canada despite the work of two notable researchers, E. D. Ashe and C. H. McLeod.[1] By 1900, the bulk of the professional astronomers were government employees, the best known of them in the Astronomical Branch of the Department of the Interior. The universities had no chairs of astronomy, few courses devoted to it and no significant observatories.

The rise of Canadian astrophysics can be traced to two remarkable men: John Stanley Plaskett[2] and Clarence Augustus Chant.[3] Their activities were contemporary, but they contributed to the rise of astrophysics in

quite different yet complementary ways. Chant, the first full-time teacher of astrophysics in Canada, educated the first generation of Canadian astrophysicists at the University of Toronto, where he taught from the 1890s until his retirement in 1935. He is little remembered as a researcher, but was an outstanding publicist for astronomy both in his capacity as teacher and as one of the primary founders of the Royal Astronomical Society of Canada and the first editor of its JOURNAL and *Handbook*.

Plaskett's role was very different: he was a government scientist, not an educator, and research was his life. Almost single-handed, he forged Canadian astrophysics on the organizational and programmatic side. He was to Canada what George Ellery Hale was to the United States. He ensured the future success of Canadian astrophysics by his incessant lobbying, organizing, creating of contacts, and setting of a peerless research example. When he began work at the new Dominion Observatory in 1905, there was no Canadian research in astrophysics; when he left for Victoria in 1917, astrophysics was the pre-eminent branch of Canadian astronomy. He continued his work unabated into the 1930s. His best-known scientific work – the studies of the early-type stars and galactic rotation (with J. A. Pearce) – was accomplished at Victoria, but it is the critical twelve-year period (1905–17) that I would like to explore in detail here.

J. S. Plaskett was born near Woodstock, Ontario, in 1865. He was a natural mechanic and machinist with a knack for improving any device that came into his hands. After working in industry for several years he became, in 1889, mechanical assistant to James Loudon, Professor of Experimental Physics at the University of Toronto. The university had recently created a physical laboratory, and Plaskett's time was devoted to designing and building instruments. His family and friends, recognizing his great abilities, persuaded him to enter the university as a student. Still performing his job and already well beyond his youth, he followed the mathematics and physics programme, attaining his B.A. in 1899. He continued to work at the university after graduation, spending his spare time on colour-photography research. He joined the Astronomical Branch of the Department of the Interior in 1903.

Prior to Plaskett's arrival on the scene, Canadian government astronomy was the preserve of two recognized scientists – Dr. William F. King and Otto J. Klotz – and their assistants in the Department of the Interior. King and Klotz, Chief Astronomer and Astronomer, respectively, had lobbied for the creation of a national observatory in Ottawa along the lines of those at Greenwich, Paris, and Washington. The principal work of the institution was to be astronomically-based surveys of Canada and the development of an official time service. Although King's own expertise was in surveying

and mathematics, he had the foresight to include in his proposal the procuring of an equatorial telescope capable of astrophysical research. Success came in 1900 when Parliament authorized the construction of a building and the purchase of instruments. In 1905, the Dominion Observatory opened, under King's direction, provided with a fully-equipped 15-inch refractor with Warner and Swasey mounting and Brashear optics. Since the Astronomical Branch had no one besides Plaskett interested in pursuing astrophysics, King duly placed him in charge of the 15-inch telescope.

Plaskett was an excellent choice to inaugurate astrophysical research at Ottawa. Although his formal education was limited and his astronomical record as yet nonexistent, he had the combination of drive, talents, maturity, and political finesse to organize an astrophysics division within the observatory. He was so successful that, within a decade, his group was internationally recognized; he was the most prominent Canadian astronomer, and most important, had secured the future of Canadian astrophysics with the government's promise to construct a large reflector to be devoted entirely to stellar astronomy.

While Plaskett was involved in a number of efforts at any one time, it is convenient to divide his work at the Dominion Observatory into five categories: (1) his efforts to increase the instrumental capabilities of the institution; (2) his organization of the staff; (3) his initiation of solar research; (4) his programme of radial-velocity measurements and spectroscopic-binary orbit calculations; and (5) his efforts to attain a large reflector for further research.

