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FINITE-SIZE AND TRANSIENT EFFECTS IN THERMAL CONDUCTION BY PHONONS

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ABSTRACT Transient thermal grating (TTG) experiments offer the opportunity to extend Peierls-Boltzmann transport theory from the usual regime (bulk conductors, steady state, linear Fourier response) to include finite-size, transient, and even, if appropriate, nonlinear effects. The reason is, that the finite size is an externally-imposed spatially periodic heating, which leaves intact the usual bulk vibrational phonon spectra. In other words, we still have a good phonon gas, with none of the complexities of finite samples, surfaces, or interfaces. Time-dependences can be externally driven, and time-dependent responses can be measured. The space- and time-dependent phonon distribution function *N(Q,x,t)* should be well-defined, and well described by the full Boltzmann apparatus. This has several advantages over molecular-dynamics simulations. Lower temperature quantum aspects are correctly included, and simulation-cell limitations are significantly diminished. In the linear regime, Fourier's law $J = -\kappa \nabla T$ can be generalized to the non-local relation, $J(x,t) = -\int dx' \int_{-\infty}^{t} dt' \kappa(x,x';t-t') \nabla T(x',t')$. Theory motivated by these thoughts will be described.