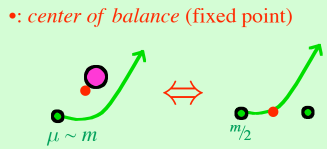
e-i, i-i, i-e collisions

m: electron's mass, M: ion's mass
$t_c^{e-e} \propto m_e^{1/2}$

1) e-i collision (electron's momentum is changed by ion)

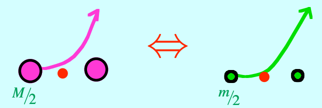
Reduced mass (relative coordinates): $\mu = \dfrac{mM}{m+M} \sim m$



→ $t_c^{e-i} \sim t_c^{e-e}$

electrons become thermalized (T_e is determined)

2) i-i collision (ion's momentum is changed by ion)



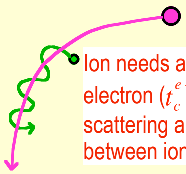
→ $t_c^{i-i} \sim \dfrac{M^{1/2}(k_B T_i)^{3/2}}{n_i e^4} \sim \sqrt{\dfrac{M}{m}}\, t_c^{e-e} >> t_c^{e-e}$

ions become thermalized (T_i is determined)

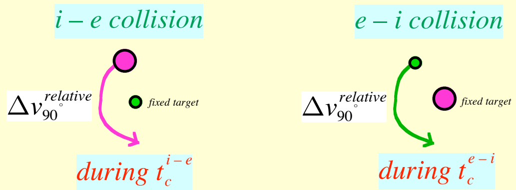
3) i-e collision (ion's momentum is changed by electron => momentum exchange is considered)

Ion and electron exchange the same amount of momentum per unit time:

$$M \frac{\Delta v_{90^\circ}^{relative}}{t_c^{i-e}} \sim m \frac{\Delta v_{90^\circ}^{relative}}{t_c^{e-i}}$$



→ $t_c^{i-e} \sim \dfrac{M}{m} t_c^{e-i} >> t_c^{i-i} >> t_c^{e-e}$



ions and electrons become thermalized
($T_e \sim T_i \sim T$: same temperature)

Debye length

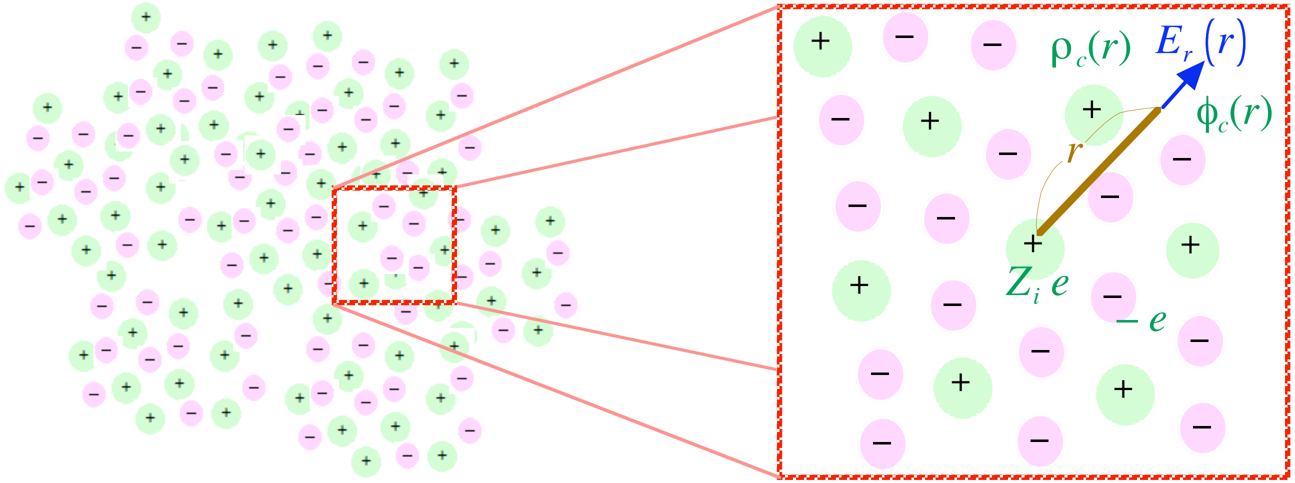
(shielding of electric field)

Debye length

Isotropic distribution model

... only depends on the distance r from the central particle

(each particle continuously moves, while keeping the same isotropic distribution)



Z_i... *ion's valency number*

($Z_i = 1$ for a proton)