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PHYSICS AND ASTRONOMY

Presents:

Heat Flow in Disordered Carbon Nanotube Networks: Steps Toward Low Cost Organic Materials for Energy Harvesting

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Via Zoom (848 7723 7502)

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Management of heat is increasingly important in advancing technology and is particularly critical for nanoelectronics and green energy. Desire to reduce heating or use unwanted heat to generate useful work continues to drive research into materials for heat management and thermoelectric systems that convert waste heat to electricity. Nanoscale engineering of these materials bring both tremendous promise and serious fundamental measurement challenges. Carbon nanosystems are one important special class of materials for heat management applications, which also display fascinating electronic and vibrational physics. The earliest examples of this work focused on carbon nanotubes, which when isolated show some of the largest thermal conductivities ever measured. As I will overview in this talk, this heat flow is dominated by phonons; vibrational excitations that travel in carbon at high velocity with long lifetimes. The discovery of graphene showed that these tubes maintain exceptionally large thermal conductivity when unrolled. Some of our group's recent work, in collaboration with the National Renewable Energy Laboratory, focuses on exploring these systems as low-cost, all organic thermoelectric systems. This seems counter-intuitive, since efficient thermoelectric materials convert heat to electricity in part by having low thermal conductivity. The key to this approach lies in disorder, as a tangled network of single-wall carbon nanotubes introduces phonon scattering that dramatically reduces the thermal conductivity. In fact, our most recent work shows that some of these networks drive the phonon contribution to thermal conductivity to nearly zero in a certain temperature range. This is a dramatic and never before observed for carbon nanosystems. Further study of this phenomenon could point the way to engineering of low-cost thermoelectric energy harvesting of waste heat.

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