

Arthur Ashkin

Physicist

Date of birth: September 2, 1922

Place of birth: New York, New York

Also known as: Art Ashkin

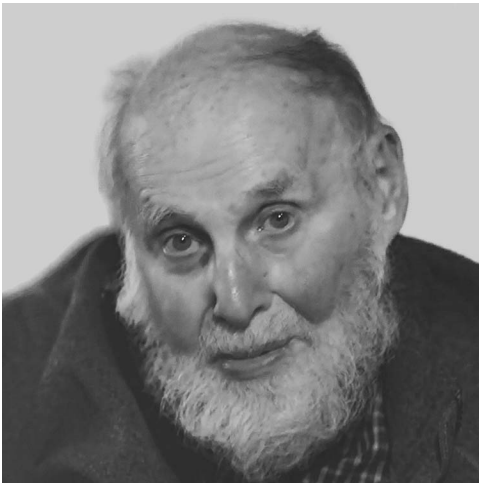
Education: Columbia University; Cornell University

Significance: A pioneer of laser radiation pressure, Arthur Ashkin invented the optical trap, which uses laser radiation pressure to hold individual atoms in place, and optical tweezers, a method to pick up microscopic particles without damaging them. He was awarded the Nobel Prize in Physics in 2018.

Background

Arthur Ashkin was born on September 2, 1922, in New York City to Anna and Isadore Ashkin, Jewish immigrants to the United States from what is now Ukraine. He had an older brother, Julius, and a younger sister, Ruth. Julius went on to become an accomplished nuclear physicist and worked on the Manhattan Project.

Arthur Ashkin, 2018 Physics Nobel Laureate.



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Ashkin grew up in Kings, Brooklyn, where he graduated from James Madison High School in 1940. As a second-year student at Columbia University, he was allowed to join the US Army Reserves in lieu of his draft and, from 1942 to 1945, served

as a technician at the Columbia Radiation Laboratory, where he built magnetrons for military radar systems. He completed his studies and received a bachelor's degree in physics in 1947. He then attended Cornell University and received a PhD in nuclear physics in 1952.

Research in Optics

Sidney Millman, Ashkin's former supervisor at Columbia and then director of physical research at Bell Laboratories (now Nokia Bell Labs), recruited him to join Bell Laboratories in 1952. Ashkin first worked at the Murray Hill, New Jersey, facility, where he studied microwaves, an expansion of the radar work he had done during the war. In 1961, he began work on lasers and researched the nonlinear properties of optical fibers, as well as parametric oscillators. He became the head of the Department of Laser Science in 1963, a position he held through 1987 while remaining a member of the technical staff. He moved to the Holmdel, New Jersey, laboratory in 1967.

Ashkin's research on laser optics led to his team's discovery of the photorefractive effect in 1966. His team also first observed several optical phenomena, including the continuous wave, laser harmonic generation, and parametric amplification.

In the late 1960s, Ashkin began a study on how to use pressure from light and other forms of radiation to manipulate microscopic particles and atoms. He discovered he could use laser beams to move small latex spheres through water. Using two beams from opposite sides, he held the spheres in place, creating an optical trap.

Ashkin theorized that the same technique could be used to manipulate atoms, viruses, and microscopic living organisms like bacteria. He wrote up his discovery and theory in a seminal paper published in *Physical Reviews Letters* in 1970. He continued to research laser radiation pressure, and in 1986 he and his team were able to use a single laser beam to cool and trap sodium atoms. This method, which came to be known as "optical tweezers," allowed scientists to isolate individual atoms and particles and study them under a microscope. Ashkin published the results of his study in another landmark paper in *Physical Reviews Letters* in 1986. The following year, he used his optical tweezers technique to research biological systems, picking up bacteria without damaging them, proving his theory. He was subsequently able to examine viruses, algae, and even internal cell structures and DNA.

Ashkin retired in 1992 and continued his research in a laboratory he set up in his basement. During the 2010s, his research focused on solar energy for heating homes and ways to reduce its costs, something he considers critical due to climate change.

