Lecture 42 iq37

1. Derivation of the Snell's law
   - Propagation of wave front in region 1 and in region 2.
   - The transition region
   - There are emission of wavelets along the wave front AB'

     The tangent to all wavelets defines the new wave front BB'
2. Young's double slit experiment.
   - Superposition of two coherent waves, with same frequency and same amplitude
   - Conditions on the maxima in the path difference Delta r, and in the phase difference \phi=k Delta r.
   - The intensity distribution in the double slit experiment.
3. Intensity distribution on a circular screen.
4. Textbook 25.P.22. Double slit experiment with polarized sources.

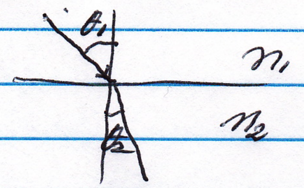
Class announcement:

- The updated course summary of unit 4 has been posted with the date 4/21/13.
- Mark your calendar: Review on unit4, 5-6 pm on Wed (May1). Location CPE 2.212.
- Extra office hour: Thursday 2:30 to 3:30.
- From Lisa **The Fall 2013 LA Application (aka Undergraduate TA) is available on the table across from my office, RLM 5.216. Please let all interested students know. The deadline is extended until May 3, 2013.**

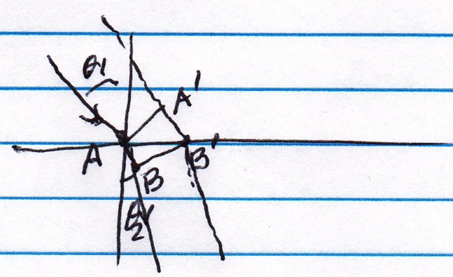
  *Lisa's contact information: Undergraduate Coordinator, Department of Physics
  Ph: 512-471-8856 Fax: 512-471-9637
  email address: ugaffairs@physics.utexas.edu

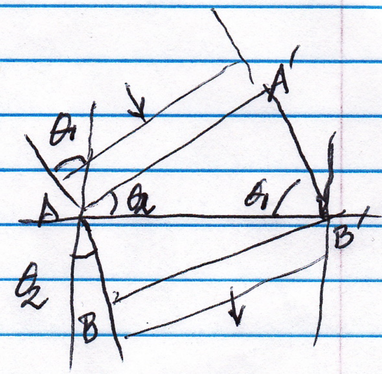
1. Derivation of the snell's law.

Ray diagram



Finite beam width:



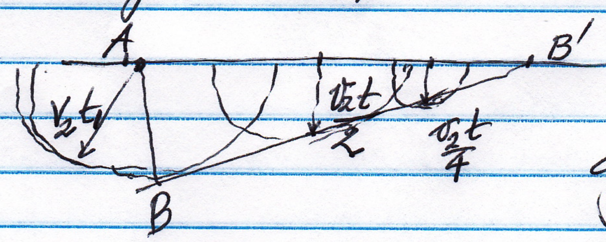


Transition region: Matching band description
(from $t=0 \to t_1$)

- Near end $A \to B$, $\overline{AB} = v_2 t_1$
- Far end $A' \to B'$, $A'B' = v_1 t_1$
- Wave front from AA' to BB'
  Direction of propagation from $\vec{AA'}$ to $\vec{BB'}$

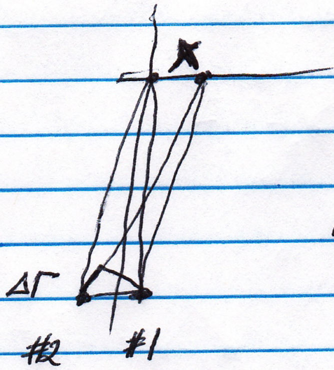
Alignment within the wave front –

- Along AB', each point emits a new wavelet.



