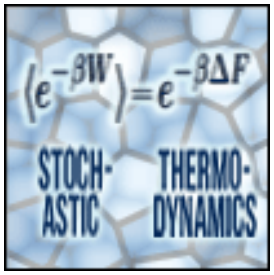

Contribution ID: **263** Type: **not specified**

Adiabatic Piston and Momentum Deficit due to Dissipation: From Hydrodynamics Perspective

Wednesday, March 13, 2013 10:00 AM (1 hour)

A Brownian piston separating two gases of different temperature mediates heat transfer from one gas to the other via its velocity fluctuations. Such heat transfer is well understood at the Langevin theory. However, the gases in turn exert non-equilibrium force on the piston. Such a force is responsible for various intriguing non-equilibrium processes such as adiabatic piston and a certain types of Brownian motors. It has been shown that the standard linear Langevin theory fails to explain the force. The Master-Boltzmann approach beyond the Langevin description successfully predicted the force but it did not reveal the physical origin of the force. Recently, Freleux et al [PRL 108, 160601 (2012)] introduced the new concept of momentum deficit due to dissipation (MDD) and showed that it can explain the origin of the force with a few lines of calculation only based on the energy and momentum conservation laws.

However, all previous theories including the MDD assume that the gas particles hitting the piston are taken from an equilibrium velocity distribution and outgoing particles disappears without colliding with the incoming particles. Since the outgoing particles are not in a thermal equilibrium due to dissipation, their collision with the incoming particles disturbs the velocity distribution of the incoming
particles, invalidating the assumption used in the previous theories. Therefore, I would like to discuss the MDD from the hydrodynamics point of view. When a nonequilibrium steady state is established, we can show that the heat and momentum fluxes in the gases satisfy the MDD condition
such that energy and momentum transport in hydrodynamics is consistent with the MDD theory of adiabatic piston.

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