

Chapter 1

光的量子化

1.1 黑體輻射 Blackbody Radiation

In 1859 Gustav Kirchhoff

Definition 1.1. *BlackBody*

an object that absorbs all the electricmagnets radtion on it.

Law 1.2. *Kirchhoff's law of thermal radiation*

$$e_f = J(f, T)A_f \quad (1.1)$$

where.

- e_f is the power emitted per unit area per unit frequency
- $J(f, T)$ is a universal function that depends only f , the light frequency and T , the body temperature
- A_f is the absorption power (fraction of the incident power)

But why emitted power connect with absorption power?

$$e_{total,1} \cdot A_1 \cdot \Delta t = a_1 \cdot A_1 \Delta t \cdot I$$

$e_{total,1}$ is the power emitted per unit area,so LHS is the energy which emitted from backbody,and let RHS is the energy of absorption.

where a_1 is a material constant and I is Intensity.

RHS means Right hand side
and LHS means Left Hand
side

$$\begin{aligned} e_{total,1} &= a_1 I & e_{total,2} &= a_2 I \\ \frac{e_{total,1}}{a_1} &= \frac{e_{total,2}}{a_2} = I \text{ (a material independent constant)} \end{aligned}$$

According to Definition 1.1, A_f of Blackbody Radiation is 1 in Eq. 1.1. ($A_f = 1$ at blackbody)

1.1.1 Spectral Energy Density of a blackbody

The more convenient of Law. 1.2 to consider the apectral energy density, $u(f, T)$, the energy per unit volume per unit frequenct og the radiation.

Law 1.3. *Rayleigh-Jeans Law*

$$E = \frac{\int E \cdot e^{-E/k_B T} dE}{\int e^{-E/k_B T} dE} \quad (1.2)$$