ELECTRICAL & COMPUTER ENGINEERING **RESEARCH SEMINAR** **Spring 2018**

# *Molecular Computing Machines Realized through Plasmonic Arrays and Laser Spectroscopy*


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**Friday, March 23, 2018, 2:00pm – 2:50pm, Location: BB 3.03.24**


**Abstract**

Like the vacuum tube led to ENIAC, and the transistor led to the Cray-1, we contemplate the theoretical foundation for a new molecular-based fabric and device architecture to create advanced computing machines: the post-electronic Molecular Processing Unit (MPU), which capitalizes on photonic-plasmonic transduction of information. The MPU functions as both an analog encoder of the incident light field with molecular information and a processing unit from which the inelastically-scattered light fields are programmed to perform computations that are projected into virtual space and stored as three-dimensional images. It consists of an array of cavities within which a series of structurally-distinct molecular crystals are individually contained. We consider small features embedded in the MPU which are designed to elicit surface plasmons, such that the interaction between incident laser light fields and the array of molecular crystals are non-linearly enhanced below diffraction limits. Accordingly, we define the MPU as a photonic-plasmonic "metacrystal" – a contemporary abstraction of an engineered metamaterial at the boundary between photonics and molecular physics. The combination of plasmonic metacrystals with methods of resonance and coherent vibrational Raman scattering, are key enablers of this MPU-based computing machine. The Raman scattered field affords a highly dense, multidimensional capability for encoding and processing information in space, frequency, and time. We will show through hypothetical test cases how molecularly-encoded light fields scattered simultaneously from each cavity of the MPU array can be programmed to entrain a spatially-correlated process result in virtual space that is then incrementally indexed in the Raman frequency domain and stored into memory as an image.


**Biography**

Dr. Miller has over 34 years of experience as a physical and synthetic chemist, specializing in materials science, surface science, solid-state chemistry and physics, as well as molecular spectroscopy. In the field of theoretical solid-state chemistry, he employs *ab initio* and semi-empirical computational methods as a means of designing new nano-structured motifs and predicting their thermal, electrical, mechanical, and spectroscopic properties under various conditions. Dr. Miller has led or contributed to a diverse range of programs in the areas of chemical physics and materials science. Some examples include theory and synthesis of metamaterial-inspired structures for eliciting coupled interactions between surface plasmons and the vibrational dynamics of molecules, and development of a materials-by-design approach to hard functional coatings formed from chemical adducts in high impulse power plasmas. Recently, he has been working in the fields of solid-state energy storage, computing architectures based on photonic-molecular transduction, and theoretical predictions of MW-IR and MW-Raman double resonance effects in molecules.