

# Biographical Encyclopedia of Astronomers

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Poisson, Siméon-Denis

Born Pithiviers, (Loiret), France, 21 June 1781

Died Paris, France, 25 April 1840

Siméon-Denis Poisson's greatest contribution to astronomical and physical theory, the Poisson bracket, was generated by the mathematical development of perturbation calculation for the Solar System. He is also remembered for poisson statistics, appropriate for samples with small numbers of members, as often happens in astronomy.

Poisson came from a modest family background. His father, a former soldier, had purchased a low-ranking administrative post in Pithiviers. In 1817, he married Nancy de Bardi, an orphan born in England to *émigré* parents

The French Revolution, which Poisson enthusiastically supported, made it possible for him to advance to the presidency of the district. Poisson was guided by his father toward those professions to which access had been made easier by First Republican social legislation. Thus, enrolled in the *École Centrale* of Fontainebleau, he took advantage of his instruction to obtain first place in the national competitive examination in order to enter the new *École Polytechnique*, to which he was admitted in 1798

At the *école*, Poisson impressed the eminent Pierre de Laplace and his colleague, Louis Lagrange, with his intelligence, industriousness, and perspicacity. With formidable mathematical talent and enjoying the steady support of the highly placed Laplace, Poisson advanced rapidly to positions of increasing responsibility and eminence: instructor at the *École Polytechnique* upon his graduation in 1800; deputy professor in 1802; professor of analysis and mechanics in 1806; astronomer at the Bureau des longitudes in 1808; professor of mathematics at the newly established Faculty of Sciences at the Sorbonne; and culminating in election as a member of the physics section of the elite Institut de France in 1812

J. Heilbron terms the mathematical worldview within which Poisson worked as the first modern "standard model." It interpreted physical law as the operation of weightless, "imponderable" fluids, two each for electricity and magnetism, one for heat, one for light, and one for the newly discovered infrared radiation. These imponderables were believed to operate in a manner analogous to gravitation, as inspired by the delicate experiments of Charles-Auguste de Coulomb demonstrating how the attraction between static electrical charges varied, as did gravitational attraction, with the inverse square of their separation. Laplace was the leader of this enterprise and Poisson his outstanding disciple.

In the analysis of perturbations, one may begin with the positions of a number of celestial bodies, all mutually attracting one another gravitationally, along radius vectors. If we call the number of vectors  $r$ , their attraction will satisfy  $r$  second-order differential equations, which can be written in the generalized coordinates introduced by Lagrange Whether or not these

equations are analytically solvable, the integrals of the set of differential equations depend upon  $2r$  arbitrary constants. In a supplement to Book VIII of Laplace's *Mécanique céleste*, published in 1808, Lagrange developed the implications of Poisson's observation, reported to the Academy of Sciences early that year, that the  $2r$  arbitrary constants must satisfy physical constraints. Specifically, Lagrange proved that in the presence of a perturbation that forces the arbitrary constants to be treated as functions of time, the derivatives of the desired functions with respect to time are the solutions of a linear system in which the coefficients of the unknowns are independent of time.

Using a mathematical transformation, Poisson, in 1809, then extended and generalized Lagrange's result, modifying the variables so that they retain the same form of the Poisson bracket—even upon the introduction of the perturbation function. In the following decades, William Rowan Hamilton and Carl Jacobi used the Poisson bracket as an essential element in their geometric reformulation of the dynamical equations of physics, and in the 1920s, Paul Dirac identified the Poisson bracket as crucial in the mathematical structure of Werner Heisenberg's novel quantum mechanics. It is of interest to note that Poisson also anticipated the delta-function made famous by Dirac's use of it.

Poisson also attempted to complete a didactic presentation of the "standard model" in a series of clearly written and widely read textbooks. He assumed the positions of examiner of graduating students at the *École Militaire* in 1815 and that of the *École Polytechnique* the following year. He was named to the Royal Council of the university, the highest educational consultative body in the restored monarchy, in 1820

Another work by Poisson that is of great significance to astronomy is his *Recherches sur le mouvement des projectiles dans l'air* (1839), which first discussed in print the importance of a term, discovered by his doctoral student Gustave Gaspard de Coriolis, to correct for the deviations from the law of motion arising from a rotating frame of reference. A decade later, this work inspired the striking experiment of the Foucault pendulum, which dramatically demonstrates the Earth's rotation on its axis. Poisson, however, chose not to mention Coriolis's name. By the time of his death, Poisson had published some 300 papers and books

Poisson was elected a foreign associate of the Royal Society of London in 1818 (and received its Copley Medal in 1832); he was a member of virtually all the academies of the day, from Boston to Saint Petersburg. That this adherent of the First Republic was honored by the empire and made a Peer of France by the Orleanist monarchy in 1837 is evidence of his political discretion.

*Michael Meo*

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