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(*b*. Amiens, France, 19 September 1749; *d*. Paris, France, 19 August 1822)

astronomy, geodesy, history of astronomy.

Delambre's early life resembles those novels of the nineteenth century in which industry overcomes hardship and is rewarded with social distinction and financial gain. He began his education in the local schools of Amiens and eventually won a small scholarship that enabled him to move on to Paris and the Collège du Plessis, where he studied literature (chiefly Latin and Greek) and history. He was especially skilled in languages and began to make translations of works in Latin, Greek, Italian, and English. He was apparently so poor that upon graduation he lived for almost a whole year on a diet of bread and water.[1] He then was engaged as a private tutor in Compiègne and undertook private studies in mathematics, presumably so as to be able to teach this subject along with languages, literature, rhetoric, and history—in which he had received schooling. A local doctor seems to have suggested to Delambre that he might eventually learn astronomy. The opportunity to do so did not occur, however, until 1780, when Delambre had been established in Paris for some nine years. He was thus in his early thirties when he first began to study astronomy, the subject in which he was to establish his reputation.

A most fortunate event that helped Delambre in his career occurred in 1771, when he became tutor to the son of Geoffroy d'Assy *(receveur générale des finances)* in Paris. Eventually d'Assy built a small, private, and apparently well-equipped observatory for Delambre's use—acting on the suggestion made by the astronomer Lalande.[2] Delambre had begun to attend Lalande's lectures at the College de France in 1780, and he at once attracted the attention of Lalande when the latter made reference to the Greek poet Aratus, of the third century B.C., author of the astronomical poem *Phaenomena*. Delambre, who was endowed with a prodigious memory, thereupon recited the whole passage in question and went on to discuss various explanations and commentaries that had been made by different scholars. Lalande soon learned that Delambre had written a series of annotations and emendations to his own writings, notably his *Astronomie*, the course textbook. After reading Delambre's notes, Lalande made him an assistant, and eventually Delambre became Lalande's scientific collaborator. Lalande fondly referred to Delambre as his "meilleur oeuvre."[3]

The beginning of Delambre's career as an observer is dated (by himself) on a day in 1786 when only he and Messier, of all the astronomers in Paris, had seen the transit of Mercury across the sun. The event occurred three-quarters of an hour later than the time predicted by Lalande; the other observers, too easily discouraged, had given up. Delambre had more faith in Halley's tables, which predicted the occurrence of the transit an hour and a half later, and so he persevered. This particular episode is cited by Jacquinet[4] as an example of the lack of precision in astronomical tables of that time. Delambre's experience with the transit must have provided a strong incentive for making more accurate tables of various major astronomical phenomena.

Before long there was a public challenge to all astronomers to solve the problems of precise planetary motion. The Académie des Sciences announced a general competition for the prize of 1790 on the subject of the motion of the planet Uranus, which had been discovered by William Herschel in 1781. Some idea of the difficulty of the problem may be gained from the simple fact that these eight years of observation of Uranus represent only about one-tenth of its sidereal period. To determine the orbit and motion of Uranus, Delambre had to consider the perturbations produced by Jupiter and by Saturn: in short, he had to combine a skill in computation with a theoretical understanding of applied celestial mechanics. After winning the prize, he went on to establish himself as a foremost expert in positional astronomy. Eventually there followed tables of the sun, of Jupiter, of Saturn, and of the satellites of Jupiter. The high esteem in which his results were held is shown in the statement by Arago: "In perfecting the methods of astronomical calculation he merits, by reason of the variety and elegance of his methods, a distinguished place among the ablest *géomètres* France can boast."

The above-mentioned tables were published by Lalande in a later edition of his *Astronomie* and earned two further honors for Delambre. In 1792 he was again given the annual prize of the Academy, and he was elected *membre associé* in the section of *sciences mathématiques*. This election was a major factor in his being designated to make the fundamental geodetic measurements on which the metric system was to be based.

