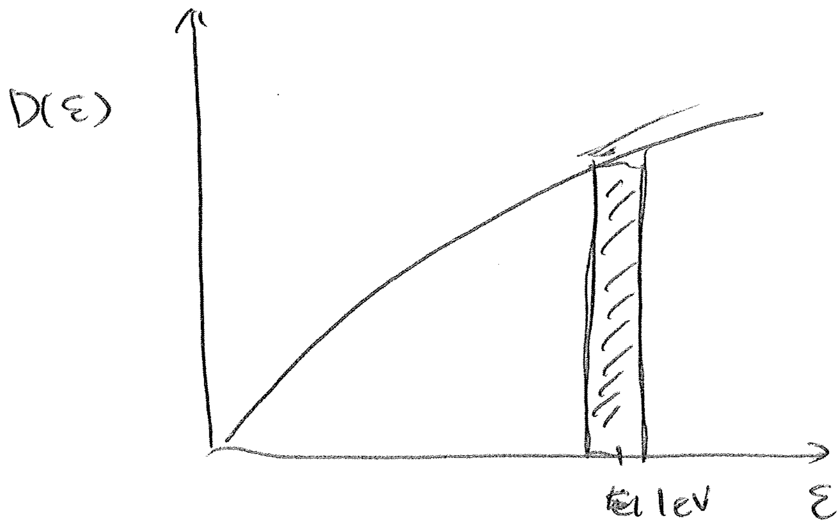



$$D(\varepsilon) = \frac{dN}{d\varepsilon} \quad ?$$

$$\frac{\Delta N}{\Delta \varepsilon} = D(\varepsilon)$$

$$\Delta N = \underbrace{D(\varepsilon)}\Delta\varepsilon$$

$$\underline{\#\text{of}_{\text{STATES}}} = \#\text{ OF STATES}/\text{eV} \cdot \overset{(\text{eV})}{\cancel{\text{eV}}}$$

# # OF MODES AVAILABLE

$$\frac{dN}{d\lambda} = - \frac{8\pi L^3}{\lambda^4}$$

DECREASES AT HIGHER WAVELENGTHS

EACH MODE CONTAIN $\frac{1}{2}kT + \frac{1}{2}kT$

$$\underline{U = \frac{\varepsilon_0 E^2}{2} + \frac{B^2}{2\mu_0}}$$

So $$\frac{dU(\lambda)}{d\lambda} = -\frac{8\pi L^3 kT}{\lambda^4}$$

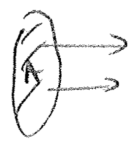
$$\cancel{\frac{dU(f)}{df} = \frac{dU}{df}\frac{df}{d\lambda} = \frac{dU}{df}\frac{d(c/\lambda)}{df}}$$

$$\frac{dU}{df} = \frac{dU}{d\lambda}\frac{d\lambda}{df} = \frac{dU}{d\lambda}\frac{d}{df}\left(c/f\right) = \frac{dU}{d\lambda}\left(-\frac{c}{f^2}\right)$$

$$= -\frac{8\pi L^3 kT}{\lambda^4}\left(-\frac{c}{f^2}\right)$$

$$\lambda = \frac{c}{f} \qquad = \cancel{kT}\ \underline{\frac{8\pi f^2}{c^3} kT}$$

THATS ENERGY.



