BPT-401 Date-13/04/2021

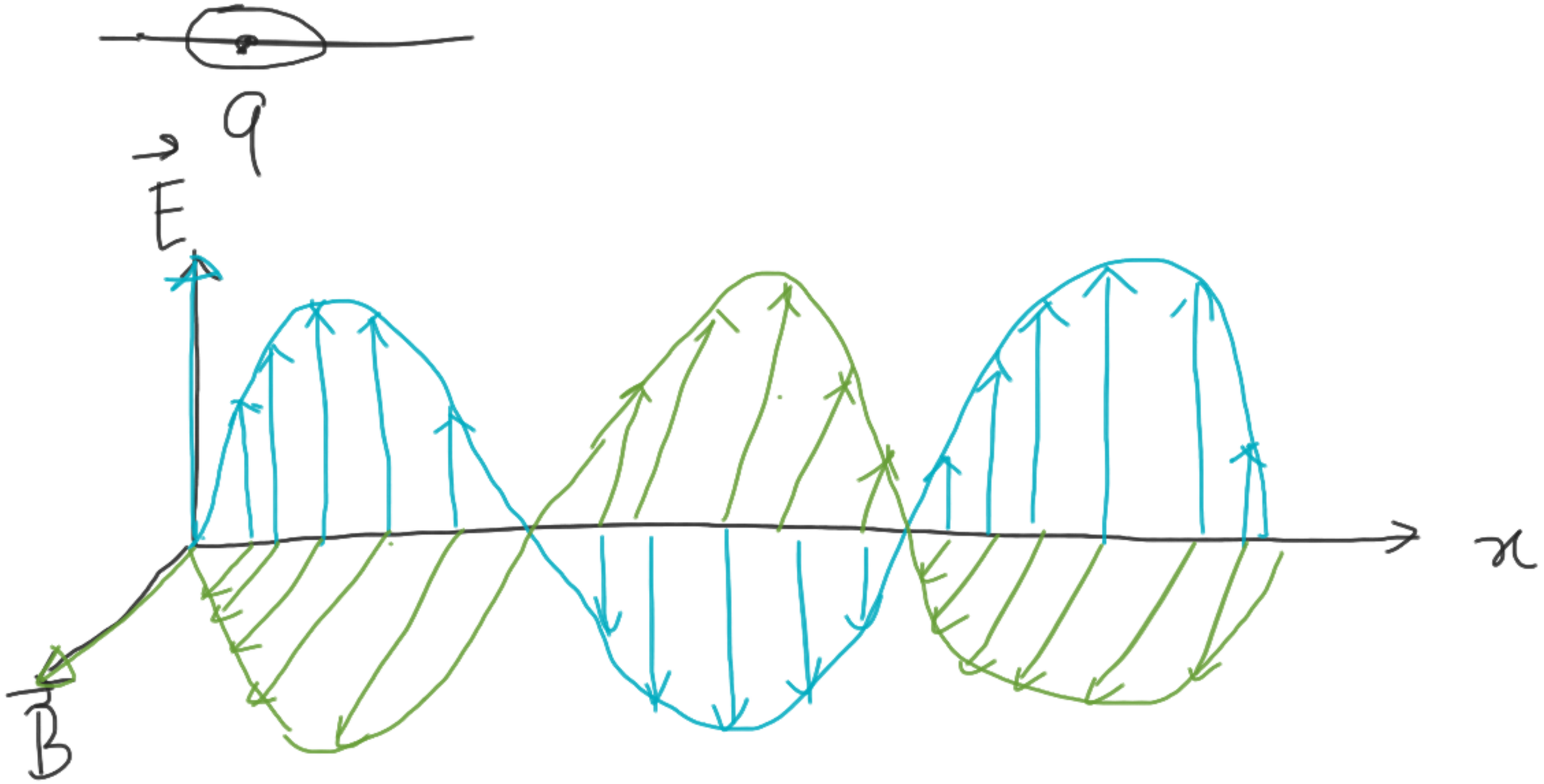
✓ Next class - Friday (16/04/2021) - 3-4.00 pm
Saturday (17/04/2021) - 9.00-10.00 am

Particles
Wave
} classical (mechanics) physics

What is the nature of light ?

In 1864, James clerk Maxwell
⇒ Electromagnetic wave.

Light is a em wave.



