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Gas motion induced by unsteady boundary heating in a small-scale gap AVSHALOM MANELA, Department of Mathematics, MIT, NICOLAS HADJICONSTANTINOU, Department of Mechanical Engineering, MIT — We study the response of a gas confined in a small-scale gap to a small, time-dependent change in the temperature of its boundaries. Using the collisionless Boltzmann equation, a general scheme for the calculation of the probability density function and the respective hydrodynamic fields in response to any heating history is developed. Asymptotic results are obtained for the cases of "ramp" (linearly varying with a cutoff value) and oscillatory heating. The "ramp" solution may be used to approximate arbitrarily slow and fast process timescales (compared to the mean free time) and thus complements and bridges previous analyses. For oscillatory heating at frequencies higher than the collision frequency it is shown that, in steady state, hydrodynamic fields decay proportionally to $\exp[-(\omega\delta_{\mathrm{W}})^{2/3}]$, where ω is the oscillation frequency and δ_{W} is the distance from the wall. The steady state gas motion is thus confined to narrow layers in the vicinity of each wall. Our results are compared with low-variance particle simulations of the linearized Boltzmann equation using the low-variance deviational simulation Monte Carlo (LVDSMC) method. The good agreement found between the two methods of calculation suggests the former as an accurate and simple means of calculating the response of systems of arbitrary size within one mean free path from the heated boundary.

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