



I. History of astronomy for the year 1800

Jerome De Lalande

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THE
PHILOSOPHICAL MAGAZINE.

I. *History of Astronomy for the Year 1800.* By JEROME
DE LALANDE*.

THE century now closed has been very remarkable in regard to astronomy: telescopes, indeed, and the laws of Kepler and of attraction, will place the 17th century at the head of all the rest. Nothing had been before done, and the first century, when astronomers began to labour, ought to be that of discoveries. But the 18th century has furnished us with at least twelve epochs so important that it will bear to be compared with the preceding. A new capital planet and eight satellites discovered, the periodical return of comets known and demonstrated, and 68 new comets observed and determined; the aberration and nutation of the stars; the transit of Venus, and the true distance of the sun and of all the planets; the figure of the earth and its irregularities; calculations in regard to the inequalities produced by attraction, and, above all, in regard to Jupiter and Saturn, which have furnished correct tables of all the planets and their satellites; tables of the moon, the most important of all, carried to the precision of a quarter of a minute; and, in the last place, 50,000 stars accurately observed: all these far surpass the hopes which could have been conceived a century ago of the progress of astronomy since that period. To these we must add the improvement of astronomical instruments: sectors, meridian telescopes, whole circles, reflecting circles,

* From *Magazin Encyclopedique*, No. 17, an. 9.

telescopes by Short and Herschel, compensation balances, marine time-keepers, all assumed in the last century a new face.

The conclusion of the last century was remarkable in many respects. Some days before the end of the year 1799, C. Mechain discovered a comet in Ophiuchus; it was observed also by Messier. Mechain and Burckhardt took the earliest opportunity of calculating the elements of it.

What was so tedious and difficult fifty years ago, is at present the work of a few hours. This comet was seen only for a few days, and appeared to the naked eye as a star of the fifth or sixth magnitude. It is the 91st, the orbits of which have been calculated. Its orbit has been calculated also in Germany by M. Olbers and M. De Wahl.

The prize proposed by the Institute for determining the orbit of the comet of 1770, has produced an excellent memoir by Burckhardt, in which the question has been resolved; but, to represent the observations, he has been obliged, like Mr. Lexel, to recur to an orbit of five years. However extraordinary that result may appear, the attraction of Jupiter seems capable of explaining that derangement; but this article would require long discussions.

The grand labour respecting the stars, which we began on the 5th of August 1789, has been continued with courage, and successfully terminated by Le Français-Lalande. He has determined the places of 50,000 stars, from the pole to two or three degrees below the tropic of Capricorn; and he has already begun, with Burckhardt, to review the zodiacal constellations, in the hopes of finding some new planets. Madame Le Français, who has already reduced 10,000 stars, has begun the reduction of the whole number with exemplary ardour. These 50,000 stars, terminated with the 18th century, will, in my opinion, form a remarkable epoch in the increase of our astronomical knowledge during that period.

M. Bode, of Berlin, has published the fourth number of his large and beautiful Celestial Atlas: he announces that the fifth and last will appear in the course of four months, with a preface and index, and a catalogue of 17,000 stars, a great part of which were furnished by me. This atlas consists

sists of twenty large charts. They may be had at the *College de France*, at Paris.

The conclusion of the century has been distinguished also in a very remarkable manner by the theory of the moon. On the 13th of June Laplace announced a new result of the theory, which is a nutation of the lunar orbit, resulting from the oblate figure of the earth. According to this inequality, we may suppose that the lunar orbit, instead of moving with a constant inclination to the ecliptic, moves in a plane passing through the equinoxes between the equator and the ecliptic, inclined to the latter at an angle of six or seven seconds. He has found also an inequality of the moon, depending on the longitude of the node, which is six seconds. Disputes were long maintained respecting this inequality, which the English totally neglected, and which did not seem to be indicated by theory.

The motion of the moon during the course of 1002 years was attended with a difficulty which has been now removed. The observations of the Arabs in the tenth century were of great importance, in this respect. We were acquainted only with three, when I discovered among the manuscripts of my old master, Joseph Delisle, an Arabic copy of a part of the work of Ibn Iunis, which contained a great many; but the original was at Leyden; and we long solicited the Batavian government to entrust us with it. At length, on the 26th of May 1799, the ambassador brought to the Institute this valuable manuscript, written in a small character, and forming 400 pages in quarto. Caussin is employed in giving a complete translation of it; and we hope, that not only the translation, but also the Arabic original, as far as it relates to the observations, will be printed at Paris. Caussin has already translated that which I procured him. He was assisted by Bouvard in regard to the astronomical part and the calculations. The results of the observations of the moon have been already printed.

