Velocity Distribution of Driven Granular Gases

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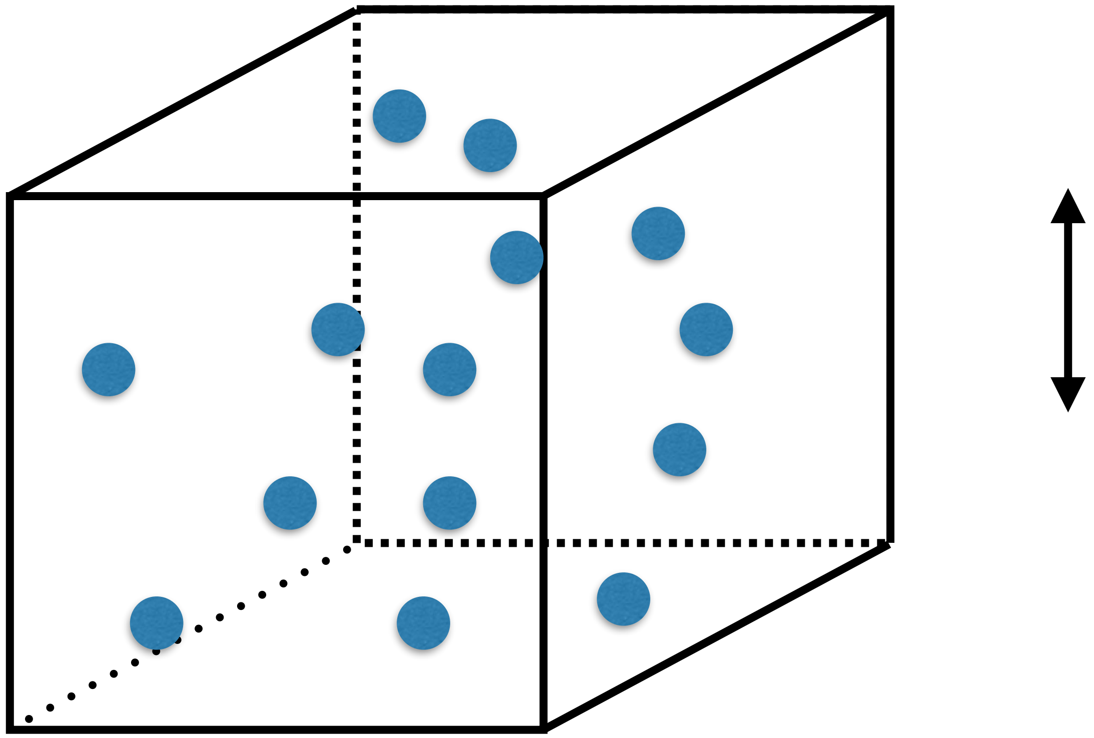
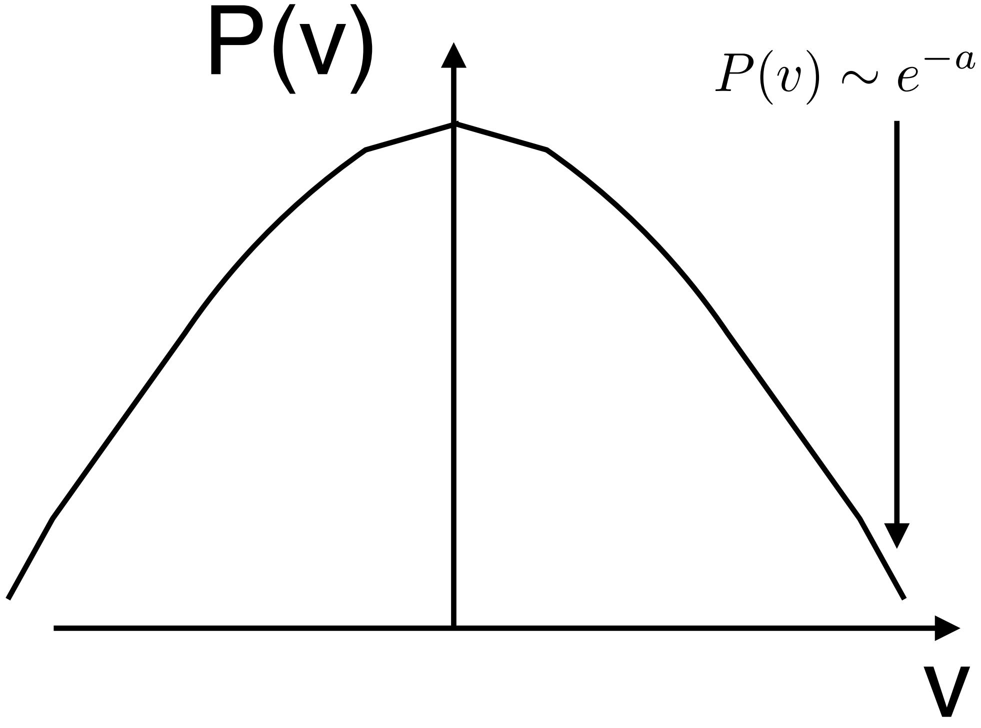
ArXiv:1701.03600



