Physics 114 - April 18, 2006

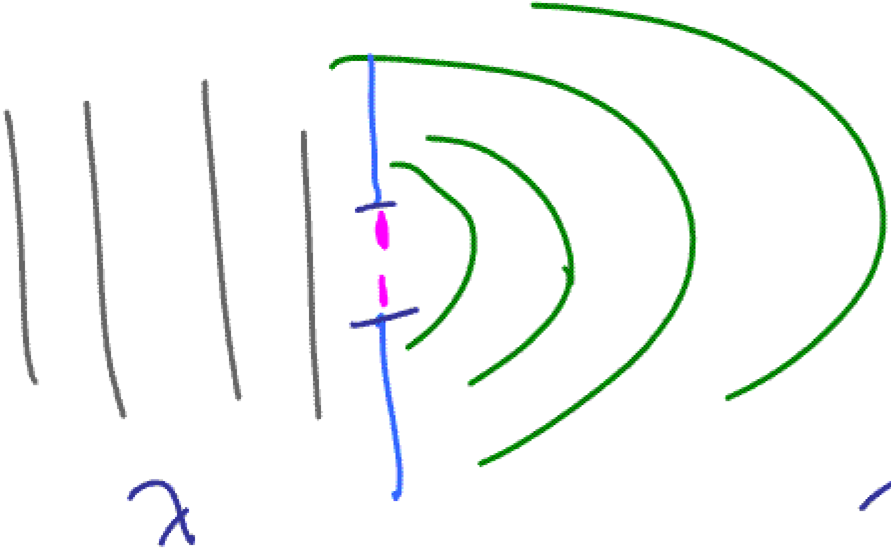
- physical optics Lect.
- Exam issues
- finish Geometric optics
- diffRACT. gratings

→ QM

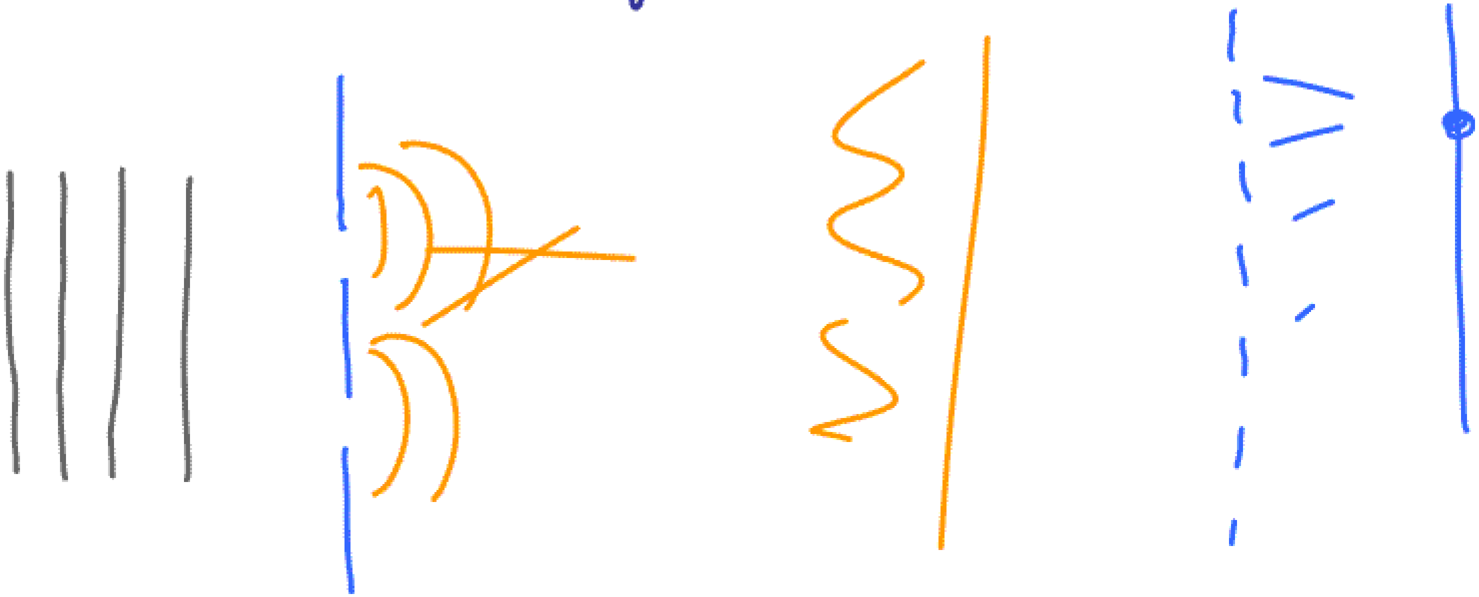
need to set time/place for Q + A session for Exam 3

