Opportunities, Challenges and Solutions in the Ultrahigh Energy Resolution Regime

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Electron energy loss spectroscopy (EELS) in the scanning transmission electron microscope (STEM) has always been critical tool for the analysis of the nanoscale behavior of collective excitations. However, in the last decade, electron monochromation has improved by an order of magnitude enabling STEM-EELS to straightforwardly access the mid-infrared spectral regime with high spatial resolution. As a result, there are a host of new experiments and phenomena to explore in the infrared such as electronic structure[1], excitons[2], plasmons[3], phonons[4], phonon-polaritons[5], and molecular vibrations[6] that were previously inaccessible. However, with these new opportunities come significant challenges, that are unique to the behaviors and systems of infrared materials.

Here, I will present on four promising new avenues for monochromated STEM-EELS: 1) emergent electronic structure in epitaxially fused quantum dot networks, 2) assessing the influence of heterogeneity on hyperbolic phonon polariton propagation with interferometry, 3) identifying vibrational signatures in beam-sensitive biological whole-cell samples, 4) near-atomic localization phonons in perovskite superlattices and grain boundary dislocation cores. In each, I will focus on the unique challenges inherent to these systems and how we can use careful experimental design to overcome the limitations and achieve novel results.

References

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