# Key points lecture 04/27/2022

Kinetic theory $\hat{=}$ describes behavior of out-of-equilibrium system due to collisions

Without collisions, density of particles in phase space $f(\vec{r},\vec{p},t)$ is governed by:
$$\underbrace{\left(\frac{\partial}{\partial t} + \dot{\vec{r}}\cdot\vec{\nabla}_{\vec{r}} + \dot{\vec{p}}\cdot\vec{\nabla}_{\vec{p}}\right)}_{\text{"phase space derivative"}} f(\vec{r},\vec{p},t) = 0$$

$\dot{\vec{p}} \rightarrow \vec{F}$ : external force

in the presence of collisions, the r.h.s. becomes $\left(\frac{\partial f}{\partial t}\right)_{coll}$

Formalism assumes:

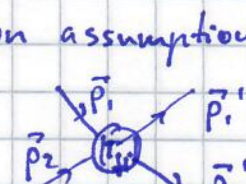
$\delta\tau \ll \tau^*$

$\delta\tau$: duration of collision

$\tau^*$: time between collisions (mean free path $l \sim \tau^* \underbrace{\langle v \rangle}_{\text{average velocity}}$)

**Boltzmann transport equation** (based on assumption of "molecular chaos"):

$$\left(\frac{\partial}{\partial t} + \dot{\vec{r}}_1\cdot\vec{\nabla}_{\vec{r}_1} + \dot{\vec{p}}_1\cdot\vec{\nabla}_{\vec{p}_1}\right) f(\vec{r}_1,\vec{p}_1,t)$$




$$= \int \delta(\vec{P}'-\vec{P})\,\delta(E'-E)\,|T_{fi}|^2\left[f(\vec{r}_1,\vec{p}_1{}',t)f(\vec{r}_1,\vec{p}_2{}',t) - f(\vec{r}_1,\vec{p}_1,t)f(\vec{r}_1,\vec{p}_2,t)\right] d^3\vec{p}_2\, d^3\vec{p}_1{}'\, d^3\vec{p}_2{}'$$

The only time-independent solution (equilibrium distribution fct.):

$$C\, e^{-\beta\left(\frac{\vec{p}_1^2}{2m} + U(\vec{r}_1)\right)} \hat{=} \text{Maxwell-Boltzmann velocity distribution}$$

$C$: normalization constant

$U(\vec{r}_1)$ pot. associated w/ external force $\vec{F}$