Inelastic particles
e.g., steel balls

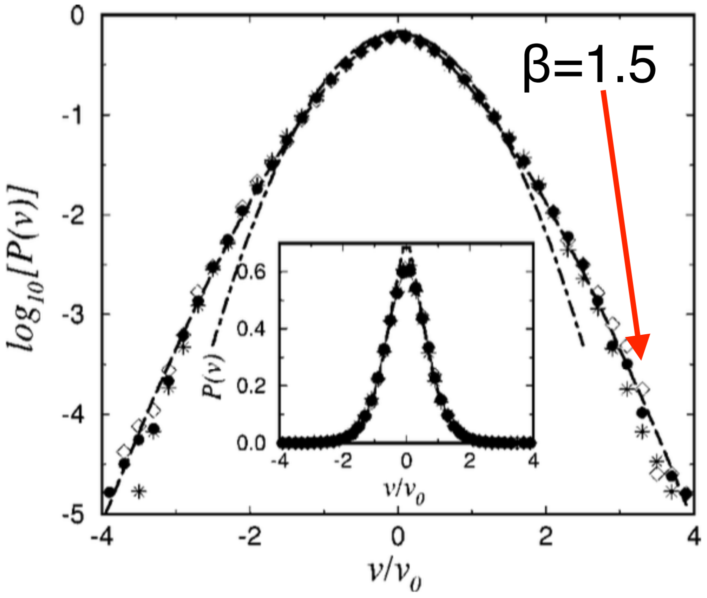
Is the steady state velocity distribution universal?

If yes, what is the distribution?

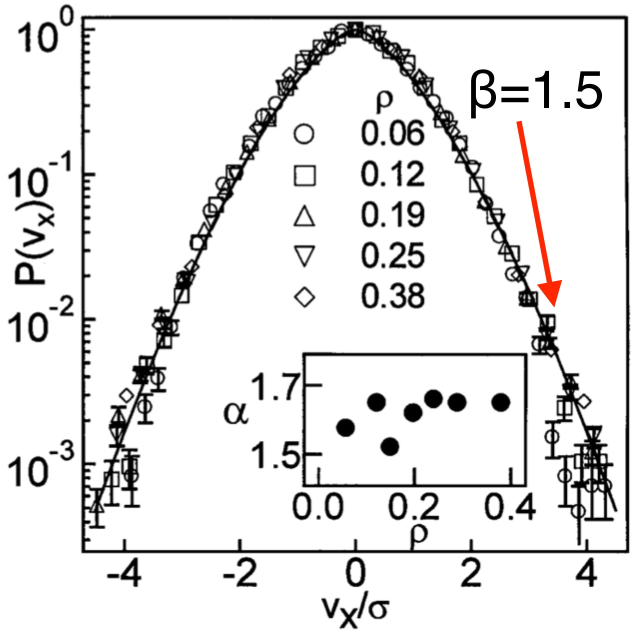


Some experiments

$$P(v) \sim e^{-a|v|^{\beta}},\ v \gg v_{rms}$$



Aranson et al, PRE (2002)