Morey 525
4 - 5:30
on Monday

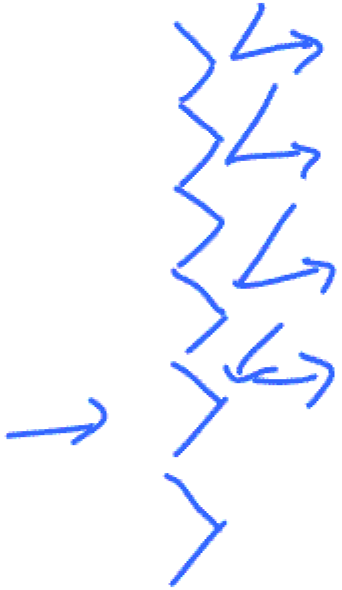
Diffraction



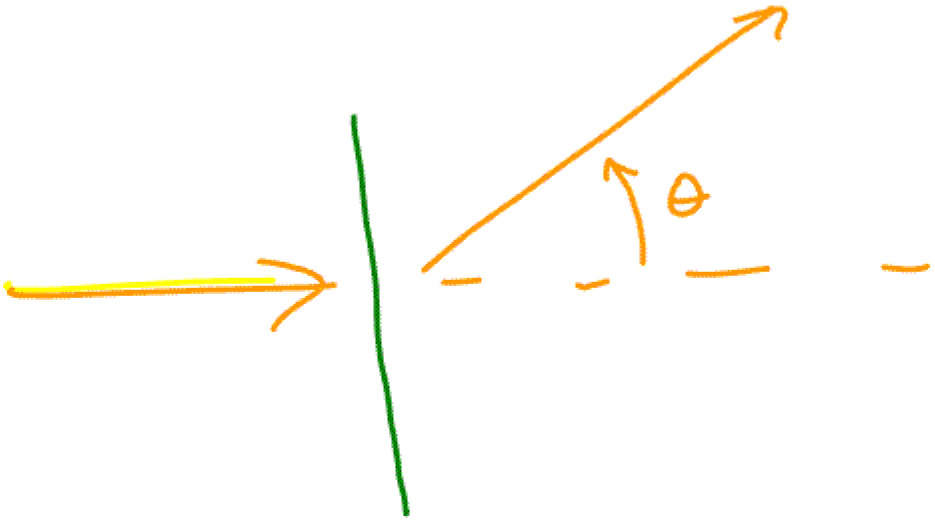
Diffraction limits resolution
of microscope/Telescopes