The Institute had proposed as the subject of a prize, the comparison of a great number of observations of the moon, with the tables to fix the epochs of the longitude of the moon,
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of the apogee, and of the node. The two papers of Burg and Bouvard, which shared the prize of the Institute, contain new determinations of the moon's motion, founded on so great a number of observations, that there is reason to think that the tables thence resulting will never err more than 15 or 20 seconds; that is to say, one-half or one-third less than those which Mafon published in England. Dr. Maskelyne made him undertake them by determining the co-efficients of 24 equations of the tables of Mayer by a comparison with those of Bradley. But the new researches are founded on a much greater number of observations.

The equations, which De Laplace found by theory, have added to them a greater degree of perfection, and nothing remains but the latitude, for which a new prize ought to be proposed.

Burg has calculated 3233 of Maskelyne's observations, in order to determine the epoch of the moon. He has again determined also the 24 equations of the moon as Mafon has done, but with more correctness. Madame Lavoisier has had the courage to calculate more than 500 places of the moon for the researches of Bouvard on the same subject.

Burckhardt, one of our ablest and most zealous astronomers, has calculated tables of the moon, according to the new results of Burg, for the use of the astronomers who have set out on a distant expedition. They will perhaps find themselves in situations when it will be of importance for them to have the longitudes calculated more exactly than they are either in the English Nautical Almanack or the French *Connaissance des Temps*, which, besides, may be exhausted before their return.

The French Board of Longitude has proposed a prize of 6000 francs (250*l.*) for more perfect tables of the moon, which we shall soon obtain. This part, therefore, of so much importance to astronomy and navigation, which has occupied astronomers for more than 100 years, is at length terminated in the completest and most satisfactory manner.

De Parceval, an able geometer, has terminated a grand analytical theory of the moon, in which he has given exact

formulæ for a greater number of equations than are in the tables above mentioned. He proposes publishing a history of the integral calculus.

De Laplace is employed also on the theory of the moon ; and we have reason to expect from him new and valuable things. He has given a memoir on the satellites of Saturn and those of Herschel's planet. He has shown that the last satellite of Saturn has a constant inclination, and he determines the motion of its nodes. New considerations in regard to those of Herschel, induce him to think that this planet may maintain in the same plane its first five satellites ; but that the case, in all probability, is not the same in regard to the sixth.

Vidal continues to send us rare observations on Mercury, which he has made at Mirepoix. He is our valuable Her-mophilus, who sees Mercury every day, and who sees him even at the distance of some minutes from the sun. This astonishing observer has already sent me more than 500 observations of Mercury. He has done more in this respect than all the other astronomers in the world. At Mirepoix, perhaps, it is not known that such a man exists in that small town, but we shall proclaim it to the universe and to posterity.

The minister appointed him director of the national observatory at Thoulouse on the 21st of April last, and a better choice could not have been made.

Michel Le Français-Lalande, my nephew, finding that Mars was the only planet the tables of which were still liable to errors of one or two minutes, has re-calculated all the observations of that planet. Burckhardt has re-calculated the perturbations which I formerly gave in the memoirs of the Academy of Sciences, and which Schubert and Oriani afterwards calculated ; and Le Français has presented to the Institute new tables of Mars in tenths of a second, and which give us reason to apprehend no more than a few seconds of error. They are now printing in the *Connoissance des Temps* for the year 12 ; and the opposition of the 8th of November last has confirmed the correctness of these tables. An exact observation of the 13th, gave an error of only 15 seconds in longitude

longitude and 6 in latitude; and the observation made by Bouvard with the new instruments of the observatory, gave the same number of seconds; which confirms, in a satisfactory manner, the goodness of our instruments and the exactness of our observers.

Triefnecker has undertaken a similar labour at Vienna, and Oriani at Milan. The differences are insensible, but none of the three knew any thing of what was doing by his fellow-labourers.

Wurm has also calculated the perturbations of Mars by the method of Klugel, inserted in the memoirs of the Society of Göttingen. Oriani, Burckhardt, Schubert, and Wurm, do not always agree, but the differences are trifling.

Bouvard is employed in calculating the perturbations of all the planets, as they affect each other, by the formulæ of De Laplace. This will be a very complete work, the result of which will appear in the second volume of the *Mécanique Céleste*.

