Biographical Encyclopedia of Astronomers

Delaunay, Charles-Eugène

Born Lusigny, Aube, France, 9 April 1816.

Died at sea near Cherbourg, France, 5 August 1872.

Charles-Eugène Delaunay was a professor, director of the Paris Observatory, mathematician, and a significant contributor to lunar theory. The son of Jacques-Hubert Delaunay, a mathematics teacher, and Catherine Choiselat, Delaunay entered the École Polytechnique in 1834. Ranked first in his class two years later, he received the first Laplace Prize, a copy of the astronomer's complete works that is said to have prompted his interest in celestial mechanics After turning down an offer from Dominique Arago to join the Paris Observatory after his mentor Félix Savary, from the Bureau des longitudes, said that this amounted to forfeiting his independence, Delaunay attended the École des mines, with which he remained closely associated through the early part of his career. He married Marie-Olympe Millot in 1839, and they had a son the following year; after her untimely death in 1849, he raised his son alone and devoted himself to the pursuit of lunar motion theory.

In November 1838, Delaunay was hired by the École Polytechnique as a *répétiteur* (teaching assistant) for the course on geodesy and machines, later nominated *répétiteur* of mechanics to replace Urbain Le Verrier, and was made professor in 1851. From 1841, he was Jean-Biot's substitute for the course of physical mechanics at the University of Paris (Sorbonne), whose chair Delaunay occupied in 1848.

Despite Le Verrier's opposition, Delaunay was elected to the Paris Académie des sciences in 1855. He was later nominated to the Bureau in 1867, became a Fellow of the Royal Society in London in 1867, and was appointed director of the Paris Observatory after Le Verrier's dismissal on 2 March 1870. That same year, Delaunay was awarded the Gold Medal of the Royal Astronomical Society

Above all, Delaunay was an indefatigable analytical computer. His first paper was a short note published in 1838 in Joseph Liouville's *Journal de mathématiques pures et appliquées*. Although astronomy seems to have been his early passion, Delaunay's 1841 doctoral thesis at the Sorbonne was also concerned with mathematics, namely the calculus of variations ("De la distinction des maxima et des minima dans les questions qui dépendent de la méthode des variations"). In the 1840s, he also worked on Uranus inequalities and tide theory.

"Baron of the Moon," according to Biot, Delaunay dedicated 20 years to the painstaking computations involved in the theory of its motion. Starting in 1846, he developed an original method for this problem that involved canonical equations in what are today called Delaunay variables In 1860 and 1867, he published the two volumes of his monumental *Théorie des mouvements de la lune*, in which, in this important case of the three-body problem, Delaunay expressed the longitude, latitude, and parallax of the Moon as an infinite series. His results were correct to 1 arcsecond but not very practical due to slow convergence. In the language of modern-day nonlinear dynamics, he replaced the actual chaotic (non-integrable) Hamiltonian with a non-chaotic (integrable) approximation designed to give good agreement with the real dynamics. The 461 terms in the perturbing function, sometimes developed to the ninth order, take up more than 100 pages. Delaunay's contemporaries and followers, Simon Newcomb and Henri Poincaré among others, praised this work highly. Delaunay's theory introduced methods

that formed the basis for theoretical developments in analytical mechanics by Poincaré, George Hill, and Anders Lindstedt. that are still in use today for the computation of artificial satellite motions.

An intense and bitter rivalry developed between Delaunay and Le Verrier. After presenting the academy with preliminary results concerning inequalities in Uranus' motion in 1842, Delaunay was criticized by Le Verrier. Because of discrepancies between Peter Hansen's tables of the Moon and Delaunay's theoretical predictions, Le Verrier alleged to have found errors in the theory. In 1865, Delaunay suggested that they arose from a slowing of the Earth's rotation due to tidal friction, an explanation believed today to be correct

The opposition was mostly rooted in personal resentment and struggle for control over French astronomy. The author of two successful textbooks on mechanics and machines, *Cours élémentaire de mécanique théorique et appliquée* (1851) and *Traité de mécanique rationnelle* (1856), Delaunay had caught the attention of Emperor Napoleon III, who sought his support in rejuvenating the moribund Bureau des longitudes as a counterpower to Le Verrier's observatory. Delaunay was thereby instrumental in Le Verrier's fall from grace in 1870 and was appointed in his place, despite having no experience in astronomical observation

As director of the Paris Observatory, Delaunay was keen to transfer it outside of the city to the suburban town of Fontenay-aux-Roses, or to keep it in Paris only if Louis XIV's buildings were leveled. During the unrest caused by war and insurrection in 1870–1871, Delaunay courageously preserved the integrity of the institution. He had set out to reorganize the conduct of astronomical research and observation in France when he lost his life in a shipwreck while surveying the fortifications of Cherbourg's harbor.

David Aubin

Selected References

Adams, John C. (1870). "Address Delivered by the Chairman, J. C. Adams, on Presenting the Gold Medal of the Society to M. Charles Delaunay." *Monthly Notices of the Royal Astronomical Society* 30: 122–132

Aguillon, Louis (1889). *L'École des mines de Paris: Notice historique*. Paris: Vve Ch. Dunod.

Hill, G. W. (1896). "Remarks on the Progress of Celestial Mechanics since the Middle of the Century." *Science*, n.s., 3: 333-341.

Pavelle, Richard, Michael Rothstein, and John Fitch (1981). "Computer Algebra." *Scientific American* 245, no. 6: 136-152

Thévenot, Arsène (1878). *Charles-Eugène Delaunay, Membre de l'Institut, Directeur de l'Observatoire de Paris* (1816-1872). Troyes: Dufour-Bouquot.

Tisserand, Félix (1894). *Cours de mécanique céleste*. Vol. 3. Paris: Gauthier-Villars. (Reprinted in 1990. Paris: Jacques Gabay.)