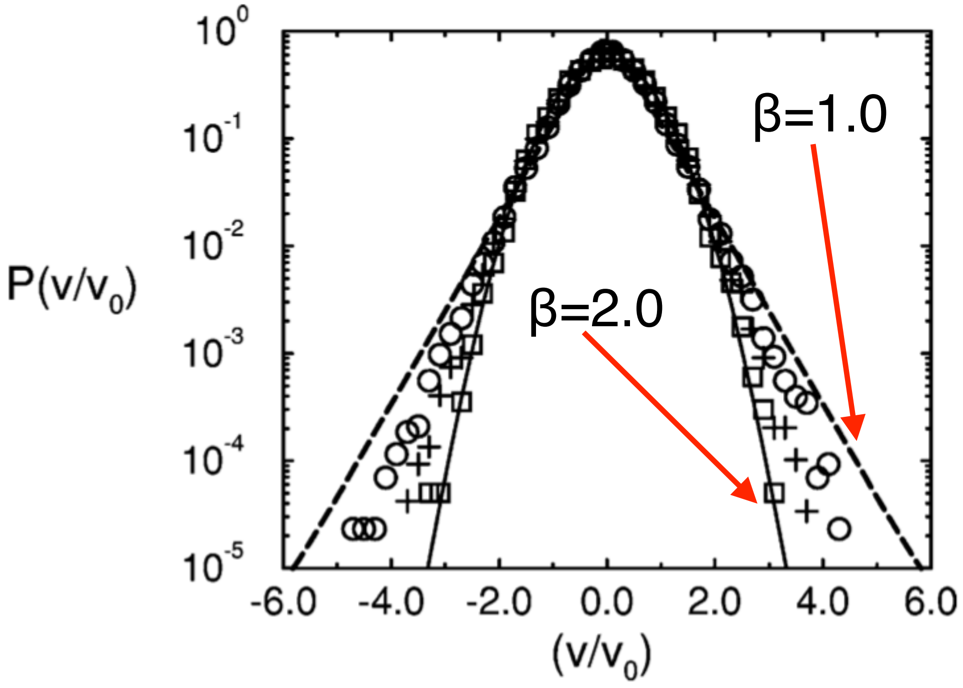


Rouyer et al, PRL (2000)

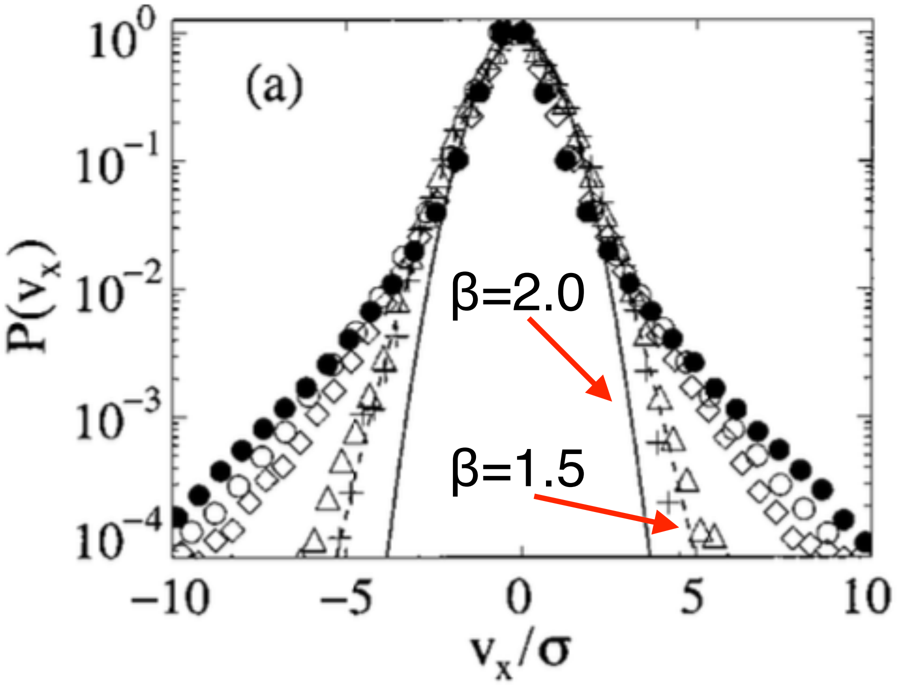
Universal, non-Maxwellian, β=3/2

Other experiments

$$P(v) \sim e^{-a|v|^{\beta}},\ v \gg v_{rms}$$



Olafsen et al, PRE (1999)