The transit of Mercury over the sun has afforded me an opportunity of verifying the place of the aphelion by the method which I gave in the memoirs of the Academy for 1786, and which is the most conclusive. By my result it appears that there is no reason for making any change in the tables of Mercury, which I published in the *Connaissance des Temps*. The same agreement in regard to Venus may be seen in the *Connaissance des Temps* for the year 11, p. 456.

For Jupiter we have found the correction to be made in the tables + 34" in the opposition and + 30" in the quadrature.

For Saturn the correction in the opposition is — 10", nearly as the preceding year.

For Herschel's planet I have found — 9"; and Von Zach, by employing five observations, had the same result.

We have reason therefore to be satisfied with the correctness of our tables for all the planets.

In regard to the tables of the sun, I have still found 8 or 10" too much in our longitudes: whether this arises from a retardation in the motion of the earth for 15 or 20 years past, or from some error respecting the mean motion in the construction

struction of the tables of Delambre and Von Zach. However this may be, I deduct $10''$ from the sun's place in calculations where great precision is required.

Delambre does not admit this correction: he says, that in the 300 observations of Greenwich, which he calculated in order to construct his tables, he compared the sun with the stars which passed in the day-time, one before and the other after the sun; and he adds, that unless this precaution is taken, we cannot assert that $10''$ are to be deducted from his tables.

An account of the grand labour by Delambre respecting a degree of the meridian between Dunkirk and Rodez, has been printed. The southern part, executed by Mechain, will next appear.

Vidal continues to send us observations of the stars below the tropic. Bernier, who laboured with me for nine months before his embarkation, reduced them up to the year 1800; and they will soon be printed.

Delambre has undertaken to observe with a whole circle the declinations of the stars of the 1st, 2d, and 3d magnitude; which will add a new degree of perfection to the catalogue of the principal stars published annually in the *Connoissance des Temps*.

The description of the astrolabe planisphere, found by Gail in Synesius, has induced Delambre to give a long memoir on the history of astrolabes, their construction, their properties, and the method of finding new results even in the most hackneyed part of astronomy.

Burckhardt has found a formula which represents the declinations of the magnetic needle observed at Paris since the year 1580. It appears from this formula that the period of the declination of the magnetic needle is at Paris 860 years; that the greatest declination west is $30^{\circ} 4'$, and will take place in the year 1878: the greatest eastern declination is only 23° .

The printing of the *Histoire celeste Française*, which is a collection of all our observations, is still continued. My *Bibliographie Astronomique* is also continued, but the printing-office of the republic is not sufficient for all the undertakings which have already been begun in it. Chaptal, the

minister of the interior, has given special orders for finishing this volume.

The printing of tables of sines to thousandth parts of the circle has been finished. The late Borda caused them to be calculated under his own inspection. The printing was pretty far advanced, but several things still remained to be done. Delambre put the last hand to them, and verified the calculation in several parts: he corrected the proofs and wrote the explanation.

The decimal tables have been calculated to a much greater extent at the *Bureau du Cadastre* by the care of Prony; but the difficulty of printing them will perhaps greatly retard the advantage we expect from them. If we can get all the astronomical tables reduced to decimal degrees, that is to say, calculated for the hundredth and thousandth parts of a quadrant, astronomical calculations will be much simplified; but a long time may elapse before astronomers will agree in regard to this reformation, though useful.

I have published an edition of the *Mondes de Fontenelle*, with notes and additions. This work, so celebrated, which is still generally read, stood in need of notes for correcting its errors. As Bode had given a German edition of it, and Codriska one in Greek, I thought it my duty to give a new one in French.

I have begun a small portable stereotype edition, in eighteen, of the tables of logarithms, published by Lecaille and myself in 1760, and since reprinted four or five times with a great many faults. This will be the most convenient small-sized edition, and the most correct.

Firmin Didot will insure the beauty of the impression: I have added explanations for the use of those astronomers, philosophers, geographers, surveyors, who may have occasion to employ logarithms; but I have suppressed all useless formulæ.

For a century past astronomers have been continually disputing on the obliquity of the ecliptic and the quantity of its diminution. The circles with which observations may be multiplied at pleasure, presented new means for deciding this question. I caused one of 19 inches radius, the greatest
hitherto

hitherto employed, to be constructed: Français-Lalande and Buerckhardt have used it with great success during the two last summer solstices.

