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Tykeson 140

Engineering electronic and thermal transport in complex crystals

A certain level of disorder is inherent to every solid, since it contributes to entropy and minimizes the Gibbs free energy of a system in thermodynamic equilibrium, and can be a defining quality of metastable materials like glasses. Controlling and manipulating disorder provides widespread opportunities to optimize material properties (e.g., electronic, ionic, and thermal conductivity). Such endeavors (e.g., optimizing thermoelectrics, photovoltaics, batteries, and [micro]electronics) require a profound understanding of the physics of solids, including transport theory and defect chemistry. Here, analytical models are useful for investigating mechanistic causality and uncovering novel insights to materials design. This talk will explore the role of defects and disorder in tuning electronic and thermal transport, and how analytical models aid in explaining experimental observations. In particular, the metal-to-insulator electronic transport transition in Ge-Sb-Te phase change materials, as well as the change in thermal transport mechanism from phonon-gas-like to diffuson-like in Ag argyrodites highlight the novel transport that can occur in complex crystals.