Blair et al, PRE (2001)

Non-universal, non-Maxwellian, varying β

Modelling

Collisions → Momentum Conserving

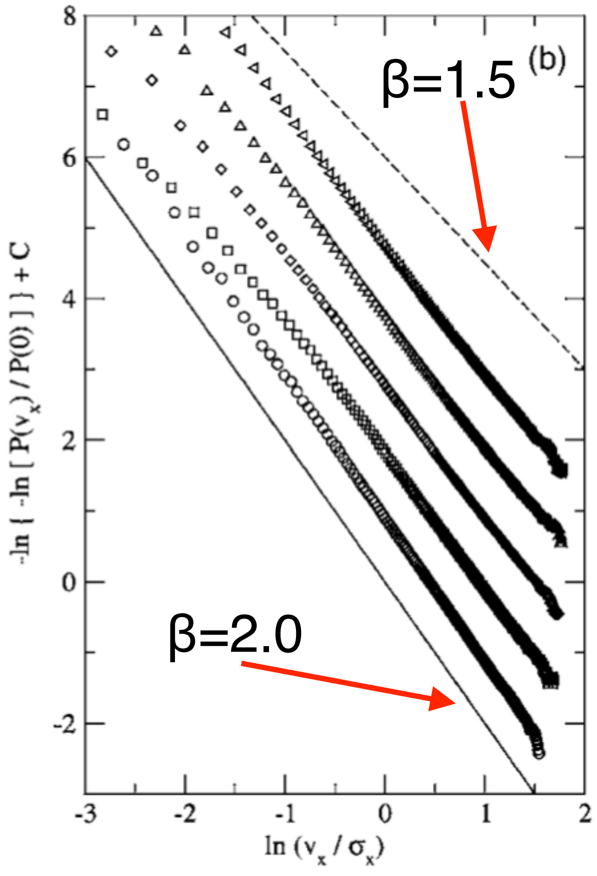
Collisions → Energy Dissipating

Driving → $v \to v + \eta$

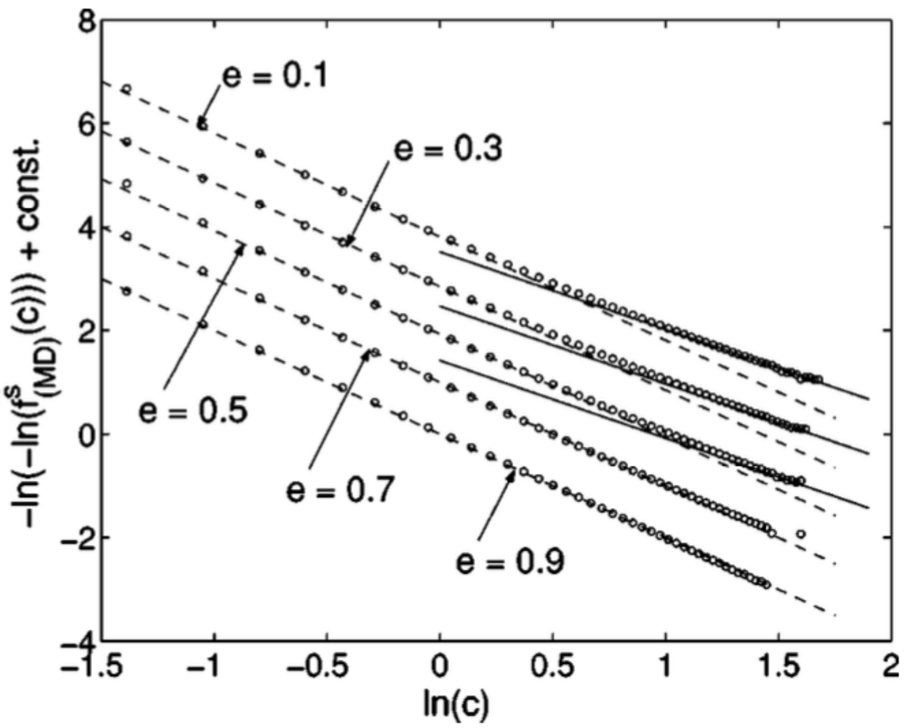
Collision rate $\propto |v_1 - v_2|$: Hard sphere model

