USC Dornsife
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USC Viterbi
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Department of Chemical Engineering & Materials Science

Department of Physics and Astronomy Colloquium
Department of Chemical Engineering & Materials Science Seminar

"Control and Imaging of the Quantum Electron Motion in Action"

Dr. Mohammed Hassan
Physics Department and Optical Sciences
University of Arizona

Monday, September 26, 2022
4:15 p.m.
SLH 200
(Refreshments will be served at 4:00 pm)

Abstract: The electron motion in atoms and molecules is at the heart of all phenomena in nature. The advances in ultrafast light field synthesis and attosecond spectroscopy enabled tracing and controlling electron motion dynamics in matter (1). In the first part of this talk, I will present our capability for on-demand tailoring of light field waveforms spanning two optical octaves, from near-infrared (NIR) to deep-ultraviolet (DUV), with attosecond resolution (2). Moreover, I will show a demonstration of controlling the quantum electron motion in dielectric using synthesized light waveforms (3). This fine control allowed for switching the optical signal (ON/OFF) with attosecond time resolution (4). Furthermore, I will introduce you to the possibility of encoding binary data on ultrashort laser pulses waveforms. This work paves the way for establishing optical switches and light-based electronics with petahertz speeds, several orders of magnitude faster than the current semiconductor-based electronics, opening a new realm in information technology, optical communications, and photonic processors technologies. In addition, I will present a new methodology for all-optical light field sampling and electron meteorology, which allows to measure the electronic delay response in the dielectric system (5). In the second part of the talk, I will present our latest results of imaging the quantum electron motion in solid-state in action. I will explain how we were able to attain the native electron motion (attosecond) temporal resolution in the electron microscope—orders of magnitude faster than the highest reported imaging resolution—by generating a single-isolated attosecond electron pulse inside the microscope and the embellishment of what we so-called "Attomicroscopy" (6-8). This attosecond electron imaging by Attomicroscopy provides more insights into the electron dynamics in real-time and space with attosecond and picometer resolutions and promises to find long-anticipated real-life attosecond science applications in quantum physics, chemistry, and biology.

Joint Hosts:

Moh El-Naggar
Dean's Professor of Physics and Astronomy
Professor of Physics, Biological Sciences, and Chemistry

Andrea Martin Armani
Chemical Engineering and Materials Science