COLLOQUIA

UNIVERSITY
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Room A110 – Polo Ferrari 1

Nanoscale dynamics by extreme ultraviolet transient gratings

Abstract
The study of collective dynamics in condensed matter at the nanoscale, such as heat transport, vibrational or magnetization dynamics, is important for advancing both fundamental science and modern technology. Experimental tools for probing such dynamics in the sub-100 nm length-scales and on the relevant timescale (i.e. picosecond and sub-ps) mainly rely on combinations between ultrafast laser excitation and ad hoc sample's nanostructuration.
In this colloquium we present an alternative approach, developed at the FERMI seeded free electron laser (FEL) facility (Triste, Italy), where the sensitivity to the sub-100 nm length-scale is obtained by using extreme ultraviolet transient gratings (EUV TG) [1,2]. EUV TG is a specific case of so-called four-wave-mixing (FWM) process [3] and is obtained by crossing two ultrafast FEL pulses, while the stimulated dynamics is revealed by monitoring the transient diffraction of a third, time-delayed FEL pulse.
We will discuss the application of this new experimental tool for studying nanoscale thermal transport in thin membranes of crystalline silicon and amorphous silicon nitride. In the latter sample the thermal transport timescale is consistent with a diffusive behaviour, while the crystalline sample shows a marked deviation with respect to the diffusive regime [2]. This can be interpreted within the frame of the Boltzmann transport equation as a transition from diffusive to ballistic transport at room temperature [4].
We will also discuss on the potential of EUV TG in other contexts, such as: (i) generating and detecting bulk and surface phonons on a previously inaccessible wavelength range and in ultra-thin samples [5], (ii) probing nanoscale magnetization dynamics at ultrafast timescales [6] and, in a broader context, (iii) the use of EUV TG to develop other types of FWM experiments, so far only theoretical conceived [7].

References
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