Albert Abraham Michelson
Father of the Interferometer

Genevieve Gill

In this issue, OPN begins a series of biographies that highlight the careers of outstanding personalities in the history of optical science. These men and women, many of them Nobel Prize winners, are towering figures in 20th century physics. The first article profiles Albert Abraham Michelson (1852-1931), the first American to win the Nobel Prize in physics.

Michelson Museum, courtesy AIP Emilio Segrè Visual Archives

Albert Abraham Michelson in his laboratory. Michelson's time at sea in the U.S. Navy sparked an interest in physics and in earth's motion through space.

Most historians of science consider Einstein's relativity theories the point of origin of modern physics. But Einstein was in turn indebted to a German-American physicist who was the first to measure the speed of light. Albert Abraham Michelson had many other "firsts" in his life, not the least of which was the invention of a key instrument in modern optics, the interferometer. Michelson's mastery of optical precision instruments won him the Nobel Prize in physics in 1907.

Michelson was born December 19, 1852, in Strenlo, Prussia. Seeking security and opportunities unavailable in their politically unstable surroundings, the Michelson family moved to New York City. There, Albert's father became a jeweler's apprentice. In a short time, wealth and adventure proved too tempting to resist, and in 1855, the family followed the Gold Rush to San Francisco. In what ultimately would prove to be an astute business move, Samuel Michelson opened a dry goods store in Murphy's Camp, California.

During his unusual, adventurous youth, Albert attended public schools, always showing promise as a student. He was left with relatives in San Francisco to continue his studies when his family decided to move their business to a new mining frontier, Virginia City, Nevada, where the silver rush was underway. After graduating from high school in 1869, he decided to enter a competition for admission to the U.S. Naval Academy in Annapolis, Maryland. Initially rejected by the program, Michelson traveled, as one of the first transcontinental rail passengers, to Washington, D.C., to make a special plea at the White House. After much persistence, Michelson was awarded an interview with President Ulysses S. Grant, and finally given a special appointment to the academy as a midshipman.

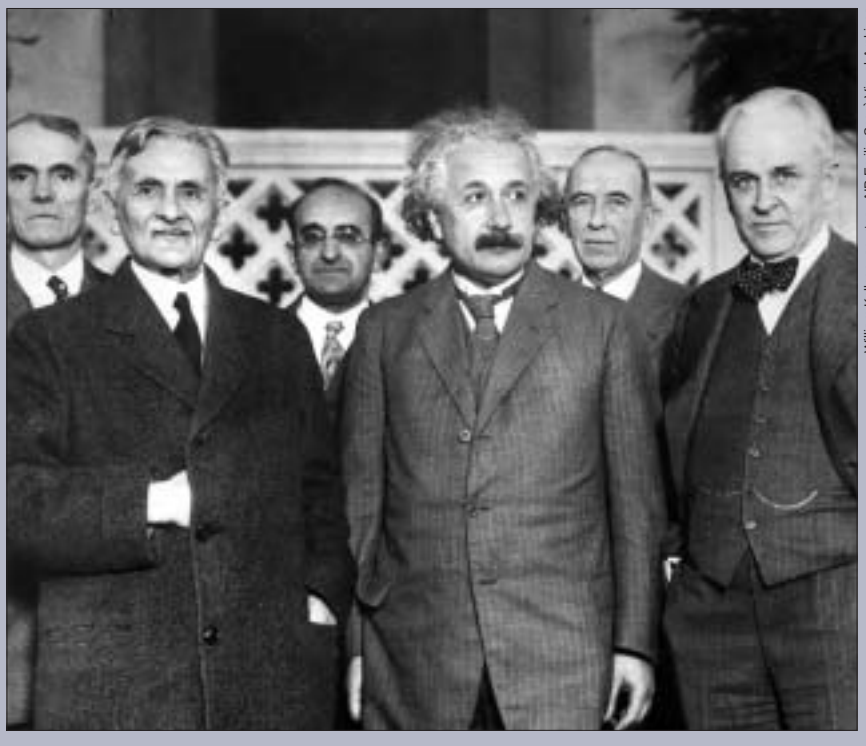
The U.S. Naval Academy fostered many of Michelson's varied interests. He enjoyed boxing, fencing, the violin, painting, and above all, science. In 1873, he graduated at the head of his class in the optics and acoustics departments.

