Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Gas-flow animation by unsteady boundary heating in a microchannel[1] NICOLAS HADJICONSTANTINOU, Mechanical Engineering Department, MIT, GREGG RADTKE, Mecanical Engineering Department, MIT, AVSHALOM MANELA, Aerospace Engineering Department, Technion — We study the response of a one-dimensional gas layer due to unsteady boundary heating. Analytical results are presented for the slip-flow/Navier-Stokes and collisionless limits. The latter is applicable to gas layers that are thinner than the molecular mean free path or to layers of arbitrary size with heating time-scales that are shorter than the mean collision time. Our analytical results are complemented by low-variance simulations of the Boltzmann equation, which are useful for establishing the limits of validity of the closed-form predictions, as well as bridging the gap between them. In particular, we consider the gas response to step-jump heating and show that the slip-flow solution captures the correct gas behavior for times as short as few collision times. The Navier- Stokes slip-flow solution is also used to elucidate a singular limit reported in the literature for oscillatory heating of a dynamically incompressible fluid.

[1]This work was supported, in part, by the Singapore-MIT Alliance.

Nicolas Hadjiconstantinou
Mechanical Engineering Department, MIT

Date submitted: 06 Aug 2010 Electronic form version 1.4