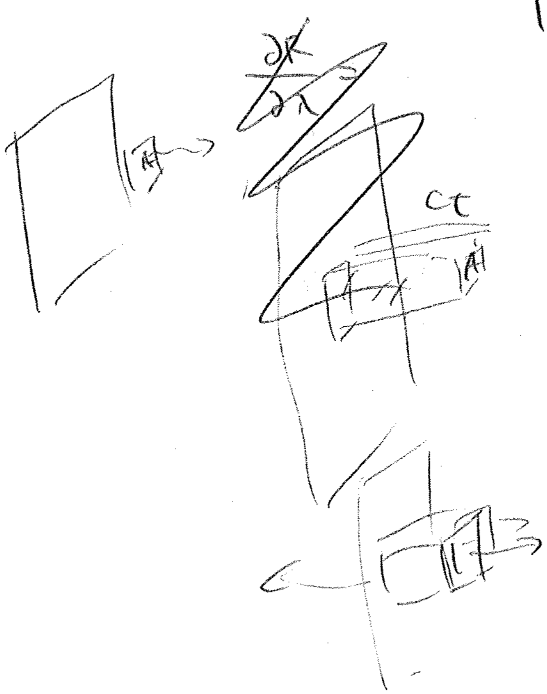

RADIATED POWER = ~~½ ... dU/dλ · ...~~

$$= \frac{1}{2} \text{ ENERGY DENSITY } \frac{\text{VOLUME}}{\text{TIME}}$$

$$= \frac{1}{2} \frac{8\pi kT}{\lambda^4} \frac{Ac\cancel{t}}{\cancel{t}}$$

RADIATED POWER ~ ENERGY

$$\sim \boxed{\frac{1}{\lambda^4}}$$



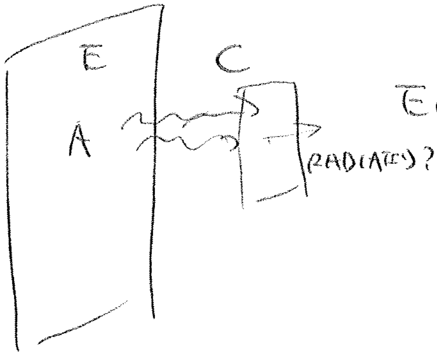

POWER ENERGY/TIME

$$\text{ENERGY DENSITY} \cdot \frac{\overset{c\cancel{t}}{\text{VOLUME}}}{\text{TIME}\cancel{t}}$$

$$\left(\frac{\partial R}{\partial \lambda}\right) A \cdot \Delta t = \frac{\partial E}{\partial \lambda}$$

$$2 \left(\frac{\partial R}{\partial \lambda}\right) A \cdot \frac{c\Delta t}{c} = \frac{\partial E}{\partial \lambda}$$

$$= \frac{E}{2}$$




ENERGY PER VOLUME PER WAVELENGTH $= \underbrace{\frac{8\pi kT}{\lambda^4}}$

POWER $= \frac{c}{4}$ ENERGY

$\frac{1}{2}$ DUE TO TWO SURFACES

$\frac{1}{2}$ DUE TO AVERAGING $\underline{\underline{\cos^2(\omega t)}}$

$c$ : $m/s$ ENERGY SPREAD OUT AWAY FROM

PLANCK DISTRIBUTION

$E_n = 0, hf, 2hf$

$$Z = 1 + e^{-\beta hf} + e^{-2\beta hf} + \cdots$$

$$= \frac{1}{1 - e^{-\beta hf}}$$

$$\bar{E} = -\frac{1}{Z}\frac{\partial Z}{\partial \beta} = \frac{hf}{e^{hf/kT} - 1}$$

IF BASIC UNIT OF ENERGY IS $hf$ FOR A GIVEN OSCILLATOR

$$\bar{n} = \frac{1}{e^{hf/kT} - 1}$$

# PLANCK DISTRIBUTION

$$\frac{1}{e^{hf/kT} - 1} = \bar{n}$$

$\cancel{\text{LIM}}$ $hf \gg kT$ $\quad \bar{n} = \underline{\underline{e^{-hf/kT}}}$ SUPPRESSED

GETS AROUND $\frac{1}{\lambda^4}$ PROBLEM

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$$n_{BE} = \frac{1}{e^{(\varepsilon-\mu)/kT} - 1} \qquad n_{planck} = \frac{1}{e^{hf/kT} - 1}$$

$\mu = 0$ FOR PHOTONS ?