Though Michelson spent only a short time at sea, some speculate that his observations on the relative motion of maneuvering a ship, on celestial navigation, and on astronomy in general sparked his love of physics and interest in earth's motion through space. Often reprimanded for being more interested in science than the sea, Michelson formed a special relationship with the head of the physics department (as well as his daughter, whom he married in the spring of 1877) and after graduation stayed on at the Naval Academy, where he taught physics and chemistry for four years. During this time, he furthered his own research with encouragement from other professors and financial support from his father-in-law.

Encouraged by promising experiments on Foucault's methods of determining the speed of light, Michelson decided in 1880 to further his studies by traveling to the universities of Berlin and Heidelberg, and to the College de France and the École Polytechnique in Paris.

In 1882, he accepted a professorship at the Case School of Applied Science, in Cleveland, Ohio. In 1890, he moved to Clark University, Worcester, Massachusetts. In 1892, he became the first head of

OSA's 13th Annual Meeting, in 1928, was named "The Michelson Meeting" in commemoration of the 50th anniversary of the publication of the scientist's historic determination of the velocity of light.



William Kellogg, courtesy AIP Emilio Segrè Visual Archives

(*Left to right*): Walter Sidney Adams, Albert Abraham Michelson, Einstein's assistant Walther Meyer, Albert Einstein, Max Farrand of the Huntington Library, and Robert Andrews Millikan, also an honorary member of OSA and a Nobel Prize winner, (Pasadena, 1931).

the Physics Department at the University of Chicago. After serving in the Navy during World War I, he returned in 1918 to the University of Chicago. In 1929, he left the Midwest for the Mount Wilson Observatory in Pasadena, California, where he would remain until his retirement.

Michelson explored many areas of physics in his work, but held a special interest in the study of optics. He is perhaps best known for determining the velocity of light. Michelson's invention of the interferometer in 1881 led to two important findings. The first was measurement of the speed of light. The second was that nothing in the universe exceeded the speed of light, a founding principle of relativity.

Michelson's quest began in Europe, when he attempted experiments with the intention of discovering the effect of earth's velocity through ether, which was then thought to make up the basic substratum of the universe. The experiment yielded no result; Michelson felt he had failed.

In 1887, Michelson concentrated on furthering his interferometer experiment with the help of American chemist Edward Williams Morley. Michelson and Morley arrived at yet another null result. However, this "failure," now known as the Michelson-Morley experiment, is one of the most significant in the history of science.

There were no interference fringes and there was apparently no motion of the earth relative to the ether. These findings showed that the speed of light plus any other added velocity was still equal only to the speed of light. The Michelson-Morley experiment disproved the existence of ether and facilitated the acceptance of relativity.

Michelson's scientific hallmark was his passion for detailed measurement. His delicate instruments and consistent precision yielded important results. In 1893, at the request of the International Committee of Weights and Measures, he used his interferometer to measure the standard meter in terms of the wavelength of cadmium light. The wavelength thus determined provided an absolute and exactly reproducible standard of length.

Again with one of his interferometers, Michelson was the first to determine the accurate diameter of a star. In 1920, with a 6-m interferometer attached to a 254-cm telescope, he measured the diameter of the star Betelgeuse (Alpha Orionis) at 386,160,000 km (300 times the diameter of the sun). He also measured the angular diameters of the satellites of Jupiter in 1891.

Michelson's participation in OSA is well noted in the Society's history. At a meeting of OSA's Executive Council in October 1922, he became the fourth honorary member to be elected to the Society. OSA's 13th Annual Meeting in Washington, D.C., in November 1928, was named "The Michelson Meeting" in commemoration of the 50th anniversary of the publication of his historic determination of the velocity of light. Two portraits of Michelson were displayed on the cover of the meetings proceedings volume, one taken at a meeting in 1920, and one of the great scientist as a young man at the U.S. Naval Academy in 1878.

Other inventions by Michelson include the echelon grating spectroscope (1907) and the grating ruling engine (1915). His major writings include *Velocity of Light* (1902) and *Studies in Optics* (1927). In 1924, he made contributions to the *Journal of the Optical Society of America.*

Michelson received honorary memberships to other scientific societies in the U.S. and Europe, and served as the second president of the American Physical Society in 1900. He was awarded multiple honorary science and law degrees as well. He died on May 9, 1931, in Pasadena, California.

Genevieve Gill, OSA staff writer, can be reached by e-mail at ggill@osa.org.