School of Molecular Sciences
Arizona State University

SMS Fall 2024 Lecture Seminar
October 25, 2024 | 3pm | PSF-166

A Brief Survey of Single-Molecule Optical Microscopy in My Laboratory: From Early Spectroscopy in Solids to Super-Resolution Nanoscopy in Cells, to Photodynamics of Individual Multi-Chromophore Emitters

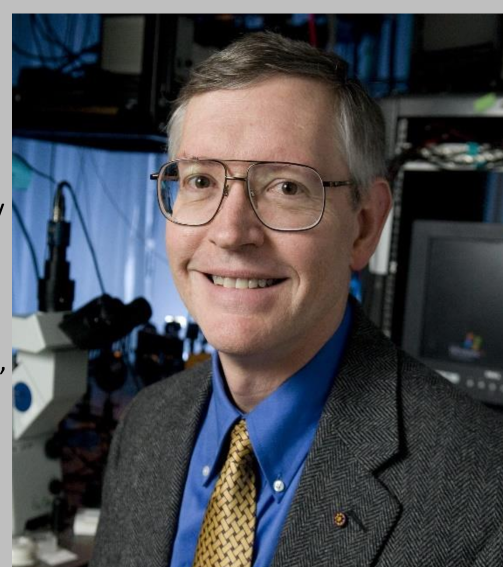
A First observed optically 35 years ago in my laboratory at IBM Research, single molecules have enabled a new field of optical microscopy of the nanoscale. Since ensemble averaging is removed, each single molecule can act as a reporter of not only its position, but also local information about the nearby environment. Combined with blinking and photoswitching (first observed at low temperatures in 1992 and then for single GFP proteins at room temperature in 1997) to ensure sparsity, in the mid-2000's, super-resolution fluorescence microscopy based on single molecules has opened a frontier in which structures and behavior can be observed in materials and in fixed and live cells with resolutions down to 10-20 nm and below. These methods have been enhanced by PSF engineering to extract 3D position and orientation information, deep learning to estimate molecular variables and structured backgrounds, light sheet illumination, and much more. A recent study shows fascinating intracellular structures formed by SARS-CoV-2 viral RNA and proteins in infected cells. Three-dimensional single-molecule tracking in live cells provides time-dependent information about biological regulation, condensed complexes, as well as anomalous diffusion of DNA loci in nuclei and more.

Another major class of work goes back to isolated single molecules and explores dynamical behavior in solution in an Anti-Brownian ELectrokinetic (ABEL) trap, with multiparameter extraction of information about complex photodynamics and enzyme kinetics. This trap has recently been extended to non-fluorescent objects with interferometric scattering detection (ISABEL trap), with fluorescence now used as an auxiliary reporter of internal states of carboxysomes.

All these developments in my laboratory over several decades have been enabled by an extremely talented cadre of students and postdoctoral researchers, to whom I am very grateful.

W.E. (William E.) Moerner, PhD

Harry S. Mosher Professor and Professor
Stanford University
Departments of Chemistry and Applied Physics



W. E. (William Esco) Moerner, the Harry S. Mosher Professor of Chemistry and Professor by courtesy of Applied Physics, has conducted research in physical chemistry, biophysics, and the optical properties of single molecules, and is actively involved in the development of 2D and 3D super-resolution imaging for cell biology. Imaging studies include protein superstructures in bacteria, structure of proteins in cells, studies of chromatin organization, and dynamics of regulatory proteins in the primary cilium.

He attended Washington University as a Langsdorf Engineering Fellow, graduating in 1975 with degrees in Physics and Electrical Engineering (both B.S. with top honors), and Mathematics (A.B. summa cum laude). His doctoral research in physics at Cornell University (M.S. 1978, Ph.D. 1982) employed tunable infrared lasers to explore infrared vibrational modes of impurities in crystals. Professor Moerner's scientific contributions were recognized with the 2014 Nobel Prize in Chemistry "for the development of super-resolved fluorescence microscopy." Among many other honors and awards, Professor Moerner was elected fellow of the American Physical Society, Optical Society of America, American Association for the Advancement of Science, American Academy of Arts and Sciences; and member of the National Academy of Sciences.

**ZOOM Available:* https://asu.zoom.us/j/89257678447