Improvement of the Dominion Observatory's Equipment. The Dominion Observatory had just opened when the staff, in cooperation with the Royal Astronomical Society of Canada, decided to outfit an expedition to observe the total solar eclipse of 30 August 1905.[4] Plaskett was placed in charge. He designed a complex of solar cameras fed by one coelostat; since his recent work at the University of Toronto had involved experiments with various colour emulsions, his own experiment was to make coronal spectrograms in the relatively-unexplored green region, especially around 5303 Å, site of the "coronium" line. The expedition, dispatched to Labrador, met with overcast conditions, but preparations had given Plaskett valuable experience in astronomical instrument design and had whetted his appetite for further solar work.

At Ottawa, the 15-inch refractor was equipped with a Brashear universal spectrograph similar in design to those in use at the Lick and Allegheny Observatories. It was primarily a three-prism instrument but could be used

in single-prism form, or with a Rowland plane grating. Plaskett was not pleased with the results of the spectra taken and set about to reduce errors by better bracing against flexure, and by building a constant-temperature enclosure.[5] This work, over the winter of 1905–06, was later of value when he designed universal spectrographs for both the Ottawa and, eventually, Victoria observatories.

The most exciting area of interest in spectroscopy at the time was radial-velocity work, and the acknowledged master was W. W. Campbell at Lick. In 1906, Plaskett introduced himself to Campbell by letter, asking what kind of programme was suitable for his modest telescope.[6] Campbell was encouraging and they began to exchange letters on various questions of spectrograph design; Campbell could give Plaskett little help with certain focusing difficulties, but experimenting with problems of collimation soon cleared up the source of error. In the same year, Plaskett made a tour of American observatories.[7] His brief visit to Mount Hamilton made the greatest impression upon him because of both the high quality of work being done by Campbell and R. G. Aitken, with whom he conversed at length, and the superb instrumentation. Armed with new ideas and renewed enthusiasm, he returned to Ottawa and in 1907 began to build a spectrograph from scratch. Further experimentation convinced him that a single-prism form was most satisfactory, given the limitations of his telescope's size.

Late in 1907 he began a series of investigations into the optimum slit width for radial-velocity measurements. This study was essentially completed by 1910, resulting in a series of papers in the *Reports of the Chief Astronomer* and elsewhere.[8] These investigations elucidated some of the problems in recording wavelengths, for if starlight does not hit the jaws centrally, spurious wavelengths result. He found that the jaws could be widened somewhat more than was usually done at the time, without a loss of accuracy. This allowed the Ottawa telescope to be used as effectively as much larger instruments. By 1911, he had five instruments with which to work: his rebuilt Brashear spectrograph which could be used in four configurations and his own single-prism instrument (designed and built in the observatory shop in 1908). Before the First World War, he was one of the most original and experienced designers of spectrographs in the world.

Although most of his technical efforts went into spectrographic work, he also solved a number of problems in the Ottawa solar telescope, designed and built a new photometer for the 15-inch, and continued his experiments with various dyes on photographic emulsions, partly in collaboration with E. S. King of Harvard College Observatory. In all, a great number of his

more than 50 publications during his first decade at Ottawa dealt with technical questions on instruments and observations.[9]

Creation of an Astrophysics Staff. Soon after the Dominion Observatory opened, the staff was divided into four divisions: Surveys (under King), Meridian Work and Time Service (under R. M. Stewart, later Dominion Astronomer), Geophysics (under Klotz) and Astrophysics and Solar Research (under Plaskett). At the outset, Klotz and Plaskett were one-man divisions, the other two divisions having only a few additional observers and technical staff. Over the next ten years, practically every addition to the observatory staff was in astrophysics. There were two reasons for this: Plaskett laid out ambitious plans for his division which he and his early assistants carried forward with great vigour; secondly, he had a sympathetic ally in King. The two senior men on staff were King and Klotz, but there was a good deal of animosity between them; both had extensive backgrounds in survey work but, by temperament, King was more inclined towards mathematics and astronomical theory, while Klotz leaned towards geophysics and practical astronomy. As long as King lived (he died in 1916), Plaskett was his protégé and was able to increase his staff while maintaining harmonious relations with the others. On King's death, however, Klotz assumed the Acting Directorship, and relations between him and Plaskett deteriorated with a resulting polarization of the staff.[10] This rift was never quite healed even after Plaskett went to Victoria.

