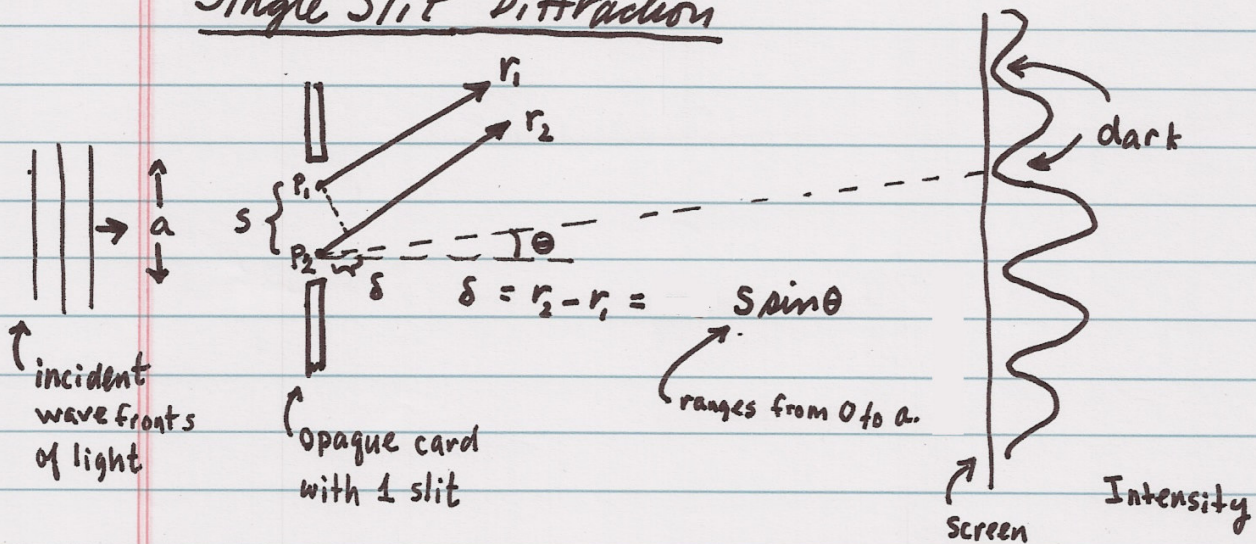# Diffraction

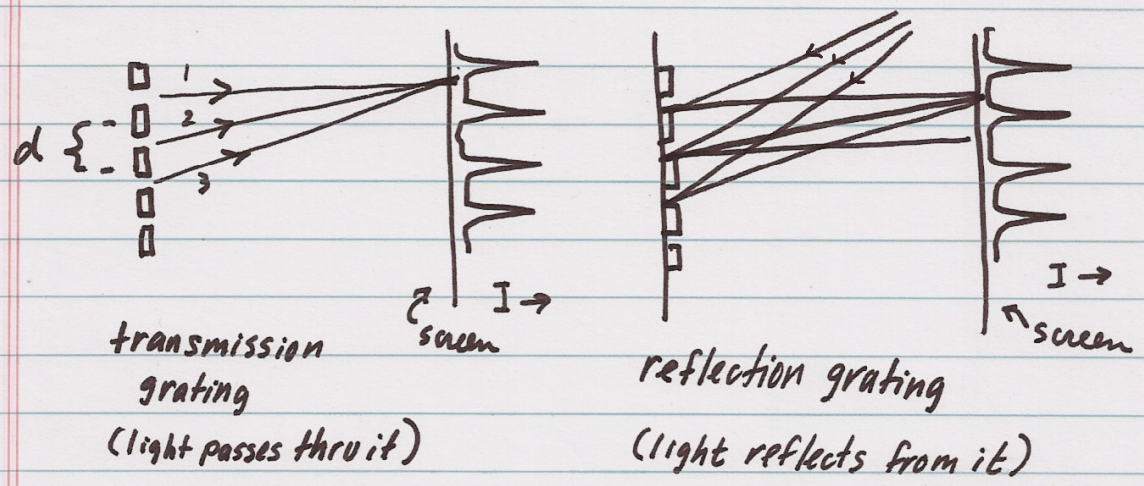Diffraction — the bending or spreading of light rays due to obstacles and small holes

## Single Slit Diffraction



$\delta = r_2 - r_1 = S \sin\theta$

ranges from 0 to a.

incident wave fronts of light

opaque card with 1 slit

Screen

Intensity

dark

- Any two points on wave front are each a light source (Huygen's Principle)

