

Joint ECE/Physics Colloquium

Transport in Molecular Junctions: Thoughts Coherent and Incoherent

Speaker: Mark Ratner

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Thursday November 5, 3:30-4:20 PM, Room: Van Allen 301

Abstract: Current experimental efforts are clarifying quite beautifully the nature of charge transport in so-called molecular junctions, in which a single molecule provides the channel for current flow between two electrodes. The theoretical modeling of such structures is challenging, because of the uncertainty of geometry, the nonequilibrium nature of the process, and the variety of available mechanisms. The talk will center on the first formulation of the problem in terms of non-equilibrium theory, and then on the generalizations needed to make that simple picture relevant to the real experimental situation. These include antiresonances, vibronic coupling, structural disorder and representations for the electronic structure. Comments will be made on the measurements of inelastic spectra, and the information to be gained from them.

Bio: Mark Ratner was in junior high school when Sputnik was launched, and that occasioned his becoming a scientist. He finished high school in Shaker Heights, Ohio, college at Harvard, and doctoral work at Northwestern (in 1969). Following postdoctoral work at Aarhus in Denmark (where he worked on the kind of very formal theory that attracts young scientists), and in Munich, he began his career in the Chemistry Department at New York University. His first student there, Ari Aviram, was really the person who launched modern investigations into the area of molecular electronics. Ratner returned to Northwestern as Professor of Chemistry in 1975. He has chaired the Chemistry Department at Northwestern, served as Associate Dean of the College of Arts and Sciences, and now holds the Dumas University Professorship in the Department of Chemistry. Ratner is interested in structure at the nanoscale, function at the nanoscale, and the theory of fundamental chemical processes. More specifically, he tries to bring together structure and function in molecular nanostructures, based on theoretical notions, on exemplary calculations, and (very importantly) on collaborations with experimentalists and other theorists, in the United States and around the world. Some principal areas of interest are molecular electronics, theories of self-assembly, nonlinear response in molecules, and exact and approximate theories of quantum dynamics. His newest interest is in using nanoscience to attack the energy problems facing this world. In the interstices of these, he spends as much time trout fishing as he possibly can. Ratner is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, the International Academy of Quantum Molecular Sciences and the Royal Danish Academy of Sciences. He has received the Langmuir Award from the American Chemical Society, the Feynman Award from the Foresight Institute and an honorary doctorate from the Hebrew University in Jerusalem. . He also has also been a member of the Faculty Teaching Honor Roll at Northwestern eleven times, and has taught roughly five thousand students in General Chemistry in the last dozen years. He is the coauthor of two textbooks on quantum mechanics in chemistry, and of non-technical books on nanotechnology.