✓ $\vec{\nabla} \times \bar{E} = -\frac{\partial \bar{B}}{\partial t}$ Faraday's law ✓

Maxwell proposed,

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

em wave in free space

speed of em wave,

$$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} = 2.998 \times 10^8 \text{ m/s}$$

light is an em wave,

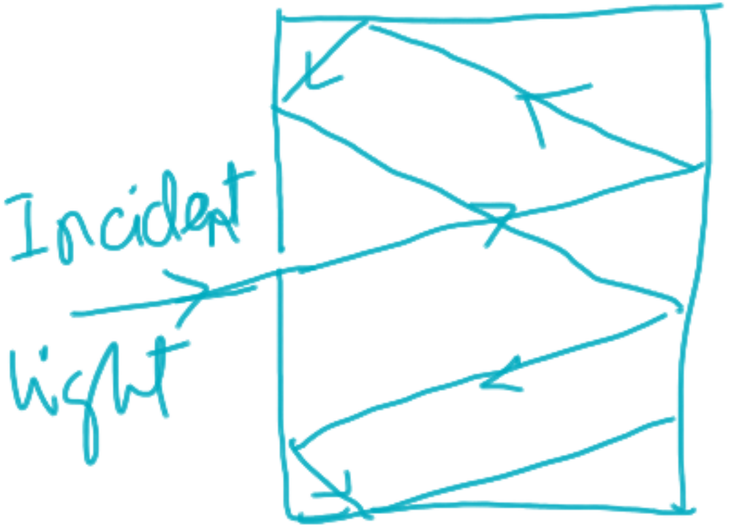
Frank Hertz proved with Expt that light is em wave.

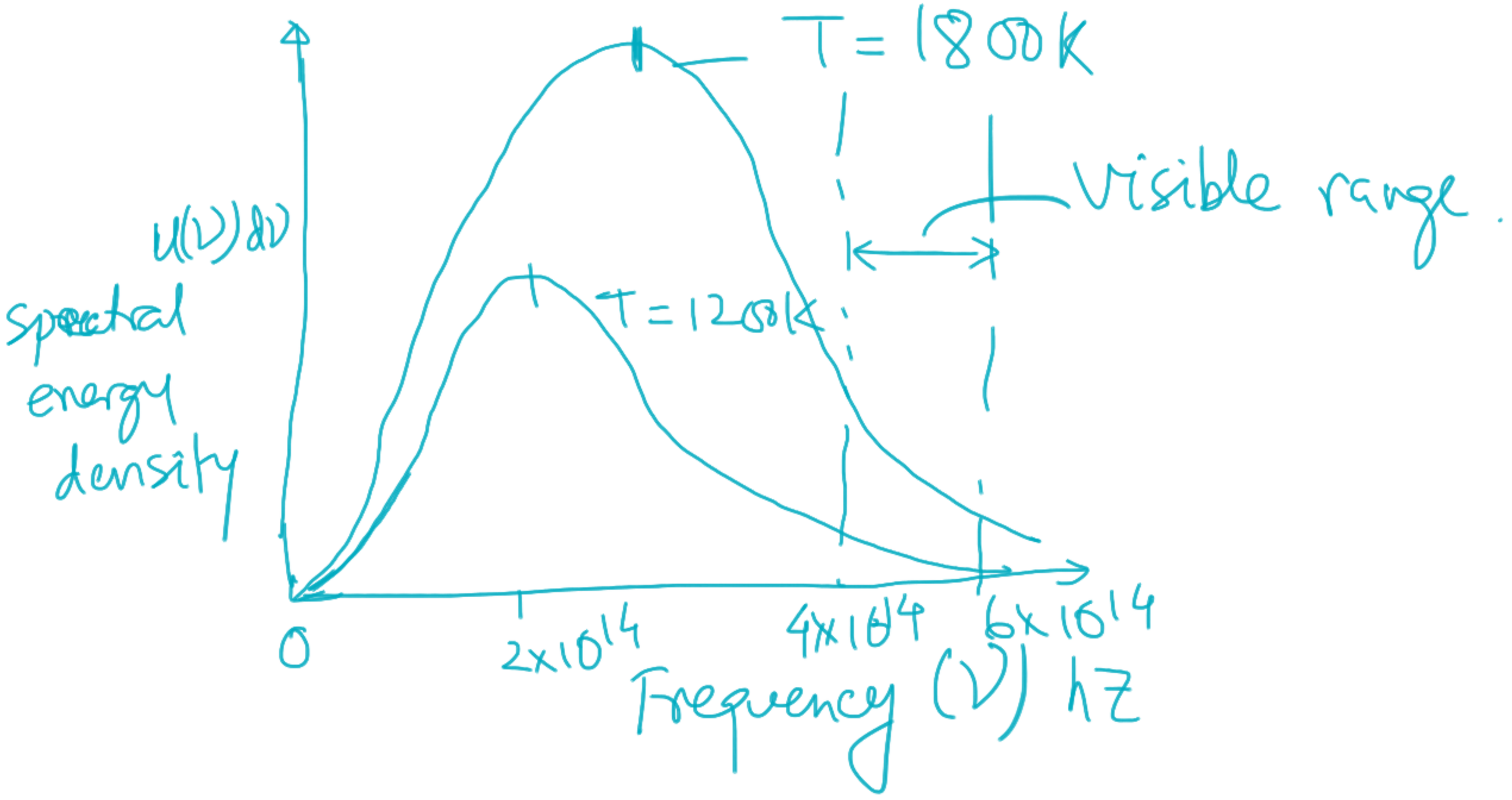
End of 19th century, u

Blackbody radiation ⇒

Question about the origin of radiation emitted by bodies of matter.)

