

Biographical Encyclopedia of Astronomers

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Fizeau, Armand Hippolyte Louis

Born Paris, France, 23 September 1819

Died Venteuil, Marne, France, September 18, 1896

Hippolyte Fizeau was a pioneer in astrophotography and is best known for his work on the velocity of light. The eldest son of Louis Fizeau, a pathologist at the Paris Medical School, and Béatrice Fizeau, he entered his father's school in about 1840, but dreadful migraines caused him to abandon medicine for physics. In 1853, Fizeau married Thérèse Valentine de Jussieu (daughter of the botanist Adrien de Jussieu), with whom he had three children.

Fizeau's optical work had an impact on astronomy. While still a medical student in Paris, he improved daguerreotype contrast, sensitivity, and stability, and encouraged by François Arago in 1844/1845, he collaborated with Léon Foucault to take the first successful daguerreotypes of the Sun, which showed clear limb darkening, indicating that the solar luminous layers were gaseous. In 1848, Fizeau announced how in sound the speeds of source and observer with respect to the transmitting medium affect received frequencies, and extended the results to light. Unknown to Fizeau, Christian Doppler in Prague had already discussed this effect in 1842, and had interpreted stellar colors as due to spectral shifts resulting from stellar velocities, which he incorrectly presumed attained many tens of thousand kilometers per second. Fizeau, however, predicted that subtle displacements of the absorption lines in stellar spectra could be used to measure much smaller celestial velocities, and the motion of the terrestrial observer, and this correct prediction underpins much of modern astrophysical inquiry.

In 1849, Fizeau made the first terrestrial measurement of the speed of light using a rotating toothed wheel to chop a light beam into pulses that were projected along a round-trip path from his father's house in Suresnes, west of Paris, to a reflector in Montmartre, almost 9 km away. The result obtained was in rough accord with the then-accepted value, which was determined astronomically from trigonometric measurements of the solar distance and the corresponding light-crossing time derived *via* either eclipses of Jupiter's satellites or the constant of aberration and the length of the year. In 1856, Fizeau's work won the 50,000 Franc Triennial Prize recently established by Napoléon III, but an accurate verification of the speed of light and length of the Astronomical Unit using improved apparatus financed by the *Académie des sciences* was not completed. It was only on the eve of the attempts to measure the solar distance from the 1874 transit of Venus that an accurate toothed-wheel experiment was finally executed by Alfred Cornu, financed by the Paris Observatory.

Evidence unequivocally contrary to the corpuscular theory of light, and hence supportive of the wave theory, was provided in 1850 by Foucault's experimental demonstration, confirmed 7 weeks later by Fizeau, that light travels slower in water than in air. A prediction of the wave theory, made by Augustin Fresnel to account for the constant refraction of stellar positions observed by Arago through a prism, irrespective of the terrestrial velocity, was that a

transparent medium of refractive index n moving at speed v partially drags the ether with it, by an amount $(1-(1/n^2))v$. In about 1850, Foucault and Fizeau failed to detect any drag in air, but in 1851 Fizeau obtained positive results through the interference of two beams that passed in opposite directions through water flowing as fast as 7 m/s. The result was confirmed 35 years later by Albert Michelson and Edward Morley. The ether drag is one of several phenomena that were puzzling to classical physics and that ultimately led to the development of the special theory of relativity.

Reserved and moody, and with an independent income, Fizeau never held any significant official post. He became reclusive after his wife's premature death in 1863, but continued to work. Of interest to astronomy are his 1868 suggestion, attempted by Edouard Stephan, and later by Michelson and Francis Pease, that stellar angular diameters could be measured interferometrically; and his involvement in the planning and analysis of French photographic observations of the 1874 transit of Venus, whence, for example, the memorial of a Mount Fizeau on the subantarctic Campbell Island.

Fizeau was a knight (1849) and officer (1875) of the Légion d'honneur, a member of the Académie des sciences from 1860, and a member of the Bureau des longitudes in 1878. The Royal Society of London awarded him its Rumford Medal in 1866.

William Tobin

Selected Reference

Cornu, A. (1898). "Notice on the scientific work of H. Fizeau." *Annuaire pour l'an 1898 publié par le Bureau des longitudes*, C1-C40. Paris: Gauthier Villars.