Mechain and Delambre have communicated to us their observations, and I now find myself in possession of more than 700: the mean result is, that $5''8$ must be added to my tables. The mean for the first of January 1800, is $23^{\circ} 27' 58''$.

The diminution would be $41''$ for a century; and taking as the term of comparison the determinations of Bradley, Mayer, and Lacaille, in 1750, I have found $36''$ for a great many other comparisons, particularly the observations of Richer at Cayenne in 1672, the oldest made with any degree of correctness. We have therefore reduced to very little the uncertainty of this element, so necessary in regard to the stars. Duc la Chapelle, with a sextant of six feet, which had been employed by Lacaille, has found $19''$ less than that celebrated astronomer did in 1750, being a diminution of $38''$ per century.

In the Ephemerides of Vienna for 1800 and 1801, Triefnecker has collected all the calculations of eclipses observed since 1747, in order to deduce from them the longitudes of the cities of Europe and America, and also the errors in the tables. Never were so many eclipses calculated; and that able astronomer has thus rendered a new and very important service to government.

Goudin, who has bestowed great labour on the analytical calculation of eclipses, and who has published several memoirs on that subject, has by his analysis completely determined the circumstances of the eclipse of 1847, the most considerable of the present new century. Duvaucel, to whom we are indebted for the delineation of eclipses for thirty years past, has delineated also this eclipse for every country on the globe: by his diagram it appears that it will be annular in England, France, Turkey, and even Cochinchina.

Duvaucel has delineated also the eclipse of the 11th of February 1804, which will be curious, because it will be total and annular in different countries according to the altitude of the sun: annular at sun-rising in America, and at the setting in

Asia, from nine in the morning till one o'clock; it will be total, with a short duration in the shadow, to the southern part of Europe: there is reason to think that some voyages will be undertaken on this occasion, since it will be an uncommon opportunity for determining the differences of the diameters of the sun and moon, the irradiation and inflection. These diagrams of eclipses have hitherto appeared in the Ephemerides of Paris and in those of Bologna; but those in the Ephemerides of Paris terminated with 1800, and in those of Bologna, which go as far as 1810, there is only one diagram for 1804; four are wanting, *viz.* of 1802, 1803, 1806, and 1807. Duvaucel proposes to construct them, and particularly the last two.

Cagnoli, an astronomer of Verona and professor at Modena, has been left in peace during the invasion of the Cisalpine republic by the Austrians; and, by means of the pension assigned to him by Bonaparte, he has published the eighth volume of the Memoirs of the Italian Society, in which he has given some memoirs on astronomy.

Bode, in the Ephemerides of Berlin for 1802, has published a great many memoirs, observations, and calculations, by himself and by Wurm, Mechain, Olbers, Casella, Koch, Koehler, Triefnecker, Burg, Schröeter, Klugel, Scyffert, Hennert, Schubert, Derfflinger, Hahn, Kautsch, Fritsch, and Schaubach.

In the *Connoissance des Temps* for the year 11, which has just appeared, there are a multitude of observations and calculations by Laplace, Delambre, Vidal, Messier, Lachapelle, Sorlin, Mougins, Quenot, Burckhardt, Thulis, Poitevin, Bernier, and myself, and a catalogue of 2300 new stars by Le Français-Lalande and Vidal.

This volume consists of more than 500 pages, agreeably to the decision of the Board of Longitude, which I requested several years ago, and yet I have still in my hands materials which I was not able to employ.

I shall embrace this opportunity to inform those who have the *Connoissance des Temps* for the year 9, without the additions, that they have been published separately under the title of *Mélanges d'Astronomie*, and that with the first part they form

form the 500 pages as above announced. It was apprehended that the use of the old calendar and the old measures found in this work would thwart the projects of government, and this sacrifice was made for the sake of peace. But the amateurs of this collection of the *Connoissance des Temps* will be deceived if they have the volume of the year 9 without the *Melanges*.

In these *Melanges*, page 282, I announced the publication of Malespina's Voyage round the World; but it has not taken place, and that officer is still in prison. I am, however, of opinion, that in the maps about to be published in Spain, advantage will be taken of his observations.

The Memoirs of the French National Institute, vol. ii. for the year 5, were published on the 12th of November 1799. They contain calculations of two comets and several eclipses already observed; the theory of the secular equation of the moon by Laplace, the discovery of which we announced, and which may be found also in the *Mecanique Celeste*, that grand and important work, of which we have already spoken, and of which three long extracts were published by Briot in the *Magazine Encyclopedique*. Burckhardt has given a German translation of it, that his former country may enjoy the valuable discoveries of Laplace.