In 1906, William E. Harper, Chant's first graduate at Toronto, joined the astrophysics division. He was interested in pursuing radial-velocity work, and Plaskett immediately assigned him to observations and reductions of spectroscopic binary stars. Harper was the most productive of the Ottawa staff in radial-velocity studies. He went with Plaskett to Victoria in 1918 and continued his work with the 72-inch until the eve of the Second World War. It has been said of him that he observed and computed more binary-star orbits than anyone, anywhere. A winner of the R.A.S.C. Gold Medal, he was a first-rate but unassuming worker; he always remained somewhat in Plaskett's shadow while at Ottawa.

In 1907, the astrophysics division numbered five: Plaskett, Harper, W. M. Tobey (an original staff member re-directed to stellar-magnitude determinations), and two new University of Toronto graduates, Dr. Ralph E. DeLury and R. M. Motherwell. DeLury was a physical chemist with an interest in solar research, so Plaskett placed him in charge of the uncompleted solar spectrograph. Motherwell, a student of C. A. Chant, was assigned to micrometric measurements of double stars and observations of

occultations. In 1910, Plaskett was able to obtain two new men (one to replace Tobey), J. B. Cannon and T. H. Parker, both Toronto graduates and students of Chant. Both were engaged in the radial-velocity programme. The astrophysics staff reached a maximum of seven in 1912 with the addition of Reynold K. Young. Young was another of Chant's students who took his Ph.D. under Campbell at Lick, returning to Canada after a year at the University of Kansas. He, too, joined in the radial-velocity work.

In 1917, the observatory underwent an organizational change. With King gone, the survey work was transferred to another government agency. With the impending departure of Plaskett, Young and Harper to the Dominion Astrophysical Observatory, the remaining astrophysical staff was divided into the division of solar physics, fifteen-inch equatorial work, and photographic photometry.[11] Various lines of research were carried on individually at Ottawa, but the research for which the observatory was by then well-known – radial velocities – moved west to Victoria.

The partition of staff was not an altogether happy one, due to the rivalry of Klotz and Plaskett. Klotz, due to his seniority, had been the obvious choice to succeed King. Plaskett naturally feared the appointment of Klotz, who had no sympathy for astrophysical research; worse, there was a distinct possibility that the Dominion Astrophysical Observatory, due to open soon, would be made a branch of the Ottawa operation. Foreseeing all kinds of problems – both real and imaginary – Plaskett appealed by circular to his American colleagues Campbell, Hale, Frost, Schlesinger, and others.[12] The circular was clear in its intentions: if Klotz became Ottawa's director, then Plaskett must be made fully independent in Victoria. If Victoria was to be a satellite, then he, Plaskett, must be named Chief Astronomer for both institutions.[13] The solicited letters were duly written and may have had some effect on the Minister of the Interior: Klotz was named to succeed King, but Plaskett was given relative autonomy at Victoria.[14] As long as Klotz lived, however, relations between the two institutions were never cordial.

Solar Research at Ottawa. During his Ottawa years Plaskett had ambitious plans and a good staff to help carry them out. The work for which the observatory became known fell into two areas, solar research and radial-velocity studies. Before the arrival of Ralph DeLury, Plaskett had little time to inaugurate solar work, but he was keen to begin. In early 1906, he began corresponding with G. E. Hale on the design of the Ottawa solar telescope.[15] His intention was to reflect the sun's image from a 20-inch Brashear coelostat through a tunnel into a grating spectograph in the

observatory basement. Further, he wanted to know what Hale thought the best line of work for such an instrument might be. Hale replied[16] that sunspot spectra and solar-rotation studies would best suit the instrumentation, but he was little pleased with the overall design and suggested extensive changes. Plaskett made the few changes possible, but the observatory's architecture would not allow for anything as effective (in his mind) as Hale's Snow Telescope. Construction snags prevented bringing the spectrograph into operation, so Plaskett and Harper made a few direct sunspot photographs with the 15-inch during 1906–07. After his arrival, DeLury took charge of the daily photography. Plaskett and DeLury worked together during 1908 and 1909 to get the spectrograph working properly, but despite the fact that the Plaskett-designed solar spectrograph was innovative and of superior construction, the grating was inferior and the results disappointing.[17]

Hale was sufficiently impressed with Plaskett's plans and enthusiasm to invite the observatory to join the International Union for Co-operation in Solar Research and to attend the Pasadena convention in 1910. As Hale diplomatically added: "... you are better equipped than any other observatory (with one or two exceptions) to take part in the work of the Union."[18] Plaskett was happy to participate and pointed out that solar-rotation work was Ottawa's best option, given the staff's expertise in radial-velocity studies.

