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CONTENTS

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PROFESSOR SIMON NEWCOMB AS AN ASTRONOMER

PROFESSOR NEWCOMB has narrated at considerable length the personal incidents of his scientific career in his book "The Reminiscences of an Astronomer," and to that source the reader desirous of knowing them may be referred. Here it is intended to note only the scope and characteristics of his more important contributions to astronomy. While Professor Newcomb wished always to be accounted a mathematician, his work seems motived by its possible application to astronomy, and no very weighty contribution from his pen has accrued to pure mathematics.

While still an assistant in the office of the American Ephemeris, then at Cambridge, Mass., Professor Newcomb began his career as an astronomer by discussing the question of the origin of the minor planets. Induced by a too great confidence in the law of Bode as to the relations of the mean distances of the major planets, Olbers had ventured to put forward the hypothesis that the minor planets were the fragments resulting from the disruption of a single major planet. This hypothesis necessitated the condition that the orbits of the minor planets at some past epoch must have had a point in common. By computing the secular variations of the elements of the minor planets, Professor Newcomb showed that at no time could this condition have been fulfilled. Thus there was no reason for entertaining the theory of Olbers.

After Professor Newcomb's appointment to a professorship of mathematics in the U. S. Navy and his removal to Washington, he was much engaged with the instruments

of the U. S. Naval Observatory, chiefly the Pistor and Martin's transit circle, but found time to investigate the distance of the sun, concluded from all the methods. His result for the constant of solar parallax was 8″.848, a value adopted in nearly all the ephemerides for quite a lengthy period. It is too large chiefly on account of the large weight attributed to the determination from Mars, whose observation is subject to systematic errors, at that time unsuspected.

About the same time Professor Newcomb undertook the investigation of the orbit of Neptune and constructed general tables of its motion. As material he had the two observations of Lalande and those of eighteen years following the discovery of the planet. This investigation, published in the *Smithsonian Contributions to Knowledge,* met an urgent need of practical astronomy at that time.

As the secure reduction of astronomical observations is a matter of prime importance, Professor Newcomb contributed to the *Washington Observations* for 1870 an appendix dealing with the right ascensions of the equatorial fundamental stars. His aim was to eliminate as far as possible systematic errors of a personal or local nature and thus obtain a homogeneous system. This is an admirably conducted investigation and has served as a foundation for whatever has been since accomplished in this subject.

The elegant method of treating the motion of the moon by Delaunay, published in 1860, led Professor Newcomb to consider this subject; thus we have his memoir in Liouville's *Journal* for 1871 on the planetary perturbations of the moon. The investigation is very neat, regard being had to the early epoch of its composition, but the final equations derived are precisely those which result from Delaunay's method.

Having treated Neptune Professor Newcomb next undertook a similar piece of work for the adjacent planet Uranus. This was a heavier task than its predecessor on account of the longer period covered by the observations. These theories of the two planets have been superseded by the investigations of Professor Newcomb while director of the *American Ephemeris,* but that of Uranus was welcomed by astronomers as a great improvement on the discussion of Bouvard. As in the case of Neptune, the investigation of Uranus appears in the *Smithsonian Contributions to Knowledge.*

In the same collection for the following year Professor Newcomb has a memoir on the general integrals of planetary motion. The aim of this paper is to show how to avoid powers of the time as multipliers of the different portions of the algebraic expressions arrived at. The thus modified expressions have since received the name of Lindstedt's series and are the chief subject of investigation in M. Poincaré's work in the line of celestial mechanics. This paper is a worthy beginning for what was to follow.

Only a few years after the introduction of Hansen's lunar tables for computing the places for the ephemerides it was seen that observation was marching away from them. From the character of the deviation they could only be attributed to an imperfect determination by Hansen of the secular and long-period terms. Always interested in the theory of the moon, Professor Newcomb undertook to see what light could be thrown on the matter by observations made before the epoch 1750, chiefly in the form of times of beginning or ending of solar and lunar eclipses and occultations. This involved a heavy load of numerical computation and a careful research for material in the libraries and observatories of Europe. The results of this labor appear

in an appendix to the *Washington Observations* for 1875. The memoir led to large modifications in our estimation of the value of Hansen's theory and it still must serve as a foundation to all future investigations in the subject.

