Kinetics of Classical Ideal Gas [15128]

- Gas consists of a large number of atoms.
- Motion of each atom is rectilinear with constant speed.
- Interactions are limited to collisions with walls or between atoms.
- Motion is randomized by collisions.
- Thermal equilibrium is characterized by uniform spatial distribution of atoms and by a velocity distribution $f(\mathbf{v})$ to be determined.

Position and velocity distribution in two dimensions.



Properties of velocity distribution $f(\mathbf{v})$:

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$$\int d^3 v f(\mathbf{v}) = 1$$
 (normalization),
• $\int d^3 v f(\mathbf{v}) \mathbf{v} = 0$ (symmetry),
• $\int d^3 v f(\mathbf{v}) \left(\frac{1}{2}mv^2\right) = \frac{1}{2}m\langle v^2\rangle = \frac{U}{N} = \frac{3}{2}k_BT$ (internal energy),
• $p = \frac{1}{3}\frac{N}{V}m\langle v^2\rangle = \frac{1}{3}\frac{N}{V}3k_BT \Rightarrow pV = Nk_BT$ (equation of state)¹,
• $S = -Nk_B \int d^3 v f(\mathbf{v}) \ln (f(\mathbf{v}))$ (entropy).

¹Expression for pressure from [tex49].