量子物理学・ナノサイエンス第 190 回セミナー

# Heat Transport at the Nanoscale


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場所　：　本館 1 階　H155B　理学院セミナー室

## 概　要


The good thermal conductivity of silicon has enabled high-density electronic devices, but improved heat removal is now critical. Heat is carried efficiently when quasiparticle heat carriers have long mean free paths *l*. At distances from the heat source smaller than *l*, heat is carried ballistically, while at distances larger than *l*, the diffusive approximation works. The "crossover" from ballistic to diffusive is known to be very important, but has been hard to observe in detail by experiment, and hard to model or predict by theory. The gas of heat-carrying quasiparticles has a distribution correctly described by Boltzmann theory. My aim has been to formulate the Boltzmann theory properly, and to apply it to realistic nanoscale geometries. Two cases will be described in detail. The simplest case is when heat is applied and removed by planar sources and sinks. How does the resulting steady-state temperature T(x) vary for distances x (from source or sink) < *l* ? We do not know yet how to measure this experimentally, but computer simulations by "molecular dynamics" model it routinely. Proper analysis by Boltzmann theory has not been done before. The second case involves heat inserted by a linear wire heater. Experiments should now be able to measure T(r) with ~10 nm resolution. This may be enough to observe the ballistic to diffusive crossover. Boltzmann theory will be formulated and used to predict T(r).


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