In 1788 the Academy decided to establish a "uniform system of measures" founded on some "natural and invariable base." The plan for the new system of measures was formally approved by a decree of the Assembly of 8 May 1790, proposed by Talleyrand; it was approved by Louis XVI on the following 22 August. A commission on the metric system, consisting of Borda, Lagrange, Laplace, Monge, and Condorcet, was thereupon appointed by the Academy. In a report submitted on 19

March 1791,[5] the commissioners rejected two proposed bases for the fundamental unit of measure: the length of a seconds pendulum (at 45° latitude), and one-quarter of the terrestrial equator. Instead they chose one-quarter of a terrestrial meridian, the common practical unit to be a ten-millionth part of this quantity. Accordingly, it was proposed to make a careful and accurate measure along an arc of the meridian through Dunkerque (which had in part been measured by the Cassinis in 1718 and in 1740), extending as far south as Barcelona, giving 9°.5 of arc.

Three fundamental tasks were envisaged. First, to determine the exact difference in longitude between Dunkerque and Barcelona (and to make any needed latitude determinations in between); second, to check by new observations and calculations the triangulations used earlier to find the distance between Dunkerque and Perpignan; third, to make new measurements that could serve for successive triangulations. Clearly a major part of this assignment would be to compute carefully the difference in actual lengths (in *toises*) corresponding to the same difference in latitude at various points along the meridian, so as to be able to determine the actual shape of the earth. While these operations were being performed, other scientists would be engaged in establishing a standard of mass. The instruments, chiefly made by Lenoir according to the plans of Borda, were ready by June 1792, and the work was started shortly afterward.

Originally, the geodetic survey was to be entrusted to Méchain, Cassini, and Legendre. The latter two begged off, and Delambre—just made a member of the Academy—was appointed. It was decided that Delambre would be in charge of the survey from Dunkerque to Rodez, leaving the survey from Rodez to Barcelona in the hands of Méchain. An account of the labors and adventures of Méchain and Delambre is available in their joint publication, *Basedu système métrique décimal* (3 vols., Paris, 1806, 1807, 1810). This may be supplemented by Delambre's own *Grandeur et figure de la terre* (Paris, 1912), edited and published from Delambre's manuscript about a century later by G. Bigourdan.

Delambre explains the inequality of the assigned distances (Méchain—170,000 *toises* from Rodez to Barcelona; Delambre—380,000 *toises* from Rodez to Dunkerque) as follows: "The reason for this unequal division was that the Spanish part was entirely new, whereas the remainder had already been measured twice; we were agreed that the former would provide many more difficulties." Then he remarks, "We did not know that the greatest difficulties of all would be found at the very gates of Paris." Méchain, the first to set out, on 25 June 1792, was arrested at his third observational site, at Essonne, by uneasy citizens who were convinced that his activities had some counterrevolutionary aspects. Only by constant explanation and good fortune was Méchain able to continue, and eventually to carry his survey into Spain. Delambre encountered similar difficulties; and, in addition, when he returned to Paris and had to leave again, he had to seek new passports as the government changed. It seems almost incredible that in time of revolution Delambre was able to continue his work as much as he did. In eight months of 1792, however, he had established only four points of triangulation; but in 1793, despite delays in getting his passport, he made better progress. Then, in January 1794, he received an order from the Committee of Public Safety to stop all observations at once. On his return to Paris he learned that as of 23 December 1793 he had been removed from membership in the commission of weights and measures, along with Borda, Lavoisier, Laplace, Coulomb, and Bresson.

Happily, the enterprise was revivified by the law of 18 Germinal *an* III (7 April 1795), and Delambre and Méchain were able to take up their old assignments, now under the title of *astronomes du Dépôt de la Guerre*, serving under the head of that establishment, General Calon, a member of the Convention. Delambre thereupon set out for Orléans on 28 June 1795 and completed his assignment within four years.