Over the next few years, as Hale's health declined, Walter S. Adams became Plaskett's chief correspondent on solar matters. DeLury and Plaskett were able to obtain their first decent rotation plates in 1910. Plaskett, as the observatory's delegate, attended the solar conference held in Pasadena later in that year. It was decided there to divide the solar spectrum into regions for intensive study at various solar latitudes. The assigned regions were given to Belopolsky (Pulkova), Schlesinger (Allegheny), Newall (Cambridge), Adams (Mt. Wilson), Dyson (Edinburgh), and Plaskett, who received the region of 5300–5700 Å. By this move, Ottawa's nascent solar programme seemed to be catapulted into the "big leagues".[19]

Plaskett and DeLury immediately plunged into solar-rotation work, employing a newly-made Michelson grating. The grating was good but not perfect and a second grating was ordered, but it was not as good as the first. Further problems surfaced when Plaskett discovered that measurements of velocities made by him and by DeLury differed markedly from one another and from those made by the Mt. Wilson staff. He intensified his correspondence with Adams in an attempt to find the causes of the differences. In 1913, after a number of lines of investigation were pursued, his son Harry Plaskett (later Savilian Professor at Oxford), by now an Ottawa staff

member, suggested that personal equation was the chief factor in the measurement discrepancies. Being essentially a psychological problem, it might be overcome. His father pressed these ideas upon Adams;[20] however, the latter was not encouraging because the war would interrupt a co-operative study of the ideas, and because of his own view that instrumental differences were as important as personal equation in accounting for the observed variation.[21] Plaskett worked further on this problem until about 1915, when he became so engrossed in the planning for the Victoria telescope that he dropped out of solar research. DeLury carried on the solar-rotation work for many years thereafter, eventually turning his interest more to terrestrial effects of the sunspot cycles. For a brief period, however, Plaskett's solar work had given Ottawa a high profile in the astronomical community.

The Radial-Velocity Programme. Plaskett's most outstanding astronomical achievements were made in radial-velocity studies. While his major papers date from his Victoria period, he entered into this line of research at Ottawa. It was with the possibility of doing radial-velocity work in mind that he began making improvements on the Ottawa spectrograph in 1905–06. With Campbell's encouragement, he was eager to begin in that relatively new and glamorous field. Only some 150 spectroscopic binaries were then known, and only about 20 of them had had orbits computed. In mid-1906, he and Harper began regularly observing a dozen stars. The orbital elements of their first binary, α Draconis, were completed in the next year.

The 15-inch telescope with the original Brashear spectrograph placed rather serious limitations on the number of binaries accessible; with Plaskett's reconstruction of the instrument, although the dispersion was only 3/5 the former value, the exposure time was cut in half and more lines were visible. With further modifications, he found that he could reach about two magnitudes fainter than before and was able to attain 5th magnitude. By 1910, he and Harper had amassed some 3,300 plates, had calculated seven orbits and had seven more in process. In that year, with the arrival of Cannon and Parker to aid in radial-velocity work, the staff, employing Plaskett's single-prism spectrograph, turned increasingly to early-type stars.

In the late summer of 1910, Plaskett went to Cambridge, Massachusetts, for the meeting of the Astronomical and Astrophysical Society of America, where his paper on the probable errors of radial-velocity measurements was well received. At this meeting Campbell proposed that the few observatories heavily engaged in radial-velocity studies co-operate for better

efficiency; a committee was struck, including those most deeply involved – Campbell, Frost, Schlesinger, K. Schwarzschild, Newall and Plaskett – and it met at Pasadena a few weeks later during the solar conference. Campbell urged the members to pursue stars down to magnitude 6.0; however, only Lick and Mt. Wilson (with their new 60-inch) were capable of good results and were willing to begin. Plaskett suggested it would be better to pursue innovations in the design of spectrographs in order to eliminate the gross loss of light; he, for his part, was going to procure a grating for further trials.[22] As it was, few bright spectroscopic binaries were left to study within the range of the Ottawa telescope.

