Joint DESY and University of Hamburg Accelerator Physics Seminar

Tuesday, 09.11.2010

(16:00 in Room 459/30b)

Relativistic Electron Gun for Atomic Exploration: REGAE Musik

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Abstract

Femtosecond Electron Diffraction has enabled atomic resolution to structural changes as they occur, essentially watching atoms move in real time — directly observe the so called transition state central to chemistry and biology. This experiment has been referred to as "making the molecular movie" and has been previously discussed in the context of a gedanken experiment. With the recent development of femtosecond electron pulses with sufficient number density to execute single shot structure determinations, this experiment has been finally realized. A new concept in electron pulse generation was developed based on a solution to the N-body electron propagation problem involving up to 10,000 interacting electrons that has led to a new generation of extremely bright (nonrelativistic) electron pulsed sources that minimizes space charge broadening effects. Previously thought intractable problems of determining $t = 0$ and fully characterizing electron pulses on the femtosecond time scale have now been solved through the use of the laser pondermotive potential to provide a time dependent scattering source. Synchronization of electron probe and laser excitation pulses is now possible with an accuracy of 10 femtoseconds to follow even the fastest nuclear motions. The camera for the "molecular movie" is now in hand. Atomic level views of the simplest possible structural transition, melting, have been obtained for a number of systems involving both thermal and purely electronically driven atomic displacements. Optical manipulation of charge distributions and effects on interatomic forces/bonding can be directly observed. New phenomena involving cooperative phase transitions in strongly correlated electron systems have also been observed. The primitive origins of molecular cooperativity has also been discovered. These new developments will be discussed in the context of developing the necessary technology to directly observe the structure-function correlation in biomolecules — the fundamental molecular basis of biological systems. The Relativistic Electron Gun for Atomic Exploration (REGAE) being developed in collaboration with DESY will have sufficient design parameters to meet this objective. To date, the entire field of direct use of relativistic electron sources as structural probes is wide open and holds tremendous promise to provide a new window on Atom Gazing.

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