Recognition

In 2018, the Royal Swedish Academy of Sciences awarded Ashkin one-half of the Nobel Prize in Physics for his development of optical tweezers. The other half of the prize was split between Canadian physicist Donna Strickland and French physicist Gérard Mourou for their development of a “method of generating high-intensity, ultra-short optical pulses.” Ashkin was unable to attend the ceremony in Stockholm, Sweden, himself but had his Bell Labs colleague René-Jean Essiambre give his Nobel lecture in his stead in December 2018.

In addition to his research, Ashkin wrote the definitive work on optical trapping, *Optical Trapping and Manipulation of Neutral Particles Using Lasers*, in 2006. By late 2018, he held forty-seven patents, including two for a solar energy collector, received in 2013 and 2015, respectively. Ashkin has received numerous awards and recognitions for his work. He was elected a member of the National Academy of Engineering in 1984, a member of the National Academy of Sciences in 1996, and an honorary member of the Optical Society in 2009. His awards include the Rank Prize in Optoelectronics (1993), the Frederic Ives Medal/Jarus W. Quinn Prize from the Optical Society (1998), the Joseph F. Keithley Award for Advances in Measurement Science from the American Physical Society (2003), and the Harvey Prize from the Technion Israel Institute of Technology (2004). In 2013, Ashkin was inducted into the National Inventors Hall of Fame.

Impact

Arthur Ashkin’s discoveries of optical trapping and optical tweezers led to a proliferation of research in multiple fields, especially physics, biology, biophysics, and medical research. His method allowed scientists to study living organisms in a way they had been unable to in the past. Researchers have used optical tweezers or optical trapping to study the mysteries of life to learn about such things as how bacteria and other pathogens attack healthy cells, the discovery of new species, and the creation of the Bose-Einstein condensate. The latter earned Carl Wieman, Wolfgang Ketterle, and Eric A. Cornell a Nobel Prize in Physics in 2001. Other Nobel laureates who used Ashkin’s discoveries in their research include physicists William D. Phillips, Steven Chu, and Claude Cohen-Tannoudji, who shared the 1997 prize for creating methods to cool atoms so they could be trapped.

Personal Life

Ashkin and his wife, Aline, met as students at Cornell. They married in 1954 and had three children, Daniel, Michael, and Judith. They have lived in Rumson, New Jersey, for more than fifty years.

Bibliography

“Arthur Ashkin.” *LaserFest*, American Physical Society, et al., laserfest.org/lasers/pioneers/ashkin.cfm. Accessed 14 Feb. 2019.

“Arthur Ashkin Wins 2018 Nobel Prize in Physics.” *Nokia Bell Labs*, 2 Oct. 2018, www.bell-labs.com/var/articles/arthur-ashkin-nobel-prize. Accessed 14 Feb. 2019.

Gleick, James. “Lasers Slow Atoms for Scrutiny.” *The New York Times*, 13 July 1986, www.nytimes.com/1986/07/13/us/lasers-slow-atoms-for-scrutiny.html. Accessed 14 Feb. 2019.

Heyboer, Kelly. “At 96 This Jersey Guy Can’t ‘Get All Excited’ about His Nobel Prize Win.” *NJ.com*, Advance Local Media, 2 Oct. 2018, www.nj.com/news/2018/10/njs_old_geezer_nobel_prize_winner_says_he_won_in_t.html. Accessed 14 Feb. 2019.

“The Nobel Prize in Physics 2018.” *The Nobel Prize*, Nobel Media, www.nobelprize.org/prizes/physics/2018/summary. Accessed 14 Feb. 2019.

Rubin, Debra. “Rumson’s Arthur Ashkin Is Oldest Person to Win Nobel.” *New Jersey Jewish News*, 10 Oct. 2018, njewishnews.timesofisrael.com/rumsons-arthur-ashkin-is-oldest-person-to-win-nobel. Accessed 14 Feb. 2019.

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