In the Philosophical Transactions for 1799, there is a new method for finding the latitude by two altitudes of the sun, and the interval of time elapsed, by Mr. Lax, professor of astronomy at Cambridge. Also, a fourth catalogue of stars, compared with each other in order to estimate their degree of light, by Dr. Herschel.

In the Transactions for 1800, there is an interesting memoir, by Dr. Herschel, on the power of telescopes to penetrate into space; that is to say, to render sensible very distant and very faint objects, which, by their want of light, would be imperceptible without the aid of instruments; useful remarks on the difference between that force of light and that of amplification or enlargement; on the different cases to which either is applicable, and the means of procuring the necessary degree of light. He gives calculations also of the loss of light occasioned by mirrors or glasses. It appears to him that the greatest amplification cannot exceed that produced

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by a telescope of from 20 to 25 feet, and such a celebrated optician is worthy of credit. The 16th number of the *Bibliothèque Britannique*, published at Geneva, contains a large extract from this paper. In the Transactions of 1800, Dr. Herschel gives a long paper on the influence of the different solar rays and those of terrestrial bodies to communicate light and heat: he has found that the yellow rays illuminate most, and that the red communicate the greatest degree of heat. Astronomers will make use of this information when they observe the sun. This paper contains a series of curious experiments on light.

Mr. Playfair, in the fifth volume of the Edinburgh Transactions, has given formulæ for the figure of the earth.

A valuable work for geometry, which treats of the calculus of derivations published by Arbogast, one of our greatest geometricians, deserves a place in our history of astronomy. This work, in page 355, contains an application of the calculus of derivations to series which proceed according to the sines or cosines of the multiples of the same angle: his methods give more facility and perfection to the manner of treating them.

I have received the Ephemerides of Milan for the year 1800, which contain the perturbations of Mars, calculated by Oriani, and his tables of Mars, which will form part of the Ephemerides for 1801. I have received also the Ephemerides from Rome by Oddi, who occupies the observatory Gaetani, and the Nautical Almanack for 1804, which Sir Joseph Banks transmitted to us with his usual zeal.

Gudin has published a poem of 600 lines, containing a history of astronomy and an account of the present state of that science. The author has added very copious and instructive notes. This poem is already employed as an agreeable fund of instruction for youth under the care of a well known preceptor. But, after so many interesting works, the historian is obliged to announce one more voluminous, called *Principes naturels, ou Notions generales et particulieres de l'Immensité de l'Espace, de l'Univers, des Corps celestes*, &c. by Lejoyand, five volumes quarto, in which the author pretends, to the disgrace of our country and of the present age, to destroy the systems of Newton and Descartes.

During the first years of the revolution the national observatory was neglected: as soon as I was appointed director of it I solicited for new instruments; and Mechain, when he returned from his voyages, employed himself in causing the necessary reparations to be made. By the month of July the new instruments were erected, but it was not till the 22d of August that Mechain was able to begin his observations of the moon. Bouvard supplies his place with that zeal by which he is so much distinguished; and we shall have at Paris a series of observations of the moon that may equal those made at the observatory of Greenwich.

The large mural quadrant of $7\frac{1}{2}$ feet, which Bonaparte procured for us, as I mentioned in my History of Astronomy for the year 7, has been erected.

Lenoir has added to the centre an ingenious machine, which eases the central axis from the weight of the telescope, and varies according as the elevation of the telescope is changed. A mural of five feet, made in England by Sisson in 1743, and which I had at Berlin in 1751, has been erected on the northern side. An excellent transit instrument by Lenoir has been placed in the meridian, and sights have been fixed up north and south at great distances, that the telescope may be always exactly in the meridian: there is reason to hope that we shall have a column in the plain, with a light to be kindled in the evening, which will serve during the night.

[To be continued.]

II. *A brief Account of the Manufacture of Gilt Buttons, comprising some Improvements important to Manufacturers. Communicated by Messrs. COLLARD and FRASER, of Birmingham.*

AS the means employed in the manufacture of plain gilt buttons are not universally known, the following summary, while it points out to the manufacturer many considerable advantages, in the use and recovery of his mercury, will also, it is hoped, be found interesting to many readers of the Philosophical Magazine.

The