Tangent to all wavelets defines the new wavefront BB'

Interference phenomena:



Running waves:

$E_1 = E_0 \cos\theta, \quad \theta = \omega t - kx$

$E_2 = E_0 \cos(\omega t - k(r+\Delta r))$

$= E_0 \cos(\omega t - kr - k\Delta r) \equiv E_0 \cos(\theta - \phi)$

where $\phi = k\Delta r$

Use the math identity: $\cos\alpha + \cos\beta = 2\cos\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2}$

$E = E_1 + E_2 = E_0\left(\cos\theta + \cos(\theta-\phi)\right)$

$= 2E_0 \cos\left(\theta - \frac{\phi}{2}\right)\cos\frac{\phi}{2}.$ (1)

Intensity: $I = \bar{u}c = 2\bar{u}_E c = \epsilon_0 \overline{E^2} c$ (2)

Using (1): $\overline{E^2} = \overline{\left[2E_0 \cos\left(\theta - \frac{\phi}{2}\right)\cos\frac{\phi}{2}\right]^2}$

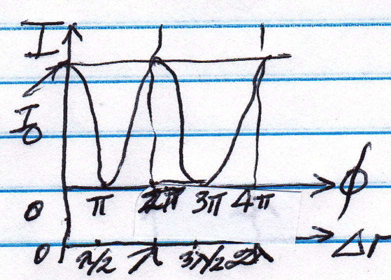
$= E_0^2 \cos^2\frac{\phi}{2}$ (3), where $\overline{\cos^2\left(\theta - \frac{\phi}{2}\right)} = \frac{1}{2}$ are used.

Substituting (3) into (2) leads

$I = (\epsilon_0 c E_0^2)\cos^2\frac{\phi}{2} \equiv I_0 \cos^2\frac{\phi}{2}$ (4)

I vs ϕ

& I vs Δr

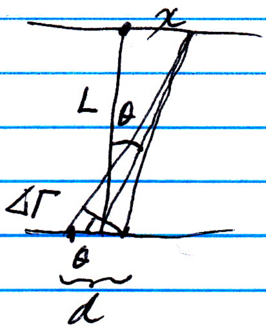


Exercise: Find Δr and ϕ for the 3rd min. Also find Δx

3rd min: $\Delta r = \frac{\lambda}{2}$ first, $\frac{3\lambda}{2}$ second, $\frac{5\lambda}{2}$ third

In terms of $\phi = k\Delta r$, third min is: $\phi = \frac{2\pi}{\lambda} \cdot \frac{5\lambda}{2} = 5\pi$

Use small angle approx.

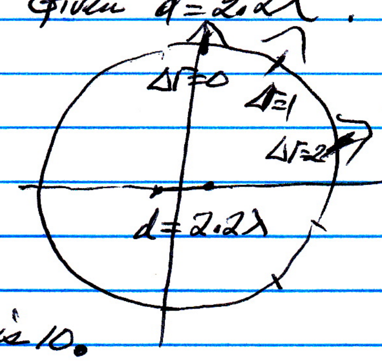


$$\theta \approx \frac{x}{L} \approx \frac{\Delta r}{d}$$

$$x = \frac{L\Delta r}{d} = \frac{L}{d}\left(\frac{5\lambda}{2}\right)$$

Exercise 2: Circular screen — Given $d = 2.2\lambda$. Consider 1st quadrant, max occurs when $\Delta r = 0$, $\Delta r = \lambda$, $\Delta r = 2\lambda$

Find: Total # of maxima.

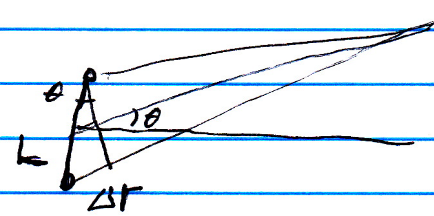


By inspection: # of max is 10.

Ex 3: Text 25P.22

(a) Detected polarized em wave has the polarization in z direction

(b)



$\Delta r \approx \theta L$

1st maximum is at $\Delta r = \lambda$

1st min is at $\Delta r = \frac{\lambda}{2}$.