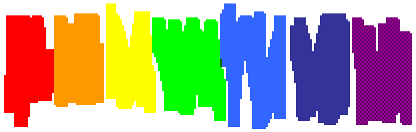
Diffraction grating



$$d \sin\theta = m\lambda$$

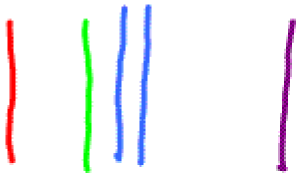


we looked thru diffraction gratings at white light source and Atomic Sources



see

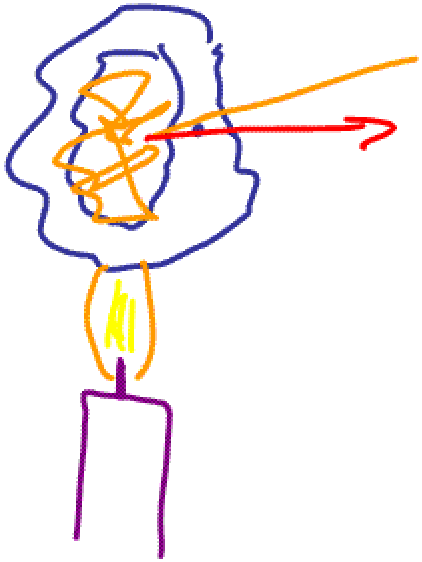
smooth color dist

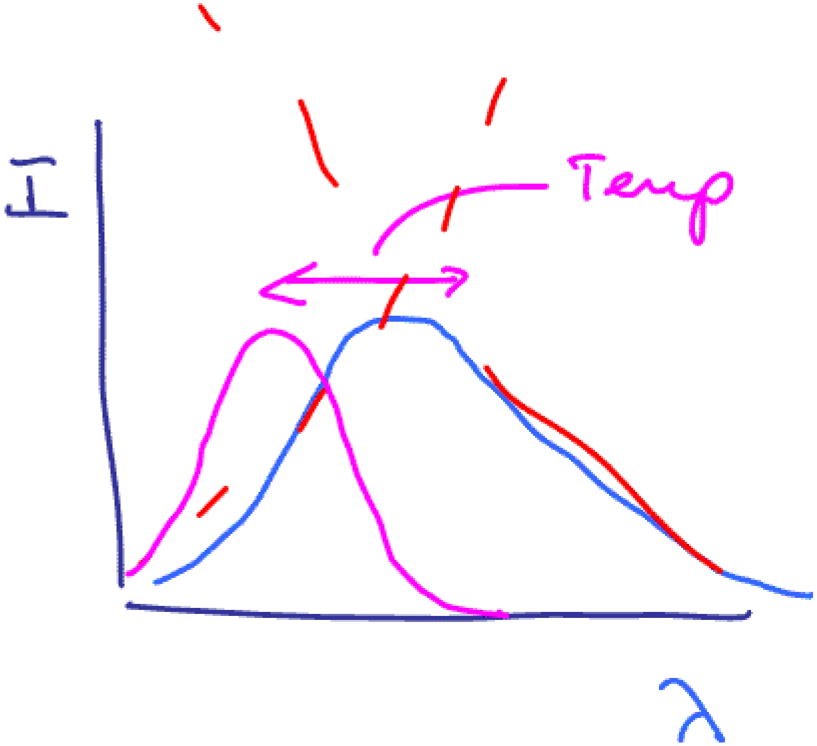


see discrete Spectral lines

Quantum Mechanics

Blackbody Radiation



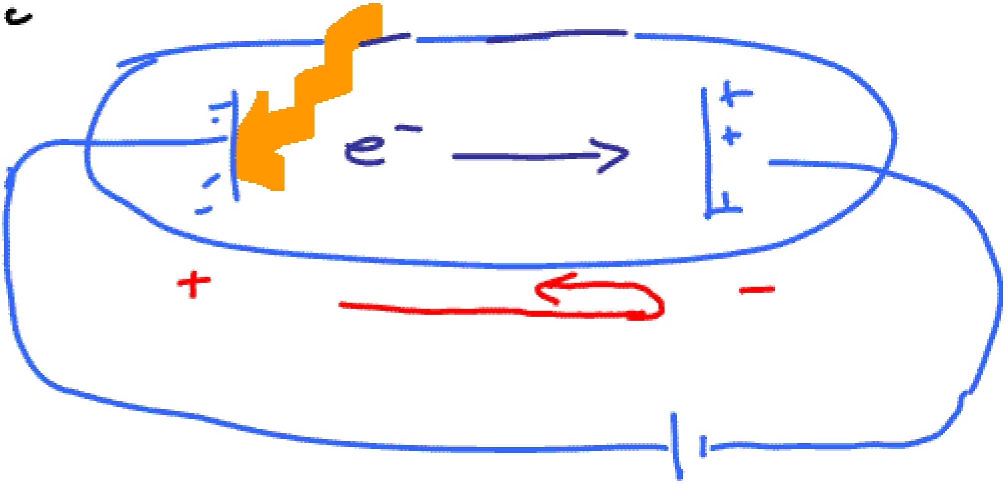


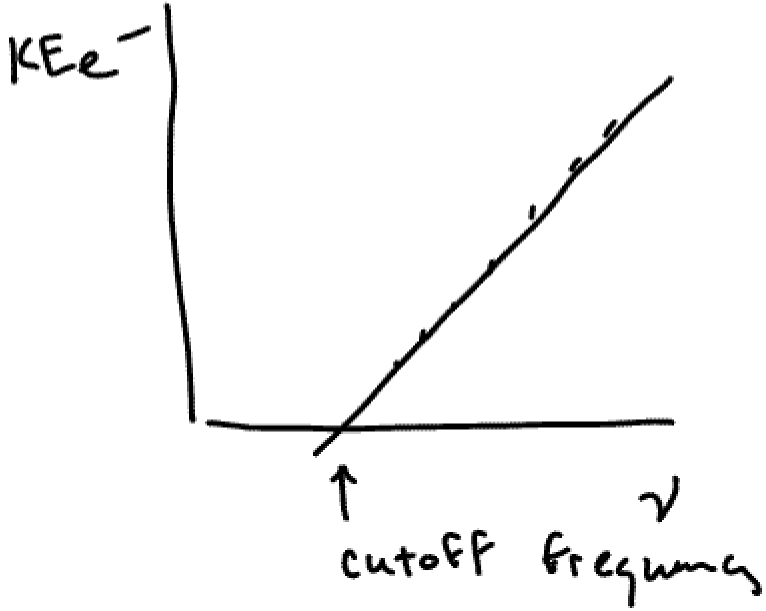
In 1900
Max Plank

$$R(\lambda) = I = \frac{c}{4}\left(\frac{8\pi}{\lambda^4}\right)\left[\frac{hc}{\lambda}\,\frac{1}{e^{hc/2kT} - 1}\right]$$

h = Plank's $\quad E = h\nu$

Photoelectric Effect





Einstein

1905

$$E \propto \nu \Rightarrow E = h\nu$$

$$E_{e^-} = h\nu - \underbrace{W}_{\text{work function}}$$

Light is A wAve	Light is a particle
interference	Blackbody
Diffraction	photoelectric effect
Maxwell's Eqns	Compton Scattering

chose NOT to discuss this

Louis DeBroglie – 1925

Consider Particle is a wAve

$$\boxed{\lambda = \frac{h}{p} \qquad \text{debroglie wavelength}}$$

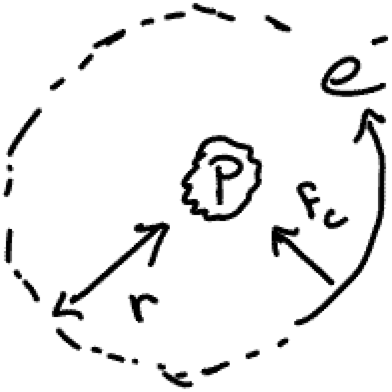
λ of 1000kg Auto 100 m/s $\Rightarrow \lambda = 6.6\times10^{-39}$ m

λ of e^- KE of 1eV $\rightsquigarrow \lambda =$ 1.2 nm

Important pre-quantum mechanics Model of Atom