~~MOST~~ PHOTONS CAN BE CREATED OR DESTROYED

ANY #

$$\frac{dN}{d\lambda} = -\frac{8\pi V}{\lambda^4}$$

$$\frac{1}{V}\frac{dN}{d\lambda} = -\frac{8\pi}{\lambda^4}$$

$$\lambda f = c$$

$$\lambda = \frac{c}{f}$$

$$\frac{d\lambda}{df} = -\frac{c}{f^2}$$

$$\frac{dN}{df} ? = \frac{dN}{d\lambda}\,\frac{d\lambda}{df}$$

$$\frac{1}{V}\frac{dN}{df} = -\frac{8\pi f^4}{c^4} \times -\frac{c}{f^2}$$

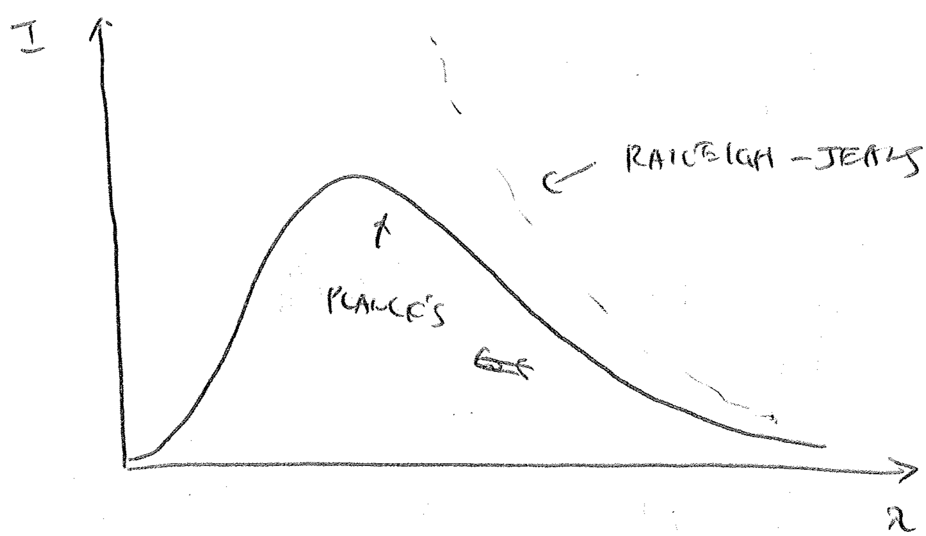
$$\frac{1}{V}\frac{dN}{df} = \frac{8\pi f^2}{c^3} = \text{\# OF MODES AT } f \text{ PER VOLUME}$$

---

ENERGY OF THIS MODE $= \dfrac{hf}{e^{hf/kT} - 1}$

$$\frac{U}{V} = \frac{8\pi h f^3}{c^3 \left(e^{hf/kT} - 1\right)}$$

$$\frac{U_{TOTAL}}{V} = \int_0^{\infty} \frac{8\pi h f^3}{e^{hf/kT} - 1}\, df$$

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| | ~~RAYL~~ MODES PER FREQUENCY | AVERAGE ENERGY PER MODE |
|---|---|---|
| RAIGHYEIGH - JEANS | $\frac{8\pi f^2}{c^3}$ | $kT$ |
| PLANCK | $\frac{8\pi f^2}{c^3}$ | $\frac{hf}{e^{hf/kT} - 1}$ |

$$-\ E = \frac{8\pi h}{c^3}\frac{\nu^3}{e^{h\nu/kT}-1}$$ ENERGY PER UNIT VOLUME PER UNIT FREQUENCY

$$f = \frac{c}{\lambda}$$

$$\frac{\partial U}{\partial f}\cdot\frac{\partial f}{\partial \lambda} = \frac{\partial U}{\partial \lambda} = \frac{8\pi hc}{\lambda^5}\frac{1}{e^{hc/\lambda kT}-1}$$

$$\text{RADIATED POWER}/\text{AREA} = \frac{\partial U}{\partial \lambda}\frac{c}{4}$$

$$\text{POWER}/\text{AREA} = \frac{2\pi hc^2}{\lambda^5}\frac{1}{e^{hc/\lambda kT}-1}$$

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$$\frac{P_{total}}{A} = \int_0^\infty \frac{2\pi hc^2}{\lambda^5}\frac{1}{e^{hc/\lambda kT}-1}$$

SUBSTITUTE $x = \frac{hc}{\lambda kT}$ $dx = -\frac{hc}{\lambda kT}d\lambda$

$$= \frac{2\pi (kT)^4}{h^3c^2}\underbrace{\int_0^\infty \frac{x^3}{e^x-1}dx}_{\frac{\pi^4}{15}}$$

$$\frac{P}{A} = \frac{2\pi^5 k^4}{15h^3c^2}T^4 = \sigma T^4$$