DEPARTMENT OF PHYSICS AND ASTRONOMY

COLLOQUIUM ***IN-PERSON EVENT***

Exploiting Infrared Light-Matter Interaction to Advance Nanoscale Characterization and Nanomanipulation of Materials

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Bypassing the limitations of conventional infrared spectroscopy imposed by optical diffraction has been achieved by monitoring of behavior of a material excited by infrared light with the nanoscale tip of an atomic force microscope (AFM). The improvements in spatial resolution and sensitivity afforded by nanoscale infrared (nanoIR) spectroscopy are expected to bolster our fundamental understanding of heterogeneous materials and living systems. However, important aspects of light-matter interactions involved in nanoIR measurements remain uncharted, leaving many opportunities to advance the performance and functionalities of the approach.

In this talk, we will first present the general concept of functional atomic force microscopy for nanoIR spectroscopy, with an emphasis on a scheme monitoring the photothermal response of the material as detection mechanism. We will describe how sensitivity and spatial resolution of nanoIR spectroscopy and imaging can be improved by implementing multi-frequency AFM developments, which exploit the nonlinear nature of the tip-sample interaction to synthesize new modes suitable for heterodyne detection. The performance of the technique will be illustrated using several examples ranging from polymeric samples to biological systems. Next, we will show how infrared light-AFM tip interactions lead to behaviors that can be exploited beyond nanoIR spectroscopy, such as the deterministic creation of nanoscale defects in 2D materials. We will present an application where nanomanipulation and nanoIR spectroscopy work hand-in-hand to monitor the formation of sub-50 nm defects in hexagonal boron nitride with significant implications in catalysis. We will conclude with a perspective delineating the opportunities of these new advances.

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IN-PERSON EVENT ROOM 202

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