Plaskett's expertise in stellar spectroscopy was further recognized by the Solar Union when, at its 1910 meeting, he was appointed to the Committee on the Classification of Stellar Spectra. He backed the implementation of the Draper Classification in Union work, but cautioned that more work was needed on certain lines in the red end of the spectrum, and that there were problems in distinguishing the spectral class of stars with broadened lines.[23]

Although he could devote little time to it, the Ottawa radial-velocity programme continued under Plaskett's direction. By the time he left Ottawa in 1917, he and his group had computed orbits for 53 binaries. At Victoria, the work on early-type stars went on unabated, leading to his important monographs on the dynamics of the Milky Way.

The 72-inch Telescope Project. By 1910, Plaskett was well aware that the effectiveness of his instruments for radial-velocity work was diminishing. Whether he was already thinking in terms of a larger telescope before 1910, it is not known, but Campbell's call for co-operation, and his desire to maintain a high scientific profile for Canada, no doubt contributed to his growing interest in obtaining a better instrument. In that winter he reported to Campbell that he had begun tentative moves to get a 60-inch reflector for radial-velocity work.[24] The Astronomical and Astrophysical Society of America had been invited to hold its 1911 meeting at the Dominion Observatory; at that meeting, its first in Canada, the Society passed a resolution praising the work already accomplished by Plaskett and his colleagues and urging the Canadian government to fund the construction of a new telescope. On the heels of this resolution were two memoranda, one from the Royal Society of Canada (of which Plaskett was a newly-elected fellow), the other from the Royal Astronomical Society of Canada (in which he was active), both supporting the proposal. William King was easily won over and he and Plaskett had made some headway with their minister when, in the General Election of 1911, the Liberal government was defeated and

negotiations had to be begun anew. King and Plaskett now began lobbying for a 72-inch reflector, and the latter enlisted Campbell to write a warm letter of encouragement to be shown to the new minister. E. C. Pickering was likewise asked to write, which he gladly did. The whole package of resolutions and letters was laid before the new minister in mid-1912. During the ensuing months, the Cabinet approved the project and announced tenders. The contracts were let in October 1913.[25]

Plaskett went into a flurry of activity, consulting with Adams on the designs of both the 60-inch and the proposed 100-inch, consulting with Pickering of Harvard, Frost of Yerkes, and others. Harper was dispatched to the West for site-testing.[26] After King's death, there were political moves to be made to secure the autonomy of the new observatory, and to Klotz's dismay, a devious attempt was made to spirit away some of the Ottawa instruments.[27] The greatest efforts, however, went into the design of the new telescope. Plaskett's lifelong mechanical experience and his extensive optical researches at Ottawa enabled him to plan an instrument of advanced design with electric drives, self-aligning ball bearings for both axes, and an improved universal spectrograph. The mechanical work was performed by Warner and Swasey of Cleveland; Plaskett's designs were engineered by E. P. Burrell, who later worked with Plaskett on the 82-inch McDonald Observatory telescope. The optical work was undertaken by John Brashear and Co. (the 72-inch was Brashear's last project). Much of Plaskett's time was taken up with correspondence with the contractors, visits to Pittsburgh and Cleveland, and negotiations with Harvard for a testing flat.

By 1917, however, most problems were resolved and Plaskett began thinking about an observing programme for the new telescope. Kapteyn wrote[28] from the Netherlands to suggest a programme of radial-velocity work to dovetail with his proper-motion studies; R. K. Young was sent down to Lick to confer with Campbell; Hale and Adams were approached about a co-operative effort to obtain velocities of fainter stars in Boss's *Preliminary Catalogue*. In the spring of 1918, the world's largest telescope was complete and Plaskett and Young began taking spectrographic plates of early-type stars.