In 1877 Professor J. H. C. Coffin was retired from the U. S. Navy on account of age and thus the *American Ephemeris* was left without a head. Professor Newcomb was appointed to the vacant place. He immediately formed the grandiose scheme of reforming nearly all the fundamental data involved in the construction of an astronomical ephemeris. One would have been inclined to predict the failure or, at least, only partial success of such a scheme; but Professor Newcomb, by his skilful management, came very near to complete success during his lifetime; only tables of the moon were lacking to the rounding of the plan. It must, however, be noted that he was fortunate in finding a few men ready to hand in relieving him not only of the drudgery of numerical calculation, but, in some cases, of devising methods. To aid matters he founded a collection called *The Astronomical Papers of the American Ephemeris* to contain all the memoirs the carrying out the scheme should give occasion to. A large proportion of these memoirs is the work of Professor Newcomb. So numerous are they that we must be content with noticing only the more striking and important ones.

The transits of Mercury from 1677 to 1881 were discussed, with the principal result of corroborating Leverrier's assertion of 40″ in the secular motion of the perihelion unaccounted for.

In the years 1880–1882 Professor Newcomb made a determination of the velocity of light by the Foucault method. The construction of the instrument and the mode of handling it enabled a very large angle of deviation to be obtained; and thus an extraordinary degree of precision in the result was hoped for. Although this hope was not completely fulfilled, nevertheless, the concluded value is far in advance of all previous determinations.

Shortly after, Professor Newcomb exhaustively treated the transits of Venus in 1761 and 1769 with the object of obtaining the constant of solar parallax and the position of the node of Venus.

In another memoir was derived the value of the constant of nutation from material afforded by observations with the transit circles of Greenwich and Washington.

Professor Newcomb deemed that improvements could be made in the mode of deriving the periodic expressions needed in the subject of planetary perturbations. His method of treatment is elaborated in a memoir in the *American Journal of Mathematics,* Vol. III., and, at greater length, in a second memoir in the *Astronomical Papers,* Vol. III.; and, finally, application is made to the four interior planets in a third memoir contained in the latter volume. For certain long-period inequalities in these planets it was found convenient to employ expressions involving time-arguments; this led to the composition of two memoirs in Vol. V., of the same collection.

The secular variations of the elements of these planets are derived and the mass of Jupiter determined from observations of Polyhymnia in the two following memoirs of the same volume.

Professor Asaph Hall having found that there was a rather rapid retrograde motion of the line of apsides of Hyperion, Professor Newcomb explained this from the point of view of the variation of elements. By an inadvertency at the very end of his memoir he failed to obtain a correct value for the mass of Titan, the disturbing body.

The completion of these preliminary investigations enabled Professor Newcomb to proceed at once to the composition of a me-

moir on the elements of the four inner planets and the fundamental constants of astronomy, which appeared as a supplement to the *American Ephemeris* for 1897. This memoir contains the data on which are founded the tables of these planets, published shortly after. In 1899 Professor Newcomb completed his work on the six major planets, he had undertaken to revise, by the publication of tables of Uranus and Neptune.

While all these investigations in the planetary theories were going on Professor Newcomb must have found time for attacking his subject of predilection, the lunar theory, for we have a lengthy memoir by him on the action of the planets on the moon, contained in the volume last mentioned. This paper must have cost him an enormous amount of labor; he seems to be determined that no inequality of sensible magnitude should escape him.

The tables of the planets being out of the way, Professor Newcomb next turned his attention to the fixed stars. Being present at the Paris Conference of 1896 on a common international catalogue of fundamental stars, he obtained the assignment of the subject of precession as his share of the work to be undertaken. Within a year he had the work done, having derived a value of the principal constant involved which is probably as good as the condition of the data at the time allowed.

This memoir is naturally followed by another containing a catalogue of more than 1,500 stars reduced to an absolute system and to be employed as fundamental.

