Frontier Science at FERMI

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The interest in studying dynamic phenomena at femtosecond-nanometer (fs-nm) length-time scale has motivated technical advances, such as the development of free electron lasers (FELs), and resulted in relevant achievements in many research fields, ranging from physics and material science to chemistry and biology. Reaching the frontier of the fs-nm scale and the energy scale of chemical bonds, holds the promise of getting the very essence of dynamics in molecules and nanostructures, that are the building blocks of all types of matter.

In this lecture we present the unique opportunities opened by the FERMI seeded FEL [1], including the special operation modes (multi-colors, polarization and phase control, etc) that have enabled innovative experimental approaches, such as coherent control [2] and extreme ultraviolet four wave mixing (EUV FWM) [3]. After an overview of the FERMI experimental facilities, i.e.: five FEL beamlines, a THz beamline and two laser laboratories, we will discuss in particular EUV FWM experiments based on the transient grating (TG) approach.

EUV TG can be used to explore the so-called mesoscopic (10's of nm) length scale with ultrafast time resolution, a range hardly accessible by other means and critically relevant for nanotechnology. For instance, nanoscale thermal transport in silicon has been studied by EUV TG and found to orders of magnitude slower than what expected by the Fourier law of heat diffusion [4]. EUV TG was also used, e.g., for investigating ultrafast magnetic dynamics [5] and the nanoscale limit of all optical magnetic switching [6]. More complex EUV/x-ray FWM approaches, so far conceived only theoretically [7], are envisioned.

References:

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