Delambre's task was not merely to make a series of correlated astronomical observations and terrestrial measurements; he had also to carry out extremely laborious calculations. The latter were made especially tedious by the need to convert the observations from the new centesimal units of angle-measure (used in Delambre's instruments) to the older units of degrees, on which all tables of logarithms and of trigonometric functions were then based.

The proponents of the metric system succeeded in establishing a decimal-positional system of mass and length (area and volume), but failed in their attempts to introduce similar systems of time or of angle measure. Delambre's instruments were constructed with the new centesimal divisions, in anticipation of their general adoption. On this score he remarks:

This subdivision is much more convenient for use with the repeating circle, and would be equally convenient for verniers with any sort of instrument. Some people still prefer the old subdivision out of long habit and because they have never tried the new one, but no one who has ever employed them both wants to return to the former system.

Extending the metric system to the subdivision of the circle, however, required the construction of new trig onometric tables. In the year II [1793], M. de Prony was requested to prepare such tables which would leave nothing to be desired in their exactitude and which would constitute the largest and most imposing monument of calculation that had ever been executed or even conceived.[6]

Prony's manuscript, never edited for publication, contained logarithms of sines and tangents to fourteen decimals in tens of centesimal "seconds" and logarithms of numbers from 1 to 100,000 to nineteen decimals. An account was presented to the Institute and was published in 1801 by Lagrange, Laplace, and Delambre, under the title *Notice sur les grandes tables logarithmiques et trigonométriques calculées au bureau du Cadastre sous la direction du ciloyen Prony*.

A more usable work was produced by Borda, a set of tables to seven decimals. Completed by Delambre after Borda's death, this work was published in the year IX of the Republic (1801), under the title *Tables trigonoméetriques déimales, ou tables des logarithmes des sinus, sécantes et tangentes, suivant la division du quart de cercle en 100 degrés, de degré en 100 minutes, et de la minute en 100 secondes;... calculéees par Ch. Borda, revues, augmentées et publicées par J. B. J. Delambre.*

Méchain died in 1804, and it became Delambre's sole responsibility to complete the computations and to write up the final report. This constituted three volumes containing the history of the enterprise, the observations, and the calculations. The third volume was completed in 1810, some twenty years after the project was begun. When Delambre presented a copy of this work to Napoleon, the emperor responded, "Conquests pass and such works remain."[7]

Delambre's results were put into the hands of a commission of French and foreign scientists, who then determined the unit of length which became the standard meter. Jean Joseph Fourier said that "no other application of science is to be compared with this as regards its character of exactness, utility, and magnitude." The newly constituted Institut de France designated this survey "the most important application of mathematical or physical science which had occurred within ten years" and in 1810 gave Delambre a prize for his share in the great work. The accuracy with which Delambre carried out his task may be seen in a comparison of two base lines: Perpignan and Mélun. Delambre measured both by direct methods. Then, making use of a network of triangulation, he used one to compute the other. According to Fourier, although the distance between the two bases is some 220 leagues, the results of calculation differed from the results of direct measurement by less than threetenths of a meter, less than one part in 36,000.

By the time of publication of his report on the base of the metric system, Delambre had become a resident member of the newly organized Institut National (*section de mathématiques de la première classe)*. He was appointed an inaugural member of the Bureau des Longitudes, founded in 1795. When the Institute was reorganized, he became, on II Pluvoôse *an* XI (31 January 1803), the first permanent secretary for *les sciences mathématiques*. In 1807, he succeeded Lalande in the chair of astronomy in the Collège de France. In 1813 he published an *Abrégé d'astronomie* and in 1814 a work on *Astronomie théorique et pratique*, based on his lectures. Until 1808, when he moved from the rue de Paradis to the outskirts of the Faubourg Saint-Germain, he continued to make observations from his private observatory, primarily checking stellar positions in the major catalogs from Flamsteed's to Maskelyne's. He also associated himself with Laplace, who was working on the problems of perturbations and other aspects of celestial mechanics, and produced new tables based on these investigations. In the official *éloge*, Fourier wrote:

