Biographical Encyclopedia of Astronomers

Legendre, Adrien-Marie

Born

Paris (or possibly Toulouse), France, 18 September 1752

Died

Paris, France, 10 January 1833

Adrien-Marie Legendre was primarily a mathematician, publishing an important three-volume work on number theory and an equally important three-volume work on elliptic functions, and was the first to publish the method of least squares. Little is known of his early life, though it is likely that he came from a well-to-do family. Legendre studied at the Collège Mazarin, graduating in 1770. He served as professor of mathematics at the École Militaire in Paris from 1775 to 1780. In 1795, Legendre was appointed professor at the École Normale. He was married by the mid-1790s.

When Pierre de Laplace was promoted to an associate member of the Academy of Sciences in Paris, an adjoint position became open, and Legendre was appointed to it in 1783. During the revolutionary era, Legendre was also one of the members of the Committee of Weights and Measures that established (1791) the metric system. Legendre survived the Terror, but the closure of the academy in 1793 deprived him of an income. As the Revolution had already destroyed his small fortune, Legendre was plunged into dire financial straits. Fortunately, in 1795, the academy reopened as the Institut National des Sciences et des Arts, and Legendre received one of the six positions in mathematics, which again provided him with a small income.

Legendre survived the turbulent revolutionary era only to fall from grace when he voted against a government-supported candidate for the national institute in 1824. Thereafter, the government withdrew its financial support of Legendre, and he died in poverty

In astronomy, Legendre was first a member of the 1787 team to work with the Royal Observatory in Greenwich to measure the size of the Earth (for which Legendre became a member of the Royal Society of London in 1787). However, his main contribution came in 1805 when he published details of the method of least squares in his *Nouvelle méthode pour le détermination de l'orbite des Comètes* (New method for determining the orbit of Comets). The details appeared in an appendix, dated 6 March 1805. This caused a priority dispute with Carl Gauss, who claimed to have been using the method since 1795, but did not publish the details until 1809. By the strict standards of academic priority, Legendre, as the first to publish, should be considered the inventor of the method of least squares.

The problem Legendre sought to solve was the following: Any physical measurement of a quantity is subject to error More specifically, when dealing with planetary orbits, five geometric parameters are necessary to describe the elliptical orbit of an object about the Sun: the length

a of the semimajor axis, the eccentricity e of the ellipse, the inclination i of the orbital plane to the ecliptic, the longitude 2 of the ascending node, and the argument w of the perihelion. A sixth parameter gives the actual position of the object along the elliptical orbit at a particular time. These parameters are not measured directly; instead, they emerge as the solution to a system of equations drawn from three (or more) complete observations of a celestial object. For example, if we wish to find the area of a rectangular field, we measure its dimensions and then compute its area. Thus, the determination of the orbital parameters of an object can be viewed as the solution to a system of equations in six unknowns, necessitating a minimum of three observations (with each observation supplying two of the unknowns). With more observations, the system of equations becomes overdetermined, and thus the question arises of finding the six parameters that best fit the observations.

The discrepancy between the actual position of the object (defined in relation to the six orbital elements or parameters) and the measured position of the object constitutes the error of observation. Legendre claimed (without proof) that, of all possible values for the parameters, the ones that minimized the sum of the squares of the errors were the ones most likely to be correct. Gauss gave a defective proof of the

validity of this assumption, but the first rigorous justification was given by the Irish-American mathematician Robert Adrian in 1808

Legendre also published a number of textbooks used throughout Europe and the United States. His *Éléments de géométrie* (Elements of Geometry) (1794) was the principal introductory text used for nearly a century.

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Selected References

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