1) Introduction : general properties of plasma
   → collisions

2) Single particle motions

3) Collisions in plasmas

4) Emission of radiation from plasmas

5) Collisional transport

6) Thermonuclear fusion

Collective affects

Fluid

Plasma

n Density
T temperature
$K_B T \longrightarrow \underline{keV}$
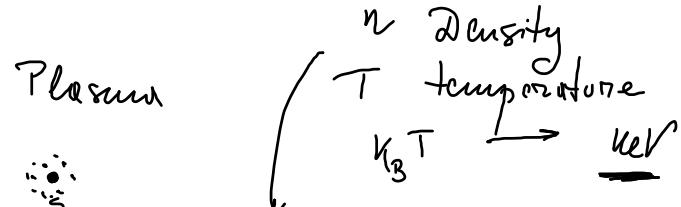
Inertial Confinement Fusion

$1 \underline{eV} \longrightarrow T = 12\,000\,K$

$\longrightarrow$ electrons   Quasi neutrality

$\longrightarrow$ ions

Overall plasma is
neutral

Debye shielding
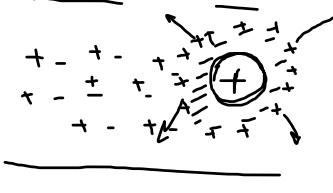
$$\frac{1}{\lambda_{Debye}^2} = \frac{m e^2}{\varepsilon_0 T_e}$$

$$m_i >> m_e$$

$$\omega_{Pe}^2 = \frac{n e^2}{m_e \varepsilon_0}$$

$$\omega_{Pi}^2 = \frac{n e^2}{m_i \varepsilon_0}$$

$$\omega_{Pi}^2 << \omega_{Pe}^2$$

$$\phi(r) = \boxed{\frac{1}{4\pi\varepsilon_0} \frac{e}{r}} \; \boxed{e^{-r/\lambda_D}}$$

$$\underbrace{\frac{4}{3}\pi \lambda_D^3 \cdot n}_{\substack{\text{Volume of} \\ \text{Debye sphere}}} >> 1$$

→ plasma density

↳ This is a plasma!

Coulomb collisions

Test Field particle
T particle

$\vec{v}_0$

b : impact parameter

θ

b

F
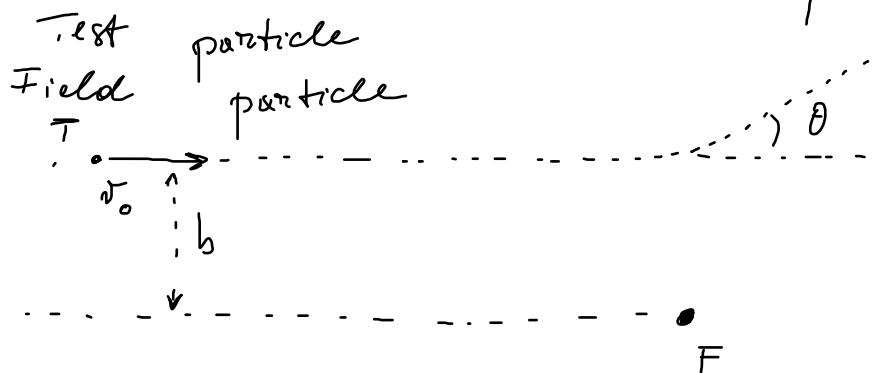
$$\tan\left(\frac{\theta}{2}\right) = \frac{q_T \, q_F}{4\pi\varepsilon_0 \, b \mu v_0^2}$$

Small angle collisions:
$$\theta < \frac{\pi}{2}$$

Large angle collisions:
$$\theta > \frac{\pi}{2}$$