Before him astronomical calculations were founded on numerical processes, which were at once indirect and irregular. These he has changed throughout, or ingeniously remodeled. Most of those which astronomers use at the present time belong to him, having been deduced from analytic formulas, which, in their application, have been found alike, sure, uniform, and manageable. The new tables which he has given us of the sun, of Jupiter, of Saturn, of Uranus, and of the satellites of Jupiter, at least some of them, may have been considerably improved by recent labors founded on a greater number of exact observations; yet, in the present state of astronomy, and up to this day, the tables of Delambre just mentioned are those employed in the calculations made for the *Connaissance des temps* and for the nautical and astronomical ephemerides of most nations. In addition, the geodetic operation, for which we are chiefly indebted to him, and of which he bore the greatest share, is the most perfect and extensive which has been executed in any country. It has served as the model of all enterprises of the kind which have been since projected.

As scientist, Delambre is remembered primarily for his improvements in astronomical tables and his contributions to the measurement of the earth (and establishment of the base of the metric system). But he had yet another career, begun in the last decades of his life, as historian. Reference has already been made to Delambre's history of the measurement of the earth (and the historical first volume of the *Base du système métrique décimal)*. In 1810 Delambre published a major historical work, *Rapport historique sur les progrès des sciences mathématiques depuis 1789*.

Delambre had at one time intended that his treatise on astronomy would be preceded by a *tableau* of the evolution of this science through the ages. But he found the subject so vast that he decided to devote a separate work to it. He began collecting and organizing his materials in 1812, at the age of sixty-three, and he devoted the remainder of his life to compiling a history of astronomy. By the time he was finished, Delambre had completed six volumes, of which the final one (on the astronomy of the eighteenth century) was published posthumously in 1827 by L. Mathieu. The first two volumes (1817) deal with ancient astronomy, a third (1819) with the astronomy of the Middle Ages, and the fourth and fifth with the astronomy of the Renaissance and the seventeenth century. Delambre also helped the Abbé Halma in his translation of Ptolemy's *Almagest* and he wrote an extensive set of notes of such importance that his name appears along with Halma's on the title page.[8]

Delambre's *Histoire de l'astronomie* is a work without parallel in any of the sciences. It is a technical work, written—as he said—"mainly for astronomers, and mathematicians in general." His aim had been to produce a "tableau complet des différens, âges de l'Astronomie," that is, "a repository where could be found all the ideas, all the methods, and all the theorems that have served successively for the calculation of phenomena." There is no synthesis, no generalization, no display of insight into the causes for great progress or decline. Delambre rather presents each major chronological period in a series of discrete analyses of one treatise (or other work) after another. Often, in the case of a long book (as Kepler's *Astronomia nova)*, the analysis proceeds chapter by chapter. Thus the reader may readily apprehend what a given astronomical work contains, plus a critical estimate of its worth; and he may follow Delambre as he compares and contrasts several works of a given author. But the method is frustrating in the extreme to anyone who may want to trace a particular topic throughout a whole century or more.

As one would expect, Delambre is especially good on astronomical tables and on methods of observation and calculation. A great virtue is the wealth of information on minor figures, for whom no other account may be available. Above all, Delambre spices his presentation with acerb and delightful comments (including critical remarks about style or errors in Greek and Latin) as his statement that Boulliau's construction is "certainement ingénieuse, mais inutile." Or again, "[We] are writing a history not eulogies." Thus, "The historian owes nothing to the dead save truth. It's not our fault if *in astronomy* Descartes produced nothing but chimeras."[9] Unquestionably the six-volume *Histoire* is the greatest full-scale technical history of any branch of science ever written by a single individual. It sets a standard very few historians of science may ever achieve.

In the course of his geodetic measurements, Delambre gained the service of a young assistant, Leblanc de Pommard. Pommard's mother, then a widow, has been described as "a distinguished Latinist, endowed with solid but not pedantic learning." Delambre married her when he was fifty-five years of age.