heating ⇒ radiating




T = 1800 K
visible range.
u(ν) dν
spectral energy density
T = 1250 K
0
2x10^14
4x10^14
6x10^14
Frequency (ν) hz

The ultraviolet catastrophe :-

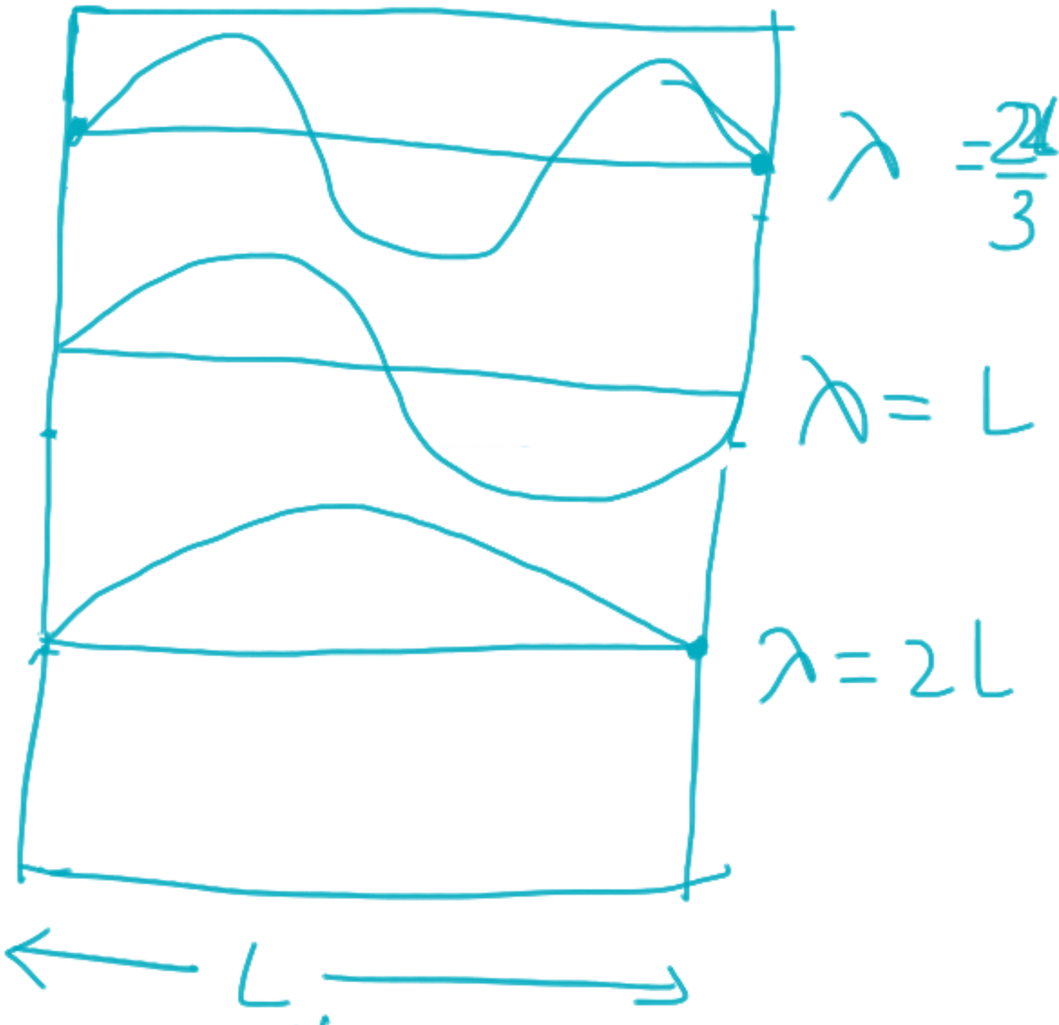
Light is an em wave

Lord Rayleigh, and James Jeans

T

!