In March, 1897, Professor Newcomb, having arrived at the age limit, was retired from the office of the *American Ephemeris*. Many of his unfinished jobs were carried to completion under the nominal superintendence of others.

At the foundation of the Carnegie Institution of Washington Professor Newcomb secured the privilege of prosecuting his researches on the motion of the moon under its auspices. Here, until the end of his life, he labored assisted by a small but very able corps of assistants. Although the period of time was short a long memoir on the planetary inequalities has appeared.

The last contribution of Professor Newcomb to science is an article in the *Monthly Notices* for January, 1909, exhibiting the deviations of the moon's mean longitude from the best theory that, so far, has been devised.

In the intervals of leisure between his labors of a more technical kind Professor Newcomb composed a book on "Popular Astronomy." Although the rapid advance of the science in the more than thirty years since its publication has caused it to fall behind, it still remains the best composition on the subject.

Professor Newcomb contributed a vast number of notes on almost every conceivable topic in astronomy and the allied sciences to the scientific periodicals. (In this connection it may be useful to state that the Royal Society of Canada has published a bibliography.) He had the management of the construction of tables for the Watson asteroids. He found time to treat questions in economics and psychics and even wrote a novel. No matter how many tools he had in the fire, he was always ready to add to them. His journeys to observe total solar eclipses, transits of the interior planets and to collect scientific data from the observatories and libraries of Europe are too numerous for mention.

With almost universal consent, it is admitted that, for the last forty years of his life, Professor Newcomb stood at the head of the cultivators of the astronomy of position. And he did not have to complain of lack of appreciation by his fellows: after he had got fairly started in his sci-

entific career, a continual flow of medals, prizes, degrees and honorary memberships in scientific societies came for his reception, till the possibilities were exhausted. His departure leaves a great gap in the band of astronomers. It will be long before we again have one of equal untiring energy.

G. W. HILL

SIMON NEWCOMB

IN the death of Professor Newcomb American astronomy has lost its chief ornament and American science in general one of its most commanding figures. His exact relation to contemporary science must be determined by the judgment of future times but to those who have been his associates during any part of the past half century his career bulks too large for oblivion, too generous to be dismissed without some word of appreciation. The common incidents of his life, its offices and honors, may here be dismissed summarily since he has given in his "Reminiscences of an Astronomer," an autobiography that must always remain their most authentic exposition.

Born in Nova Scotia, of New England ancestry, and returning in early manhood to the land of his fathers, there to build a scientific career upon a youthful experience containing scant preparation for such work, he found in the Nautical Almanac office, then at Cambridge, Mass., a position which he himself describes as his first introduction to the world of sweetness and light. Appealing equally to his tastes and talents this work upon the almanac proved decisive of his whole career in which for fifty years problems of celestial mechanics constituted the core about which all other activities centered. Even upon his deathbed his mind was fixed upon the last of the problems that had been marked out as his life work and with its completion he sank visibly and rapidly to the end. Newcomb was, however, far from being a man of one idea. During his long professional career duty and inclination alike brought him into relation with nearly every phase of astronomical activity; popular exposition and the writing of text-books, the design and use of astronomical instruments, research into astronomical history and the utilization of its ancient materials, the organization of individual effort either for such special cases as a transit of Venus and a congress of science, literature and art or for continuous relationship in a permanent scientific body, such as the Astronomical and Astrophysical Society of America or the National Academy of Sciences in both of which he was active and influential. The newer fields of spectroscopic and photometric research in astronomy into which he did not profess to enter as an investigator, commanded his active interest and especially in his later years he was solicitous to combine their results with those of the older branches into a consistent whole.

But no one science, however diverse its paths, seemed to Newcomb an adequate field for the exercise of his powers and numerous were his excursions beyond the bounds of astronomy, *e. g.*, into economic theory, physics, politics, fiction and occult psychic phenomena, most of which, however, can be expected to contribute but little to his permanent fame. In the field of his first choice, theoretical astronomy, while his attainments were large and his powers great, it may be doubted whether posterity will rank his work as of the first order. His greatest achievements unquestionably lie in the border land between theory and practise where an enormous body of observed data has been utilized by an army of computers under