Under the Empire, Delambre took on a number of official posts, including *inspecteur général des études* and *trésorier de l'université*. He had the task of establishing a number of *lycées*, including those of Moulins (1802) and Lyons (1803). Despite his "opinions libérales," he became in 1814 a member of the Conseil Royal d'Instruction Publique. He retired from public life in 1815 and was made a *chevalier* of Saint Michel by the royal government. In 1821 he became an *officier* of the Legion of Honor (he had been a *chevalier* since the foundation of the order).

NOTES

1. Mathieu, p. 305*a*.

2. This observatory was situated in the Hotel d'Assy in the rue de Paradis, in the Marais, which is now part of the Archives Nationales. The observatory remained a distinct structure until about 1910 (Jacquinet, p. 195).

3. Lalande listed the date of Delambre's birth in the preface to his *Astronomie* 3rd ed. (Paris, 1792). p. xxxiii, "parceque, je la regarde comme devant faire époque dans l'histoire de l'astronomie."

4. P. 195.

5. According to the report, "It is apparent here that we are surrendering all claim to the common division of the quarter-meridian into degrees, minutes, and seconds; but this old division could not be kept without harming the unity of the system of measure since decimal division that corresponds to arithmetical gradations is to be preferred for a standard of usage" (Jacquinet, p. 196). See also Delambre's *Grandeur et figure de la terre* (1912).

6. These extracts are taken from Méchain and Delambre, *Base du système métrique*.

7. Delambre wrote this remark in his own copy of this work.

8. In this work, and in his history of ancient astronomy, Delambre adopted a posture which has recently been subject to serious criticism: a "dislike for Ptolemy and the resulting misrepresentation of Hipparchian astronomy as being practically the equivalent of the *Almagest"* (O. Neugebauer, in his preface to the reprint of Delambre's *Histoire de l'astronomie ancienne)*.

9. For a critical analysis of Delambre as historian, see I. B. Cohen's introduction to the reprint of Delambre's *Histoire de l'astronomie moderne*.

BIBLIOGRAPHY

1. Original Works. Delambre published a large number of *mémoires, extraits, notices, éloges*, and other works in the *Connaissance des temps* from 1788 to 1822, and in various publications of scientific societies, including the Académie des Sciences (Paris), and the academies of Berlin and Turin. His major publications, in chronological order, are *Tables de Jupiter et de Saturne* (Paris, 1789); *Tables astronomiques, calculées sur les observations les plus nouvelles, pour servir à la troisième édition de l'Astronomie*, a supp. (with separate pagination) to vol. 1, 3rd ed., of Lalande's *Astronomic* (Paris, 1792)— in the preface Lalande says. "Les tables... du Soleil, de Jupiter, de Saturne, et des satellites [de Jupiter], sont de M. de Lambre..."; and *Méthodes analytiques pour la détermination d'un arc de méridien. Précédées d'un mémoire sur le même sujet, par A.M. Legendre* (Paris, *an* VII [1799]).

The *Tables astronomiques publiées par le Bureau des Longitudes de France*, pt. 1 (Paris, 1806), contains "Tables du Soleil, par M. Delambre"; pt. 2 (Paris, 1808) contains "Nouvelles tables écliptiques des satellites de Jupiter, d'après la théorie de M. Laplace, et la totalité des observations faites depuis 1662, jusqu'à I'an 1802; par M. Delambre"; a separate publication of the latter work, with a slightly different title (Tables... *d'apès la théorie de M. le Marquis de Laplace*.) was issued in Paris, 1817.

