

# Momentum transfer in NESS

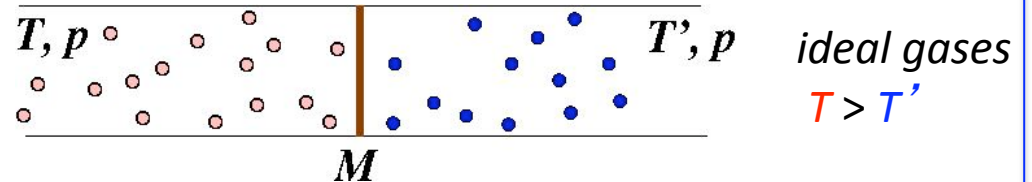
(arXiv:1109.6553)

Antoine Fruleux (P7/ESPCI) , Ryoichi Kawai (Univ. Alabama) & Ken Sekimoto (P7/ESPCI)

## NESS with gas + Brownian object

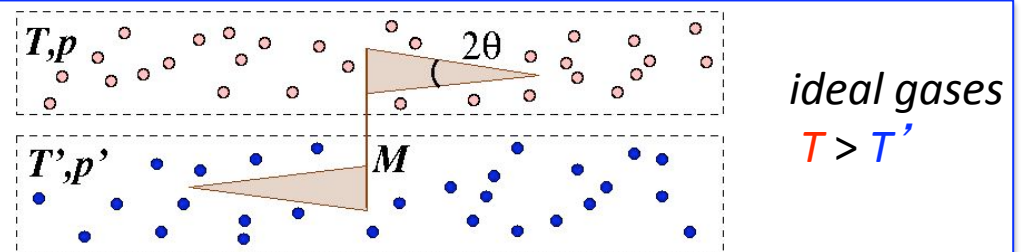
Ex. **adiabatic piston**

[Feynman (1963), Callen (1985)]



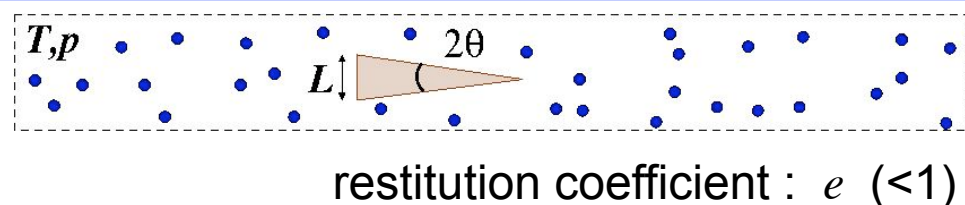
Ex. **Brownian ratchet**

[Van den Broeck, *et al.* (2004)]



Ex. **Inelastic ratchet**

[Costantini, *et al.* (2007),  
Cleuren *et al.* (2007)]



**Problem:** No understanding of **general physical principle**

(cf. MD simulations, master-Boltzmann equation)

## General principle

### Equilibrium

≈ elastic collision with hard wall

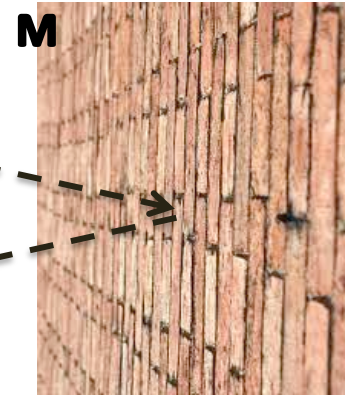
Kinetic energy : conserved by collision

→ |rebounded momentum| ≈ colliding momentum

gas



“Brownian object”



### NESS

≈ inelastic collision with dissipative wall

Kinetic energy : lost by collision

→ |rebounded momentum| < colliding momentum

→ **less momentum transfer (=force)** to B-object than equilibrium.



$$(\delta F)_{\text{noneq}} = -c J_{\text{exc.diss}}^{(\text{eng})} / v_{\text{th}}^{(\text{gas})}$$

arXiv:1109.6553 : details + NESS velocity + new model, hk...)