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Anomalous phonon/heat transport in low dimensional micro/nano materials

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When system dimension and size go down, many interesting phenomena can happen. Both experimental and numerical works in recent years have shown that phonon/heat transport in low (quasi 1D and 2D) dimensional nano structures like nanotube, nanowire, polymer chain, graphene, and other 2D materials show anomalous behavior: (a) heat conduction due to phonons does not follow the Fourier law; (b) heat transports may break down the reciprocal principle, namely heat flows asymmetrically. (c) negative differential thermal resistance will arise, namely the larger the temperature drops, the smaller the heat current. Issues (b) and (c) can be used to build up useful phononic thermal devices like thermal diode and thermal transistor, which lay the foundation of a new emerging field – phononics. In this talk, I will focus on issue (a) and present a general theoretical understanding of the anomalous phonon/heat transport. More specifically, I will discuss how the anomalous thermal transport - a macroscopic phenomenon – is connected with the anomalous energy diffusion - a microscopic process.