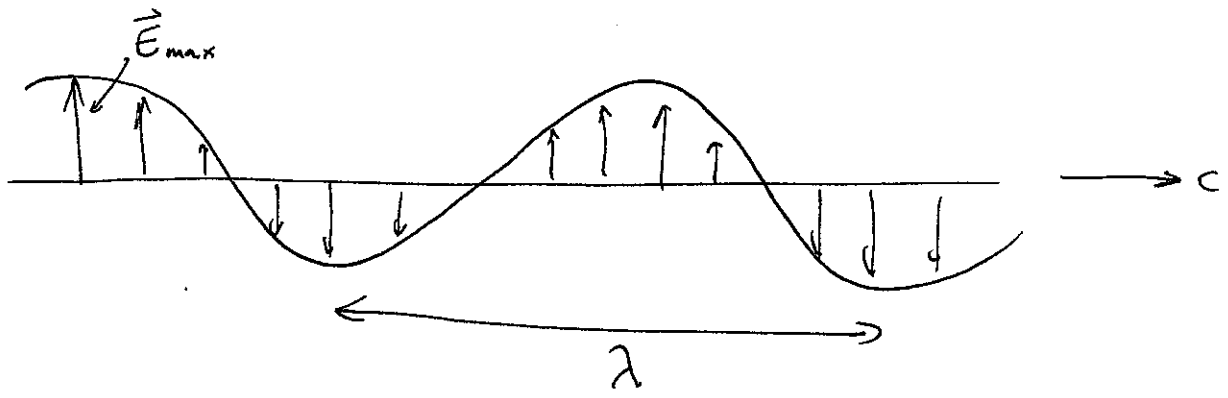
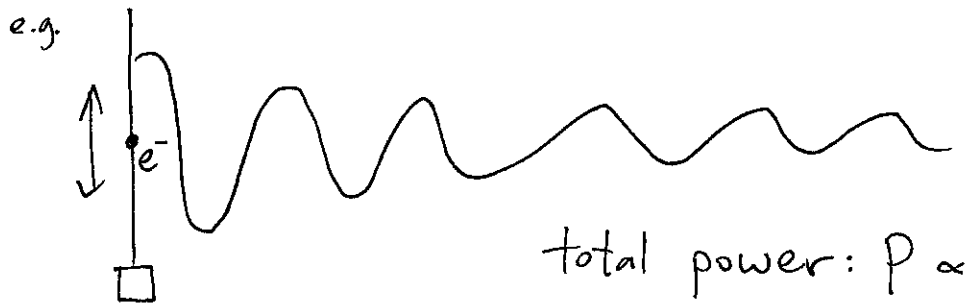
LAST TIME: classical EM radiation



energy density $e \propto |\vec{E}_0|^2$ (indep. of λ)

momentum density $p = \frac{e}{c}$

produced by accelerated charges



total power: $P \propto q^2 \cdot a^2$

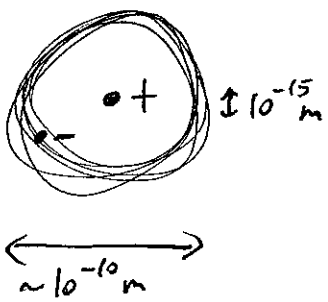
The microscopic description of matter

- All matter made of ATOMS
- Atoms have compact +ve charged nucleus surrounded by -ve charged electrons (Rutherford)

e.g. Hydrogen

electrostatic potential

$$V = -\frac{e^2}{r} \cdot \frac{1}{4\pi\varepsilon_0}$$



V like gravitational potential.

- suggests "planetary" model of atom.

BUT: orbiting electron accelerating

⇓

radiates light

⇓

loses energy

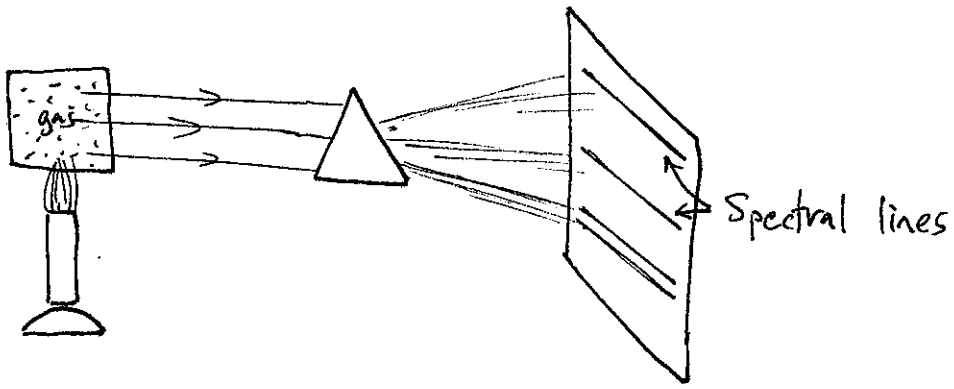
⇓

spirals into nucleus.

timescale $\ll 1$ s (HW)

"Classical" atoms unstable

Actual light from atoms



Hot atomic gases give light at discrete wavelengths

e.g. Hydrogen

$$\lambda = \lambda_0 \left(\frac{1}{n^2} - \frac{1}{m^2} \right)^{-1}$$

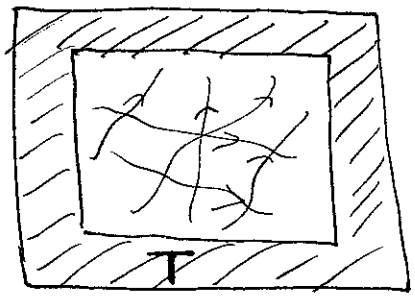
$n = 1, 2, \ldots$

$m > n$

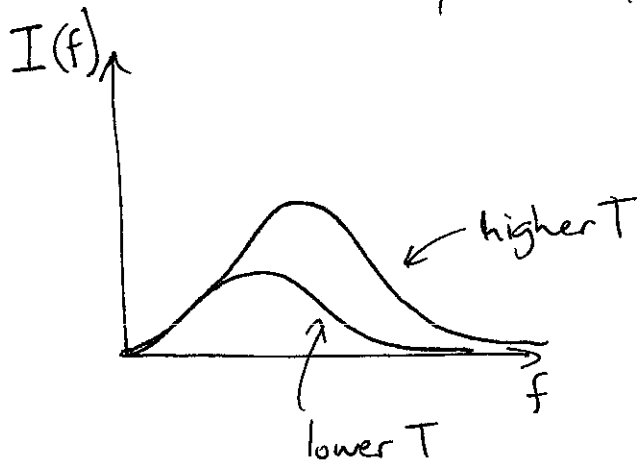
$\lambda_0 \approx 91$ nm

Nothing discrete in classical picture ∴ complete mystery

Similar mystery: "blackbody" spectrum of light from hot objects.



Kirchoff: radiation in cavity has intensity & frequency distribution that depends only on temperature



Planck: data fit by $$I(f) \propto \frac{hf^3}{\exp\left(\frac{hf}{kT}\right) - 1}$$

k : Boltzmann const. $= \frac{R}{N_A}$

h : "Planck's constant.

→ Only agrees with classical E&M & thermodynamics for $f \to 0$

→ Derived by assuming that light can only be absorbed by walls in discrete amounts $E = hf$

Einstein: proposed that light itself comes in discrete "lumps" with energy $E = hf$.