Additional comments on plasma state, kinetic & fluid approaches

Plasma state... *4th state of a system* in which

it is composed of **many charged particles**

these particles **behave collectively** => *local charge neutrality*

Kinetic approach... *more fundamental approach* in the sense that

it is based on **a real object** (**particle**)

it can be used **even for a non-plasma state** (*each particle behaves independently*)

Fluid approach... *less fundamental approach* in the sense that

it is based on **a virtual object** (**fluid element**)

it can be used **only for a thermal state** (*velocity distribution of particles is given by Maxwellian distribution*)

Characteristic scales of plasmas

MKS	CGS
B	$\frac{B}{c}$
ε_0^{-1}	4π
μ_0	$\frac{4\pi}{c^2}$
e	$e\sqrt{4\pi\varepsilon_0}$

Characteristic scales related to electric field

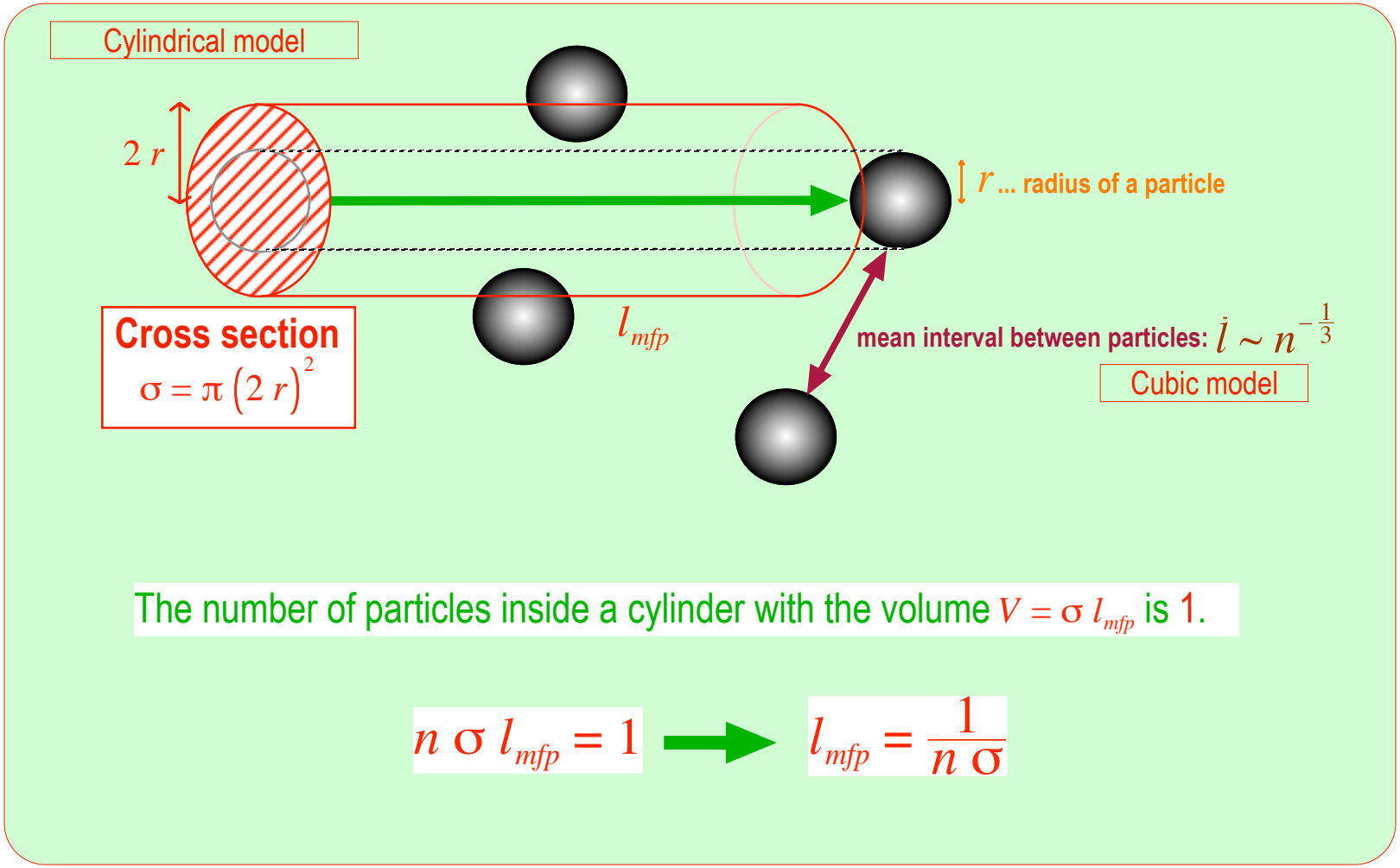
(collision, oscillation)

Mean free path

(collision between particles)

Mean free path of a neutral particle

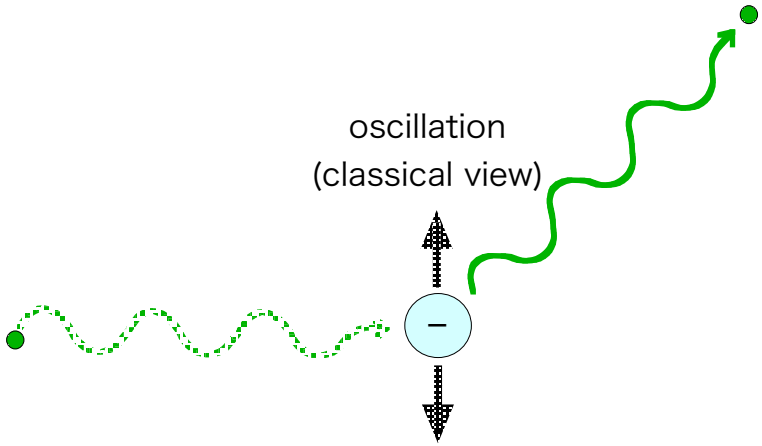
... a distance over which a particle freely travels without colliding with another particle



The number of particles inside a cylinder with the volume $V = \sigma\, l_{mfp}$ is 1.

$$n\,\sigma\,l_{mfp} = 1 \quad \rightarrow \quad l_{mfp} = \frac{1}{n\,\sigma}$$

Mean free path of a photon (collision between a photon and an electron)



Thomson formula

Cross section: $\sigma_T = \frac{8\pi}{3}\left(\frac{e^2}{m_e c^2}\right)^2 = \frac{8\pi}{3} r_e^2$

r_e... *classical radius of electron* $\sim 2.8\times10^{-15}\ m$

Photon's mean free path (**Thomson scattering**)... $l_T = \frac{1}{n\,\sigma_T}$