Supplement to HW # 8

Conceptual Questions

(5) higher energy e's correspond to lower wavelength. According to Bragg formula $\cos\theta_m = m\lambda/d$ will correspondingly be smaller for a given d and hence θ_m will be larger for each m in diffraction plate and hence better resolved.

(8) $E_0 = h/8mL^2 \propto 1/mL^2$. As because we are increasing the mass 4 times and decreasing the length by a factor of half they compensate and ground state energy remains the same.

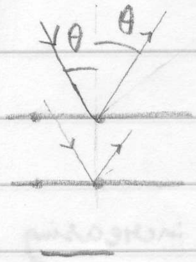
Exercises and Problems

(7) Angle for the m^{th} order line is given by

'path difference' $= 2\, d \cos \theta_m = m\lambda$ (Bragg condn). As we go to

higher and higher orders cosine of θ also increases (i.e.

value of θ goes on decreasing). However you can't



decrease is beyond zero (see left) whence you can't

make the path difference more than $2d$. Hence

the path difference lies between $0\ (\theta = 90^\circ)$ to $2d\ (\theta = 0^\circ)$.

For intermediate angle the path difference is in between

these two values. But you get the lines when

path difference is an integer multiple of λ i.e. $\lambda, 2\lambda, \ldots$

Clearly we can go upto $\leq 2d/\lambda$ order [and of course

the order has to be an integer]. So it's highest integer $\leq 2d/\lambda$.

(25) (Aside remark) From prob. 7 you can really see the highest order observable $\leq 2d/\lambda = 2d/(hc/E) \cong 3.17$ i.e. $m_{MAX} = 3$.

(29) (Aside remark) $\lambda_e = h/p_e = h/m_e v \cong 3.6 \times 10^{-10}\ m$. $d = 1.5\ mm >> \lambda_e$.

Hence we can apply the small angle appx. for fringe width

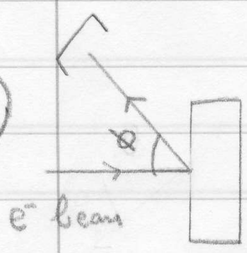
i.e. $\Delta y = \lambda L / d$.

$\lambda \propto 1/m \rightarrow \lambda_n / \lambda_e = m_e/m_n$ or, $\lambda_n = m_e/m_n \cdot \lambda_e < \lambda_e$ ($m_e < m_n$). Hence,

no problem with the earlier assumption even in here.

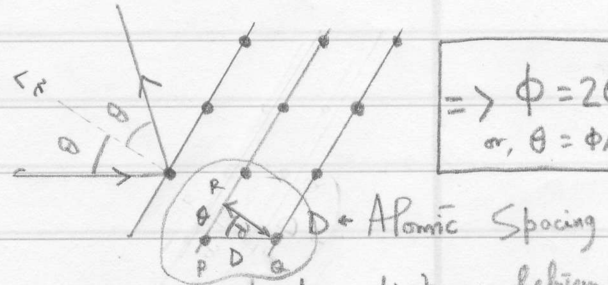
Clarification (b). We want same width of fringes as of the electron.

(32) (Aside)



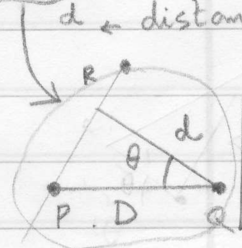
Sample

inside →



$\boxed{\Rightarrow \phi = 2\theta \text{ or, } \theta = \phi/2}$

Geometry of the set up of Davison Germer expt.



$\boxed{\Rightarrow d = D\cos\theta = D\cos\phi/2}$

Bragg condn: $2d \sin\theta_m = m\lambda$

or, (in terms of ϕ, D) : $2D\cos\frac{\phi_m}{2} \cdot \sin\frac{\phi_m}{2} = m\lambda$

or, $\boxed{D \sin\phi_m = m\lambda}$

So Davison Germer expt. is nothing but Bragg diffaction with different variables. Here $\phi = 60°$ (Scatt. angle)