The number of independent standing wave $G(\nu)\,d\nu$ within the range ν & $\nu + d\nu$ in the cavity



per unit volume

$$G(\nu)\,d\nu = \frac{8\pi\nu^2 d\nu}{c^3}$$ Density of states

ν & $\nu + d\nu$

average energy $\bar{\epsilon}$ $\Rightarrow$ classical mechanics

$\Downarrow$

Theorem of equipartition of energy

avg. energy per degree of freedom on an entity

$= \frac{1}{2} K_B T$

✓ $\frac{3}{2}k_BT$ for ideal gas molecule —

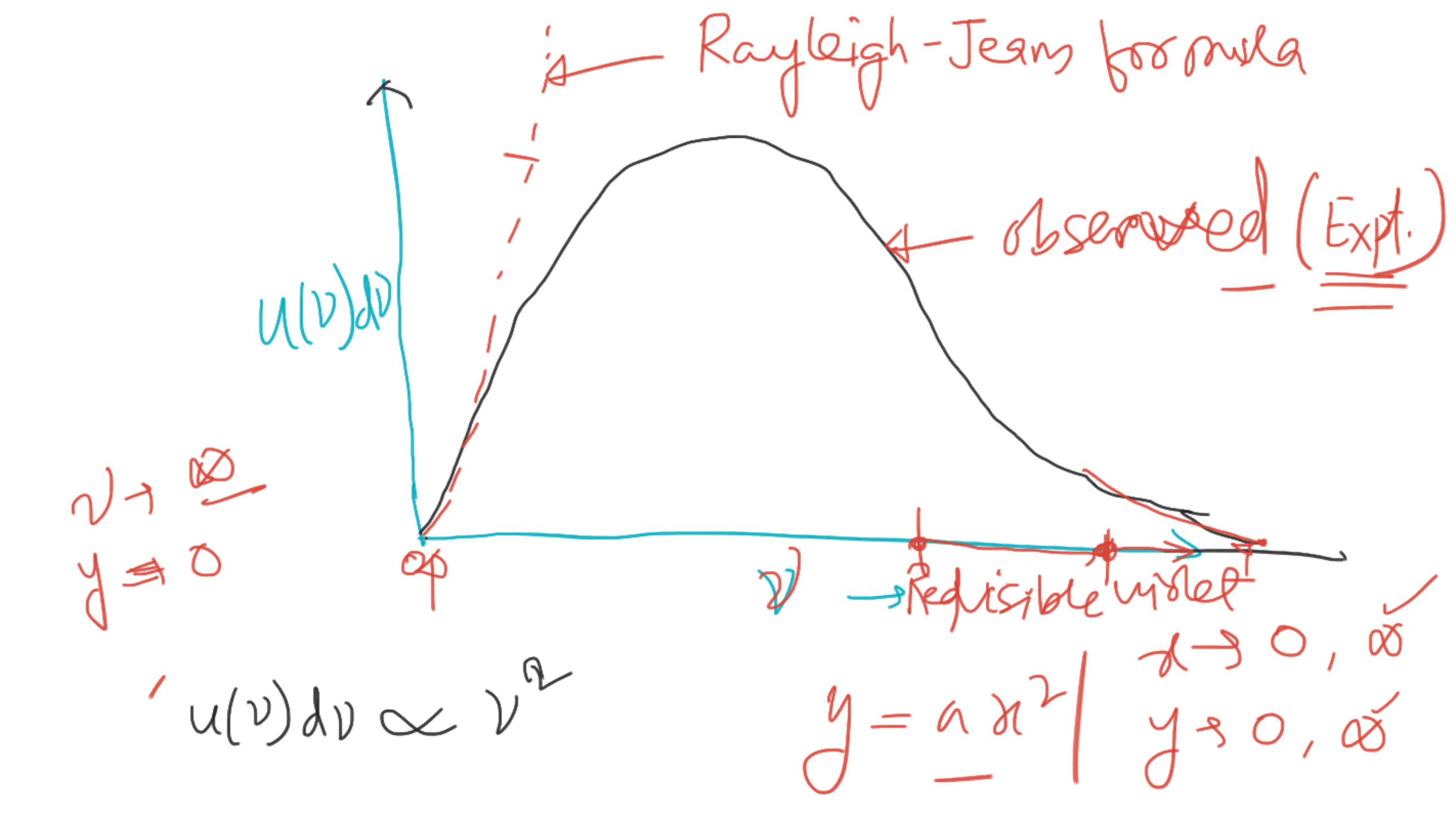
we considering Harmonic oscillator

2 deg of freedom [1 from K.E and 1 from P.E]

Avg. energy $\bar{\epsilon} = 2 \times \frac{1}{2} k_B T = k_B T$

$u(\nu)\,d\nu = \bar{\epsilon}\, G(\nu)\,d\nu = \left(\frac{8\pi k_B T}{c^3}\right) \nu^2\, d\nu$

Rayleigh–Jeans formula


Rayleigh-Jeans formula
observed (Expt.)
u(ν)dν
ν → ∞
y → 0
ν
Radiation violet
u(ν)dν ∝ ν²
x → 0, ∞
y = ax²
y → 0, ∞

Rayleigh-Jeans formula → based on classical physics