

Sheldon K. Friedlander
17 November 1927 – 9 February 2007



Professor Sheldon K. Friedlander passed away in his Pacific Palisades home in California on 9 February 2007. Friedlander was known to all involved in aerosol science and technology as a senior statesman for aerosol science and technology and as one of the founders of the American Association for Aerosol Research (www.aaar.org). He coined the phrase "aerosol science and engineering is an enabling discipline" and worked tirelessly to popularize the concept.

Friedlander was Professor of Chemical Engineering, University of California, Los Angeles at the time of his death. He was a member of the National Academy of Engineering and has won numerous awards and honors from many different organizations and agencies:

- 1990 Fuchs Memorial Award from the International Aerosol Research Assembly
- 1984-85 Senior U.S. Scientist Award (Humboldt Award) from West German Government
- past president of the American Association for Aerosol Research
- Fulbright Scholarship
- Guggenheim Fellowship
- Colburn Award from the American Institute of Chemical Engineers (AIChE)
- Alpha Chi Sigma Award from AIChE
- Walker Award from AIChE
- Certificate of Recognition from NASA
- 1995 Lawrence K. Cecil Award in Environmental Chemical Engineering from AIChE
- 2000 Junge Award from European Aerosol Assembly for pioneering work in aerosol science.

I Early Career

Sheldon Friedlander was born in New York City on 17 November 1927. He attended NYC public schools before entering Columbia University. On leave from Columbia, he served in the U.S. Army in 1946-7, just after World War II ended, and completed a bachelor of science degree in chemical engineering in 1949. After taking a master's degree at MIT, he was introduced to aerosols at the Harvard School of Public Health where he worked on an Atomic Energy Commission project on the control of radioactive aerosols. Fascinated by the many unsolved basic problems and practical applications of aerosol phenomena, he went to the University of Illinois to work with Fraser Johnstone, known for his aerosol research. After completing his PhD in 1954 on particle deposition from turbulent gases, Friedlander returned to Columbia as assistant professor of chemical engineering. His ideas on self-preserving size distributions grew out of his PhD work on turbulence and a basic paper on stochastic theory by Chandrasekhar.

In 1954, he joined Johns Hopkins University which had committed to engineering science, then a new direction in engineering education. He began publishing his papers on self-preserving size distributions. He also published a series of papers on aerosol filtration theory based on a similarity transformation he discovered for the equation of convective diffusion.

II Mid-Career

After moving to Caltech in 1964, Friedlander continued research on asymptotic size distributions and began studies of the Los Angeles smog aerosol. He pointed out that basic chemical thermodynamics shows that in atmospheric ammonium nitrate must be distributed between the gas and aerosol phases. Noting the unreliability of aerosol emission inventories, he published a series of papers on receptor modeling using chemical element balances for source resolution, a novel extension of undergraduate stoichiometry. Friedlander was one of the organizers of the 1972 Aerosol Characterization Experiment (ACHEX), the first large scale study of atmospheric aerosol funded by the California Air Resources Board. He also published the first edition of *Smoke, Dust and Haze*, conducted research on aerosol beams, and used aerosol beams to shoot particles into a mass spectrometer for single-particle chemical analysis in collaborative studies with JPL.

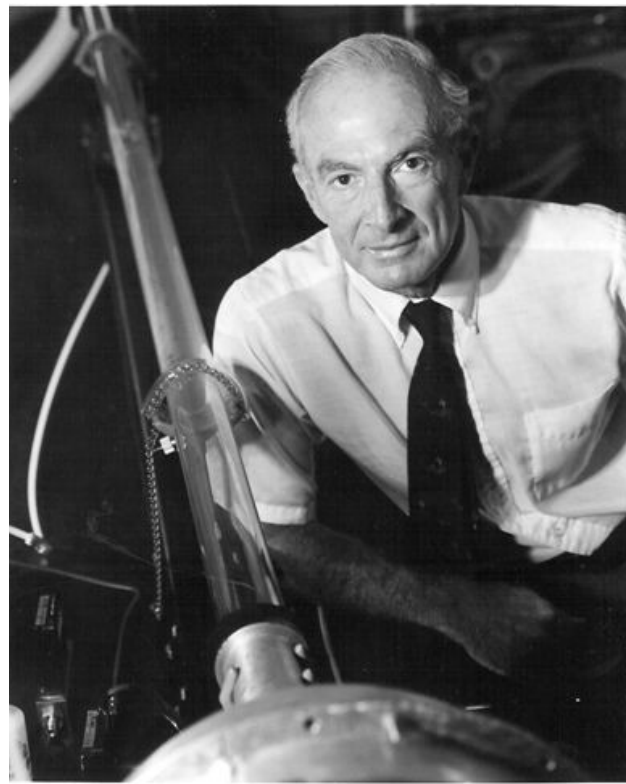
III Mature Years

In 1978, Friedlander moved to UCLA where he helped set up and later chair the Department of Chemical Engineering. He extended source resolution concepts to the carbon containing component of atmospheric aerosol. In 1982, he helped found the American Association for Aerosol Research and hosted its first meeting in Santa Monica. He coined the phrase "aerosol reaction engineering" to describe the synthesis of fine particles as a desirable product by aerosol processes. With W. Koch, he modified Smoluchowski's coagulation theory to incorporate coalescence rates, providing a basic design equation for aerosol reaction engineering. In 1997, he initiated studies of the dynamic behavior of nanoparticle chain aggregates in electron microscopes and found evidence of elastic recoil when aggregates broke under tension. Most recently his group used atomic force microscopy to measure the forces that hold aggregates together. The second edition of *Smoke, Dust and Haze* appeared in 2000.

Scientifically active until his death, Friedlander campaigned for the recognition of aerosol science and technology (AST) as an enabling discipline with its own fundamental equations and experimental and computational methods. Advances in many applied fields depend on AST -- air pollution and atmospheric sciences, occupational health and industrial hygiene, commercial synthesis of fine particles for catalysts and pigments, nanocomposite materials such as rubber, nanostructured coatings and sensor surfaces, nuclear reactor safety, and microcontamination control. Medical applications include inhalation and gene therapy. Although scientists faced with aerosol problems in the past have usually come from other fields, we are reaching the point where young people educated in AST will be chosen for their special knowledge. The Friedlander Award given by the American Association for Aerosol Research recognizes and encourages such individuals.



Friedlander and his father in his earliest years



Friedlander in his laboratory



At a reception in India (Indian Institute of Technology in Bombay) attending the NAST Workshop funded by the Indo-US Forum and the 4th Asian Aerosol Conference in Mumbai, December 2005.



At the 7th International Aerosol Conference in Saint Paul, Minnesota, USA, September 2006 with (to his left) fellow founding members of AAAR David Ensor and David Shaw. Roger McClellan is on Sheldon Freidlander's right. All are past presidents of AAAR. His pioneering talk at this conference on the next 25 years of Aerosol Science and Technology as an enabling discipline probably was his last major presentation in a large public forum.

*Biography prepared by
Pratim Biswas.*