Bohr Atom 1913 ↳ impt for giving us intuition about Atoms

Assume e^- orbits proton in a circular orbit



$$F_{cent} = \frac{m_e v^2}{r}$$

$\frac{kZe^2}{r^2}$ if single e^- Atom w/ Atomic # Z

Equation I ←

$$\underbrace{\frac{k|e|^2}{r^2}}_{\text{Coulomb attraction between p and } e^-} = \underbrace{\frac{m_e v^2}{r}}_{\text{Centripetal force}}$$

Since e^- is a wave

imagine e^- as a Circular STANDing wave

only works for certan λ that satisfy

$$2\pi r = n\lambda \qquad n = 1,2,3\ldots$$

↓ From DeBroglie

$$2\pi r = n\frac{h}{p}$$

This is where Things become discrete or quantized

$$\hbar = \frac{h}{2\pi} = \text{called h-bar}$$

So, $pr = n\hbar$

$mvr = n\hbar$ same as $L = n\hbar$ Angular Momentum

So can also say Bohr quantized Angular Momentum

Eqn 2

$$v = \frac{n\hbar}{mr}$$

Substitute into Equation 1 Above

$$\frac{k|e|^2}{r^2} = \frac{mv^2}{r} \longrightarrow \frac{k e^2}{r^2} = \frac{m n^2 \hbar^2}{r\, m^2 r^2}$$ Solve for r

$$r_n = \frac{n^2 \hbar^2}{k e^2 m} \qquad n = 1, 2, 3 \ldots$$

Says that electron only exists at discrete radii

If done for single e^- atom of atomic # Z in initial eqns

$$\frac{ke^2}{r^2} \longrightarrow \frac{k\,Ze\,e}{r^2}$$

$$\boxed{r_n = \frac{n^2 \hbar^2}{kZe^2 m}}$$

good for single e^- atom w/ At. # Z

r_1 = Ground state orbital radius

$$\boxed{r_n = \frac{n^2}{Z} r_1}$$