Other works are *Base du système métrique décimal, ou Mesure de l'arc du méridien compris entre les parallèles de Dunkerque et Barcelone, exécutée en 1792 et années suivantes, par MM. Méchain et Delambre. Rédégie par M. Delambre. Suite des Mémoires de l'Institut*, 3 vols. (Par is, 1806, 1807, 1810); *Rapport historique sur les progrés des sciences mathéntatiques depuis 1789, et sur leur état actuel...* (Paris, 1810; photo repr., Amsterdam, 1966); *Abrégé d'astronomie, ou le¸ons élémentaires d'astronomie théoriqueet pratique* (Paris, 1813); *Astronomie théorique et pratique*, 3 vols. (Paris, 1814); *Histoire de l'astronomie ancienne*, 2 vols. (Paris, 1817); *Histoire de l'astronomie du moven âge* (Paris, 1819); *Histoire de l'astronomie moderne*, 2 vols. (Paris, 1821); and *Histoire de l'astronomie au dixhuitième siècle*. The six-volume set of histories was repr. in facs., with a preface to vols. I and II by O. Neugebauer, an intro. to vols. IV and V by I. Bernard Cohen, and an intro. to vol. VI by Harry Woolf (New York-London, 1965–1969).

See also *Grandeur et figure de la terre*, with notes and maps (Paris, 1912).

Not included in the above list are certain works edited by Delambre (such as Borda's *Tables trigonométriques décimales*...) or reports (such as the one on Prony's tables), even though they are mentioned in the text of the article. But special mention should be made *of Composition mathématique de Claude Ptolémée. Traduite pour la premièrefois du grec en français, sur les manuscrits originaux de la Bibliothèque lmpériale de Paris, par M. [l'Abbé] Halma; et suivie des notes de M. Delambre, 2* vols. (Paris, 1813–1816; photo repr., Paris 1927).

II. Secondary Literature. The major biographical source is Claude Louis Mathieu's article, based on Delambre's manuscript autobiography and other manuscripts, in Michaud's *Biographic universelle* (new ed.. Paris, n.d., X, 304–308), Another major source is Pierre Jacquinet,"Commémoration du deux-centième anniversaire de la naissance de J. B. Delambre—son oeuvre astronomique et géodfésique, in *Bulletin de la Société Astronomique de France*, 63^{e} annee (1949), 193–207. Jean Joseph Fourier's *Éloge*, prepared for the Académie des Sciences, is available in an English translation by C. A. Alexander in the *Annual report... of the Smithsonian Institution... for the year 1864* (Washington, 1865), pp. 125–134.

Also available is Joseph Caulle, "Delambre—sa participation à la détermination du mètre," in *Recueil des Publications de la Société Havraise d'Études Diverses*, 103^{e} année (1936), 143–157. Other sources are Charles Dupin, "Notice nécrologique sur M. Delambre," in *Revue encyclopédique*, **16** (1822), 437–460, and the brief account by St. Le Tourneur in the new *Dictionnaire de biographic fran¸aise*, fasc, 57 (Paris, 1964), p. 675.

As Bigourdan reports, "The Academy of Amiens held a contest for his eulogy; Vulfran Warme's speech, printed at Amiens in 1824, won for him the *accessit* and a gold medal'." A copy of this work, *Éloge historique de M. Delambre. qui a obtenu I'accessit et une medaille d'or au concours de l'Académie d'Amiens* (Amiens, 1824), is in the dossier of Delambre in the library of the Académie des Sciences, Paris, with M. Desboves, *Delambre et Amperè; Discours de réception, suivide...plusieurs lettres inédites de Delambre* (Amiens, 1881). See also David Eugene Smith's *Delambre and Smithson* (New York, 1934).

A summary of the facts of Delambre's life and an evaluation of his work as historian is available in my introduction to the facs. repr. of Delambre's *Histoire de l'astronomie moderne*. In the short biography listed three paragraphs above, Mathieu says of himself: "The author of this article, a student and friend of Delambre and possessor of all his manuscripts, made use of the writings of Delambre, a biographical note written by Delambre himself, and that which he had the opportunity of learning about Delambre during the many years he spent with him. One would have to have heard this modest and sincere man giving an account of his way of life after leaving the Collège du Plessis in order to believe the tiny amount that he spent during one year."

I. Bernard Cohen