LECTURE - 4

> Deduction of wein's law from plank's law:-

From plank's radiation law is

$$E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5} \frac{d\lambda}{(e^{hc/\lambda KT}-1)} \quad \text{(I)}$$

[in Range λ and $\lambda + d\lambda$]

$$E_\nu d\nu = \frac{8\pi h \nu^3}{c^3} \cdot \frac{1}{(e^{h\nu/KT}-1)} d\nu \quad \text{(II)}$$

[in range ν and $\nu + d\nu$]

For small temperature, λT is small and for shorter wavelength $e^{hc/\lambda KT}$ becomes large compared to unity and plank's law reduces to

$$E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5} \frac{d\lambda}{e^{hc/\lambda KT}}$$

$$\boxed{E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5} e^{-hc/\lambda KT} d\lambda}$$

whis is wein's law of radiam for shorter wavelength.

> Deduction of Rayleigh-Jeans law from Plank's law

From plank's radiation law

$$E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5} \frac{d\lambda}{(e^{hc/\lambda KT}-1)}$$

For large temperature λT is large and also for longer wavelength $e^{hc/\lambda KT}$ can be approximated as $\left(1+\frac{hc}{\lambda KT}\right)$

i.e $$e^{hc/\lambda KT} = 1+\frac{hc}{\lambda KT}+\left(\frac{hc}{\lambda KT}\right)^2\frac{1}{2!}+\cdots = 1+\frac{hc}{\lambda KT}$$

Hence Planks law reduces to

$$E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5}\cdot\frac{d\lambda}{\left(1+\frac{hc}{\lambda KT}-1\right)}$$

$$= \frac{8\pi hc}{\lambda^5}\cdot\frac{\lambda KT}{hc}\cdot d\lambda$$

$$\boxed{E_\lambda d\lambda = \frac{8\pi KT}{\lambda^4}d\lambda}$$ This is the Rayleigh-Jeans law.