Epilogue. The opening of the Dominion Astrophysical Observatory was a watershed in the history of Canadian astronomy. During the 1920s, the Dominion Observatory, under the direction first of Klotz (who died in 1923) and then of R. M. Stewart, moved more into practical astronomy and geophysics, with astrophysics losing its earlier prominence. The centre of astrophysical research was Victoria. Plaskett was at the hub of this activity

until his retirement in 1935. Only in the thirties, with the arrival of a new generation of astronomers, such as C. S. Beals, A. McKellar, R. M. Petrie, F. S. and H. S. Hogg, did the work of the D.A.O. branch into newer areas of research. Radial-velocity work, begun and nurtured by Plaskett, survived at both Victoria and, from 1935, at the David Dunlap Observatory of the University of Toronto under R. K. Young's direction. Plaskett's example of international co-operation was followed by his colleagues; Canada joined the newly-organized IAU and, at its 1922 Rome convention, Canadians were elected to nine IAU Commissions, Plaskett himself to three of them. His twelve years at the Dominion Observatory had been critical; in that short time span, the Canadian astrophysical community had grown from virtually nothing to a small but firmly-established and highly-respected group, and behind it was Plaskett's untiring example and guidance, his political manoeuvering, his creation of contacts with prominent scientists and institutions, and his impressive scientific research record.

Notes

1. See R. A. Jarrell, "Origins of Canadian Government Astronomy", *J. Roy. Astron. Soc. Can.*, **69**, 77–85 (April 1975).
2. Short biographical notices of Plaskett include: J. D. North, "John Stanley Plaskett", in *Dictionary of Scientific Biography*, **XI**, 18–19 (ed. C. C. Gillispie, Charles Scribner's Sons, New York, 1975), and C. S. Beals, "John Stanley Plaskett", *J. Roy. Astron. Soc. Can.*, **35**, 401–07 (December 1941).
3. For Chant's work, see his autobiographical *Astronomy in the University of Toronto; the David Dunlap Observatory* (University of Toronto Press, Toronto, 1954), and R. J. Northcott, "The Growth of the R.A.S.C. and its Guiding Mentor C. A. Chant", *J. Roy. Astron. Soc. Can.*, **61**, 218–25 (October 1967).
4. J. S. Plaskett, "Total Solar Eclipse, 1905", *Report of the Chief Astronomer, 1905* (Dept. of Interior, Ottawa, 1906), 213–35.
5. Letters from Plaskett to W. W. Campbell, 17 March, 4 April, and 19 June 1906 (Lick Observatory Archives).
6. Letter from Plaskett to W. W. Campbell, 17 March 1906 (Lick Observatory Archives).
7. Described by him in the *Report of the Chief Astronomer, 1907* (Dept. of Interior, Ottawa, 1908), 47–73. He briefly visited the major observatories and was able to make personal contact with Campbell, Aitken, Hale, Ritchey, V. M. Slipher, Frost, Barnard, Schlesinger, Curtiss, Pickering, and many others. In future years he maintained correspondence with a good number of them and, by frequent attendance at meetings of the Astronomical and Astrophysical Society of America, was able to renew those contacts which served him so well. By 1910, he was the best-known Canadian astronomer in American circles.
8. Various experiments are detailed in the *Reports of the Chief Astronomer* for 1907 (170), 1908 (86), and 1910 (**I**, 96ff.). See, also, Plaskett, "Slit Width and Errors of Measurement in Radial Velocity Determinations", *Trans. Roy. Soc. Can.*, Sect. III, 209–214, in *Proc. Trans. Roy. Soc. Can.*, Third Series, **III** (1909). His paper on the subject to the 1909 meeting of the A.&A.S.A. brought favourable comment.