- Consider the interference between every possible pair of points between the edges of slit (use result of two slit interference)

- Result: Single slit also produces pattern of light & dark bands (fringes) on screen

$$\sin\theta_{Dark} = \frac{m\lambda}{a} \quad m = \pm 1, \pm 2, \pm 3$$
$$m \neq 0$$

# Diffraction Grating — Multiple slits



transmission grating
(light passes thru it)

reflection grating
(light reflects from it)
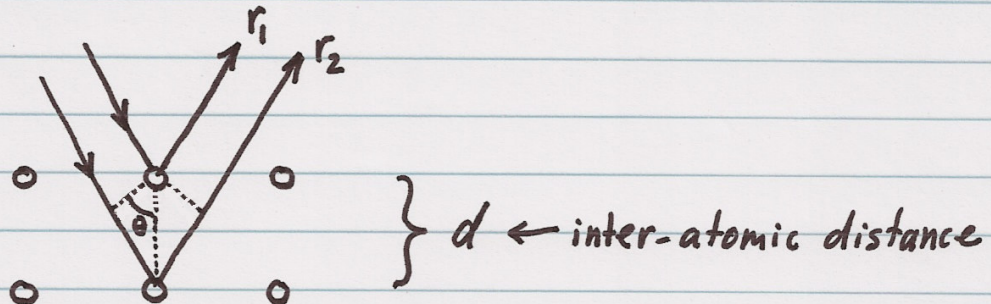
$$r_2 - r_1 = d\sin\theta = m\lambda \qquad \text{C.I.}$$

$$\sin\theta_{Bright} = \frac{m\lambda}{d}$$

C.I. and D.I. from many sources at regular separations sharpens the interference (more C.I. & more D.I.)



double slit
interference
pattern

diffraction grating
interference
pattern

## Diffraction by Crystals



$r_1$   $r_2$

$\}$ $d$ ← inter-atomic distance

$$r_2 - r_1 = \boxed{2d\sin\theta = m\lambda} \quad \text{C.I.}$$

$$m = 1, 2, 3$$

Bragg's Law

Know $\lambda$, measure $\theta \Rightarrow$ get $d$

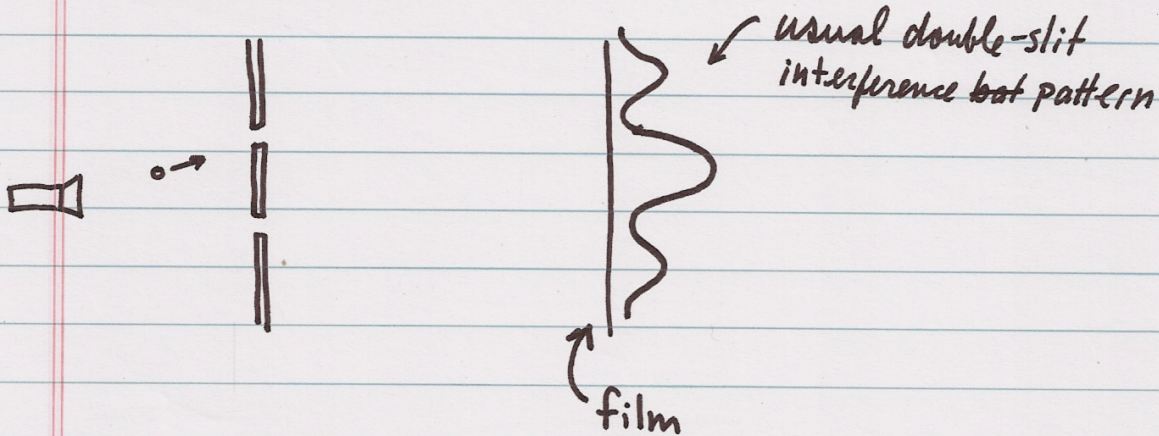$\lambda$ is X-ray frequency (penetrates matter)

## Holography

Principle — all of the visual information about
an object is contained in the interference pattern
at any surface surrounding the object

Hologram — captures the interference pattern,
then send light through it. Result is realistic
(3D) appearance of object (in its absence)

# Intro to Quantum Theory

### Double slit experiment



usual double-slit
interference bat pattern

film

- Send particles of light through the slit one at a time

- Still get the same interference pattern

- What is each particle interfering with ?!
  (Remember, they go through one at a time)

## Quantum Mechanics

- Physics needed to correctly describe very small systems such as atoms

- Classical physics gives wrong answers for atoms (e.g. electrons do not spiral in toward nucleus)