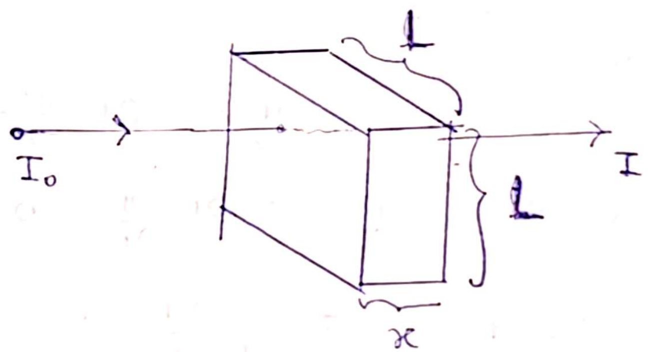
Day 02 (lecture notes)

Wiki - Source : Scattering theory

$$T = \frac{I}{I_0} = e^{-x/\ell}$$

T: transmission



T : fraction of particles that pass through

$$I = I_0 e^{-x/\ell}$$ (Beer - lambert law)

* Mean free path is avarge distance over which a moving particle travels without collison $\ell = (\sigma n)^{-1}$

n : particle density of the target

σ : effective cross-section area

Wik Source : Kinetic theory of gas

relative velocity : $v_{re} = \sqrt{2}\, v$

↓

lead to the table about vaccumn range

* if mean free path $\leq$ molecular size (ex: 0.3nm for N_2) $\Longrightarrow$ neuclear physics

* In plasma particles interact before collision due to charges.

Solar corona

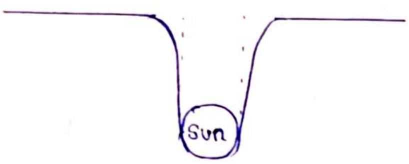
Pressure distribution of solar corona due to hydrostatic equilibrium is given by

$$\frac{P}{P_0} = \exp\left\{-\frac{r_0}{H}\left(1-\frac{r_0}{r}\right)\right\}$$

r : radius
r_0 : radius of base of the corona
H : hieght

$$H = \frac{2k_B T_0 r_0^2}{GMm_p}$$

M : mass of the Sun
m_p : mass of a proton
T_0 : temp at base of the corona



gravitational well

* If particles have enogh thermal energy they can escape the gravitational potential

Parker Solar wind equation

Continuity equation $\frac{\partial}{\partial r}(\rho v r^2) = 0 \Rightarrow \rho v r^2 = 0 \rightarrow ①$

momentum equation $\rho v \frac{\partial v}{\partial r} = -\frac{GM_\odot \rho}{r^2} - \frac{\partial P}{\partial r} \longrightarrow ②$

gas law $P = \rho C_s^2 \longrightarrow ③$

C_s^2 : Critical velocity
Sun's velocity
radial velocity

$$\frac{\partial}{\partial r}(\rho v r^2) = 0$$

$$\frac{\partial \rho}{\partial r} \cdot v r^2 + v\rho \cdot \frac{\partial r^2}{\partial r} + \rho r^2 \frac{\partial v}{\partial r} = 0$$

$$v r^2 \frac{\partial \rho}{\partial r} + 2v\rho r + \rho r^2 \frac{\partial v}{\partial r} = 0$$

$$\frac{1}{\rho}\frac{\partial \rho}{\partial r} + \frac{2}{r} + \frac{1}{v}\frac{\partial v}{\partial r} = 0 \longrightarrow ④$$

②, $\rho v \frac{\partial v}{\partial r} = -\frac{GM_\odot \rho}{r^2} - \frac{\partial P}{\partial r}$; ③, $P = \rho C_s^2$

$$v\frac{\partial v}{\partial r} = -\frac{GM_\odot}{r^2} - \frac{1}{\rho} \cdot C_s^2 \cdot \frac{\partial \rho}{\partial r} \longrightarrow ⑤$$

look the note in the web page for the derevation

* Bernouli type equation for steady flow

ln( ) term are logarithmic variations

Kinetic Energy

gravitational potential

$$\frac{v^2}{2C_s^2} - \frac{1}{2}\ln(v^2) = \frac{GM_\odot}{C_s^2 r} + 2\ln(r) + \text{constant}$$; parker's solar wind equation

; v^2 can be + or − $\Rightarrow$ ∴ mass flow can be in or out
in : black hole
out : Solar wind.

graph (note) → only $\underset{\text{solution}}{v}$ ~~and~~ is related to solar wind

Critical point (Sonic point) : here radial velocity equal to Critical sound speed. here flow turn in to supersonic from subsonic and accelate away from the sun.

next week

Governing equations :

Continuity equation : $\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho v) = 0$ (mass conservation)

Momentum equation : $\frac{\partial (\rho v)}{\partial t} + \nabla (\rho . v^2) = - \nabla P + \rho g + F_{other}$
(Navier stock' law)

Energy equation : $\frac{\partial E}{\partial t} + \nabla \cdot ((E + P) v) = \underbrace{\Phi - L}_{\Delta Q}$
(first law of thermody.)

maxwell equations : $\nabla \cdot B = 0$; $\nabla \cdot E = \rho / \varepsilon_0$

$\frac{\partial B}{\partial t} = \nabla \times (v \times B) - \nabla \times (\eta \nabla \times B)$

$\nabla \times B = \mu_0 J + \mu_0 \varepsilon_0 \frac{\partial E}{\partial t}$

faraday's law : $\nabla \times E = - \frac{\partial B}{\partial t}$