Collision rate = const : Maxwell model

Numerical



van Zon et al, PRE (2005)



Moon et al, PRE (2001)

Gaussian versus non-Gaussian

Two approaches

1. Boltzmann equation for inelastic gas

$$P(v) \propto e^{-a|v|^{3/2}}$$

2. Simple models like Maxwell model

$$P(v) \propto e^{-a|v|}$$

Universal

But

If driving $\longrightarrow$ $v \to v + \eta$

Then V$_{\mathrm{CM}}$ does a random walk ⇒ $\langle v^2 \rangle \sim t$

⇒ no steady state

Assume wall much heavier than particle

$$v \to -r_w v + \eta$$

Now steady state is reached

Prasad et al, EPL (2013), PRE (2014)

Question: What is P(v)?

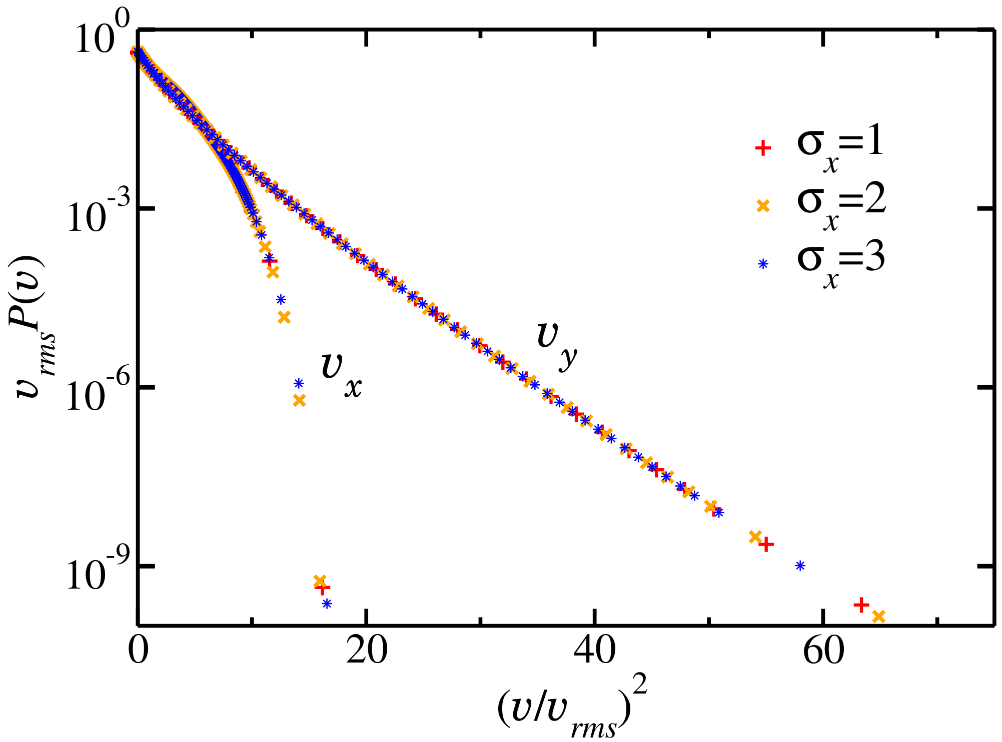
Results

- One component Maxwell gas
  - ⋆ P(v) highly non-universal
  - ⋆ Tail of P(v) ~ tail of P(η)
  - ⋆ Exact equation for moments: look at ratios
  - ⋆ Intuitively, tails populated by driven particles
  - ⋆ Valid for more components with uniform driving

Prasad et al, ArXiv:1701.03600

Results (tentative)

- Two-component Maxwell gas
  - ★ Driving only in x-direction
  - ★ Universal in y-direction for distribution faster than Gaussian (see fig)



Outlook

Including hard sphere interactions within the kinetic theory approach