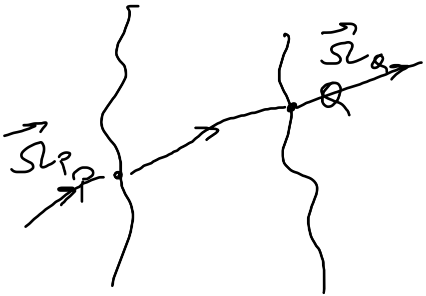

$\vec{\Omega}_P$: direction of radiation when it enters the plasma

$\vec{\Omega}_Q$: " " " exits the plasma

$\vec{\Omega}(\underline{r})$

$j(\omega, \underline{\Omega}, \underline{r}, T)$: coefficient of emission (power/volume at ω, at $\underline{\Omega}$ in $\underline{r}$)

$\alpha(\omega, \underline{\Omega}, \underline{r}, T)$: absorption coefficient

$\underline{I}$: intensity $\qquad d\underline{I} = j\,dl - \alpha \underline{I}\,dl \; ; \quad \frac{d\underline{I}}{dl} = j - \alpha \underline{I}$

$\tau = \int \alpha(l)\, dl$ optical thickness

$\tau \ll 1$ optically thin (e.g. laboratory plasmas)

$\tau \gg 1$ optically thick (astroph. plasmas)

$d\tau = \alpha(l)\, dl$

$$\frac{dI}{\alpha\, dl} = \frac{j}{\alpha} - I \Rightarrow \frac{dI}{d\tau} = \frac{j}{\alpha} - I \; ; \; \frac{dI}{d\tau} = S - I$$

Source function

at thermodin. eq.

$$S = B(\omega, T) = \frac{\hbar \omega^3}{4\pi^3 c^2} \frac{1}{e^{\hbar\omega/kT} - 1}$$

assume: T is constant (uniform plasma)

$$\frac{dI}{d\tau} = B - I + \frac{dB}{d\tau}$$

If $T = \text{const}$ $\quad \frac{dB}{dl} = 0$;

$$\frac{dB}{dl} = 0$$

$$\frac{dB}{dl} = \frac{dB}{d\tau}\frac{d\tau}{dl} = \alpha \frac{dB}{d\tau} \Rightarrow \frac{dB}{d\tau} = 0$$

$$\frac{d}{d\tau}(I - B) = -(I-B)$$

$$\int \frac{d(I-B)}{I-B} = -\int d\tau = \underbrace{-\int_0^{l_Q} \alpha(l)\,dl}_{\tau_Q}$$

$$\ln(I-B)\Big|_P^Q = -\tau_Q;$$

$$\frac{I(Q)-B}{I(P)-B} = \exp(-\tau_Q)$$

Hyp: $I(P) = 0$

(no impinging rad. in P)

$$I(Q) = B(1-e^{-\tau_Q})$$

$$I(\alpha) = B\left(1 - e^{-\tau_\alpha}\right)$$

$\tau_\alpha << 1$ $$I(\alpha) \approx B\left(1 - (1 - \tau_\alpha)\right) \approx B \cdot \tau_\alpha$$

$\tau_\alpha >> 1$ $$I(\alpha) \approx B$$