Biographical Encyclopedia of Astronomers

Foucault, Jean-Bernard-Léon

Born Paris, France, 18 September 1819

Died Paris, France, 11 February 1868

Jean Bernard-Léon Foucault determined an accurate value for the speed of light, designed a pendulum to demonstrate the Earth's rotation, invented the knife-edge test, and applied a silvering technique for mirrors that revolutionized telescope optics. He was the son of Jean Léon Fortuné Foucault, a well-off publisher and bookseller, and Aimée Nicole Foucault (*née* Lepetit). He never married. Around 1840, Foucault entered the Paris Medical School, reportedly with the intention of capitalizing on his great dexterity by becoming a surgeon, but he later abandoned medicine for physics, earning his doctorate in 1853

Much of Foucault's early work was inspired by François Arago, director of the Paris Observatory, and was undertaken in collaboration with Hippolyte Fizeau. The first successful daguerreotypes of the Sun, taken by Foucault and Fizeau in 1844/1845, showed clear evidence of limb darkening, contrary to Arago's photometric observations, indicating that the outer solar layers were gaseous rather than solid or liquid

Foucault and Fizeau worked independently after quarreling during their attempt to conduct an experimental test (suggested by Arago) to discriminate between the particulate and wave theories of light. They split a light beam into two, passed each through several meters of either air or water, and used a small, fast-spinning mirror to convert the temporal separation between them into an easily measurable angular deviation. In the spring of 1850, Foucault found that light traveled more slowly in water than in air, as predicted by the wave theory, signaling the final demise of the already moribund corpuscular theory

In 1851, Foucault devised his eponymous pendulum experiment consisting of a freely oscillating bob, the swing plane of which appears to veer slowly clockwise, as seen from above by a terrestrial observer in the Northern Hemisphere, while the Earth rotates anticlockwise beneath. Informed opinion had become fully convinced of the Earth's diurnal rotation in the decades following the publication of Isaac Newton's *Principia*, but Foucault now provided clear dynamic evidence of it, equivocal results having previously been obtained from experiments such as dropping weights down mineshafts. At the poles, the swing plane of the Foucault pendulum remains fixed relative to the inertial frame defined by the distant stars, but elsewhere, because the direction of the gravitational restoring force changes as the Earth rotates, the swing plane is not locked to the motion of the celestial sphere but to the component of this motion around the horizon. After On one sidereal day, the swing plane does not return to the same orientation, except at the poles; instead, the rotational period of this pendulum equals the Earth's 24-hour (sidereal) day divided by the sine of the pendulum's latitude. Public confusion over the sine term led Foucault to devise (and name) the gyroscope in 1852, whose freely suspended spin axis locks directly to the celestial sphere and provides a conceptually clearer

demonstration of terrestrial rotation. Mechanical gyroscopes were of importance in navigation through most of the 20th century but have now mostly been superseded by optical gyroscopes.

In 1855, Foucault was appointed "physicist" at the Paris Observatory under its new director, Urbain Le Verrier There, Foucault devised optical tests that allowed him to polish large glass mirrors for reflecting telescopes, which were made reflective by a coating of chemically deposited silver. His most famous test, the knife-edge test, reveals in exaggerated relief the figuring faults of lenses and mirrors, which can then be corrected through further polishing; amateur telescope makers continue to use this technique today. Foucault's largest telescope, which incorporated an 80-cm-diameter mirror, was installed at the Marseille Observatory in 1864. It was equatorially mounted and also included a Foucault-designed governor for sidereal tracking. Although the knife-edge test was a crucial development for the construction of large, fast-refracting telescopes, it was not until almost the 20th century and the rise of spectroscopy and astronomical photography that reflectors displaced refracting telescopes as astronomers' instrument of choice.

In his last experiment of consequence, Foucault modified his spinning-mirror apparatus to make the first accurate laboratory measurement of the speed of light. From analysis of planetary motions, Le Verrier had concluded that the distance from Earth to the Sun was about 3% smaller than generally accepted. At the time, the speed of light was derived from astronomical measurements; the procedure's largest uncertainty by far involved the size of the astronomical unit, so Le Verrier predicted that the speed of light was also 3% smaller than the then-accepted value of 310,000 km/s. Foucault confirmed this prediction in 1862, obtaining a result that is also in agreement with the modern value of the speed of light and the distance to the Sun

Foucault's last years were spent working on mechanical governors, which he hoped would make his fortune, and a siderostat for solar observations. This work was cut short by his premature death from what was probably a case of rapidly progressing multiple sclerosis. He is buried in the Montmartre Cemetery, Paris.

Foucault was awarded the Copley Medal of the Royal Society of London in 1855. He was made a knight of the *Légion d'honneur* in 1850, and an officer in 1862. Foucault was a member of the French Bureau des longitudes from 1862 and the Académie des sciences from 1865. Additionally, he was a foreign or corresponding member of numerous academies.

William Tobin

Selected References

Foucault, L. (1859). "Mémoire sur la Construction des Télescopes en Verre Argenté." *Annales de l'Observatoire impérial de Paris* (*Mémoires*) 5: 197-237 and plate.

Tobin, William (1998). "Léon Foucault." *Scientific American* 279, no. 1: 52-59 or 70-77 (pagination varies with edition).

—— (2003). *The Life and Science of Léon Foucault: The Man Who Proved the Earth Rotates*. Cambridge: Cambridge University Press