Homework for Chapter 8

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1. 某X光机的高压为10万伏，问发射光子的最大能量多大？算出发射X光的最短波长。

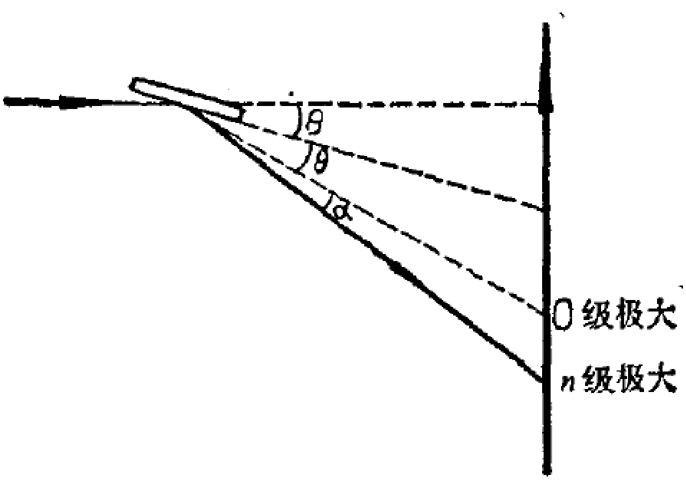
$$E = 10 \times 10^5 \mathrm{eV} \qquad \lambda = \frac{E}{h} = 0.124\text{Å}$$

2. 利用普通光学反射光栅可以测定X光波长．当掠射角为θ而出现n级极大之出射光线偏离入射光线为$2\theta+\alpha$(见习题图 8.1)，α为偏离0级极大出射线的角度．试证：出现n级极大的条件是

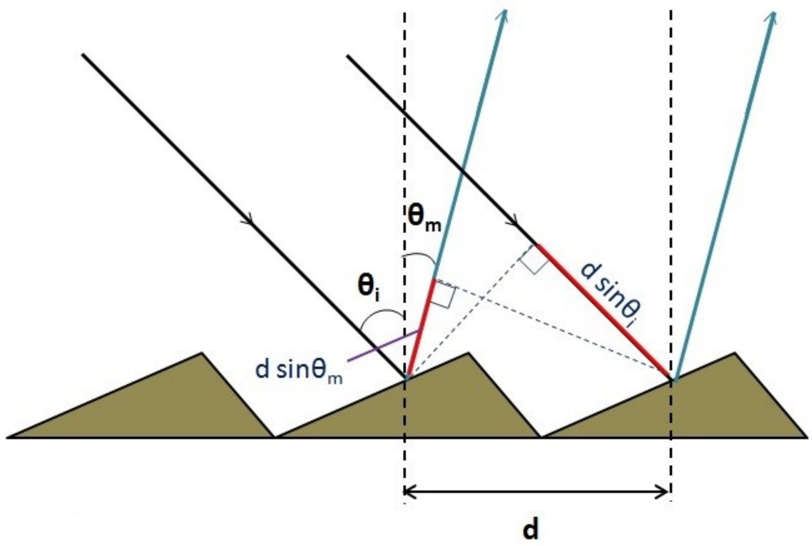
$$2d\sin\frac{2\theta+\alpha}{2}\sin\frac{\alpha}{2}=n\lambda,$$

d为光栅常数(即两刻纹中心之间的距离)．当θ和α都很小时公式简化为

$$d\left(\theta\alpha+\frac{\alpha^2}{2}\right)=n\lambda.$$



习题图 8.1



$$n\lambda = d\left[\sin\left(\frac{\pi}{2}-\theta\right)-\sin\left(\frac{\pi}{2}-\theta-\alpha\right)\right] = 2d\sin\frac{2\theta+\alpha}{2}\sin\frac{\alpha}{2}$$

In the case of $\theta \approx 0$ and $\alpha \approx 0$

$$n\lambda = 2d\cdot\frac{2\theta+\alpha}{2}\cdot\frac{\alpha}{2} = d\left(\theta\alpha+\frac{\alpha^2}{2}\right)$$

4. 已知 Cu 的 K_α 线波长是 1.542 Å，以此 X 射线与 NaCl 晶体自然面成 15°50′ 角入射而得第一级极大．试求 NaCl 晶体常数 d.

$$d = \frac{\lambda}{2d\sin\theta} = 2.825\text{Å}$$

7. 为什么在X光吸收光谱中 K 系带的边缘是简单的，L系带是三重的，M系带是五重的？

In an X-rays tube an electron emitted from the cathode strikes the target with a tremendous velocity so that it penetrates well inside the atom of the target. If it ejects an electron from the K-shell of the atom, a vacancy is created in the K-shell. Immidiately an electron from one of the outer shells, say L-shell jumps to the K-shell, emitting an X-ray photon of energy equal to the energy difference between the two shells. And the maximum of energy an X-ray photon may have is equal to the energy of the ejected electron.

When $n = 1$, the electron may has only one energy states: $^2S_{1/2}$. And $n = 2$ has three energy states: $^2S_{1/2}$, $^2P_{1/2}$, $^2P_{3/2}$. $n = 3$ has five energy states: $^2S_{1/2}$, $^2P_{1/2}$, $^2D_{3/2}$, $^2D_{5/2}$.