UNIVERSITY OF CALIFORNIA
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Space-Time Quantum Information in Single Molecules

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Abstract

Heterogeneities in the mass, charge, and spin distributions exist in all matter and give rise to its distinct static and dynamic properties. Ultimately it is important to resolve these heterogeneities by measuring excitations at atomic dimensions. The atomic scale spatial resolution has been achieved with inelastic electron tunneling spectroscopy and microscopy with a low temperature scanning tunneling microscope (STM). Furthermore, by coupling the STM to a femtosecond laser, it has become possible to probe matter with simultaneous spatial and temporal resolutions. This talk illustrates experiments in space and time to reveal two-state excitations and coherent superposition in single molecules. The vibration, spin, and charge in molecules serve as quantum sensors and carriers of quantum information. The fundamental interactions obtained from probing molecules in space and time should also be applicable to the understanding of interactions in other condensed matter systems.

About the Speaker

Wilson Ho received his B.S. and M.S. degrees in chemistry from the California Institute of Technology in 1975, and his Ph.D. in physics from the University of Pennsylvania in 1979. He spent a year at the AT&T Bell Laboratories and was on the faculty at Cornell University prior to joining the University of California, Irvine in 2000 as Donald Bren Professor and in 2018 as the Distinguished Professor of Physics & Astronomy and of Chemistry. His research has been guided by the development of new instrumentation and methods for probing atoms and molecules at solid surfaces. Over the last 25 years, he has used homemade scanning tunneling microscopes (STM) to advance the field of single molecule chemistry, physics, and optics. In 1998, his group demonstrated inelastic electron tunneling spectroscopy and microscopy with the STM that enabled measurement of elementary excitations at the atomic scale. It became possible to measure and image vibrations, spin excitations, and the skeletal structures of single molecules at below 0.1 nm resolution in 3D. By combining femtosecond lasers with STM, he extended measurement of single molecule dynamics to the simultaneous Å-fs space-time limit. Most recently, his research focuses on probing magnetic molecules with femtosecond THz lasers coupled with STM. A singular objective lies in the exploration of atoms and molecules of rare earth elements to advance the nascent field of quantum information science. His work has been recognized by fellowships in the American Physical Society and the American Association for the Advancement of Science, memberships in the U.S. National Academy of Sciences and as an Academician of the Academia Sinica of the Republic of China, the Bonner Chemistry Prize by the University of Bonn, the Victor K. LaMer Prize of the American Chemical Society, the Medard Welch Award of the American Vacuum Society, and the Irving Langmuir Prize and the Joseph F. Keithley Award of the American Physical Society.