9. His primary technical achievement, as he saw it, was his design work for the 72-inch reflector for Victoria, both for telescope and drive, and the accessories, especially the spectrograph. Letter from Plaskett to W. F. King, 19 February 1916. RG 88, vol. 473 (Public Archives of Canada).
10. This strain is evident in Klotz's diary in various entries over the years, but particularly in 1916–17.
11. This, however, was not a foregone conclusion in Plaskett's mind. He seems to have intended to move all astrophysical work to Victoria and, to that end, attempted to remove all the useful instruments from Ottawa until Klotz intervened. According to Klotz:
    (Monday, 30 April 1917) "In this morning's interview Mr. Cory [Deputy Minister of the Interior] said [to Motherwell] that Dr. Plaskett had told him that there was to be *no* astrophysical work done here hereafter and it was on the strength of this statement that he was appointed Director of the Victoria Observatory. Motherwell nearly collapsed on hearing this falsehood, and Plaskett knows it to be falsehood, for the Director Dr. King intended the work here to go on as before, besides he intended to be director of both observatories, Plaskett superintendent of the western one." O. J. Klotz, *Diary*, **VII**, 191. (Klotz Papers, Public Archives of Canada).
12. A copy of this circular is in the George Ellery Hale Papers, Roll 95.
13. As Plaskett commented to Hale: "But rather than have the work at Victoria interfered with by an envious or jealous man here [Ottawa], and of this I fear there is danger, I would accept the latter position [i.e. Chief Astronomer] (provided of course I can get the appointment)."
    Letter from Plaskett to G. E. Hale, 15 May 1916 (Hale Papers, Roll 95).
14. Plaskett had obviously made a better impression upon the Minister than had Klotz; Plaskett was recommended for the D.A.O. directorship with "full control of its policy and work" and duly appointed on 10 April 1917. Privy Council Register, 992, RG 2, 4, vol. 49, 1917 (Public Archives of Canada). Klotz was not named Chief Astronomer until 2 October 1917.
15. His ambitions in solar work show clearly from the first, for while:
    "The idea of the Director as to the function of a National Observatory is to do work of a routine character which will be useful and which might not be likely to be continued at a private observatory. Of course, there is no objection, indeed he would be glad to have some originality in the work and I would not necessarily be confined to routine observations."
    Letter from Plaskett to G. E. Hale, 27 March 1906 (Hale Papers, Roll 95).
16. Letter from Hale to Plaskett, 27 April 1906 (Hale Papers, Roll 95).
17. Ralph DeLury, "Solar Work and Laboratory Work", *Report of the Chief Astronomer*, 1910 (Dept. of Interior, Ottawa, 1912), **I**, 168–72.
18. Letter from Hale to Plaskett, 6 January 1910 (Hale Papers, Roll 95).
19. Plaskett's report of the conference is in the *Report of the Chief Astronomer, 1911* (Dept. of Interior, Ottawa, 1915), 135ff.
20. The arguments occupy several letters, but the essential arguments are in Plaskett to W. S. Adams, 26 November 1914 (Hale Papers, Roll 95); included is a circular by H. H. Plaskett on personal equation addressed to members of the Solar Rotation Committee.
21. Letter from Adams to Plaskett, 16 October 1914 (Hale Papers, Roll 95).
22. Plaskett in the *Report of the Chief Astronomer, 1911* (Dept. of Interior, Ottawa, 1915),

142–43. The grating he ordered was to throw about 45% of the incoming light to one side into the first order. This was much more efficient than a three-prism spectrograph.

23. Letter from Plaskett to F. Schlesinger, 26 January 1911; printed in *Report of the Chief Astronomer, 1911* (Dept. of Interior, Ottawa, 1915), 149–50.
24. Letter from Plaskett to W. W. Campbell, 7 November 1910 (Lick Observatory Archives).
25. Canada, Privy Council Register, 2581, RG 2, 4, vol. 45, 1913 (Public Archives of Canada). The steps in the construction of the D.A.O. are described by Plaskett in *Publ. Dominion Astrophys. Obs.*, **I**, No. 1, 7–103.
26. Harper spent many months in various places in Canada to test sky conditions – a forerunner of modern site-testing surveys. This, too, had political overtones for there was some sentiment in Ottawa to have the new telescope based in or near the Capital, but Plaskett wanted the best possible astronomical site. Harper's work narrowed the selection to Victoria and Plaskett's American correspondents confirmed his intention to use that site.
27. This unhappy incident is reported by Klotz. The full objectivity of his report might be questioned. Klotz, *Diary*, **VII**, April 1917, *passim* (Klotz Papers, Public Archives of Canada).
28. Letter from J. C. Kapteyn to Plaskett, 16 March 1918; copy (Hale Papers, Roll 95).