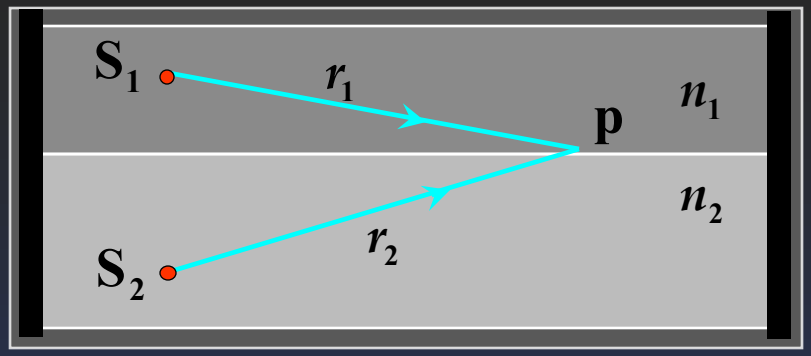
光学总结

一、干涉

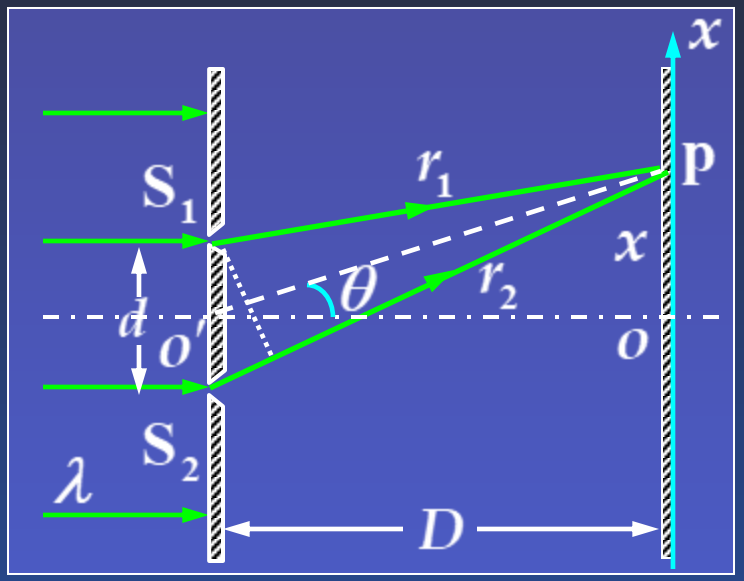
光程：　$L = nr$

光程差　$\delta = n_2 r_2 - n_1 r_1$



1. 杨氏双缝干涉

波长λ，缝距d，屏距D



偏角θ与光程差的关系：

$$\delta = d\sin\theta = \begin{cases} \pm 2k\dfrac{\lambda}{2} & \text{明纹} \\ \pm(2k+1)\dfrac{\lambda}{2} & \text{暗纹} \end{cases}$$

$$\tan\theta = \frac{x}{D}$$

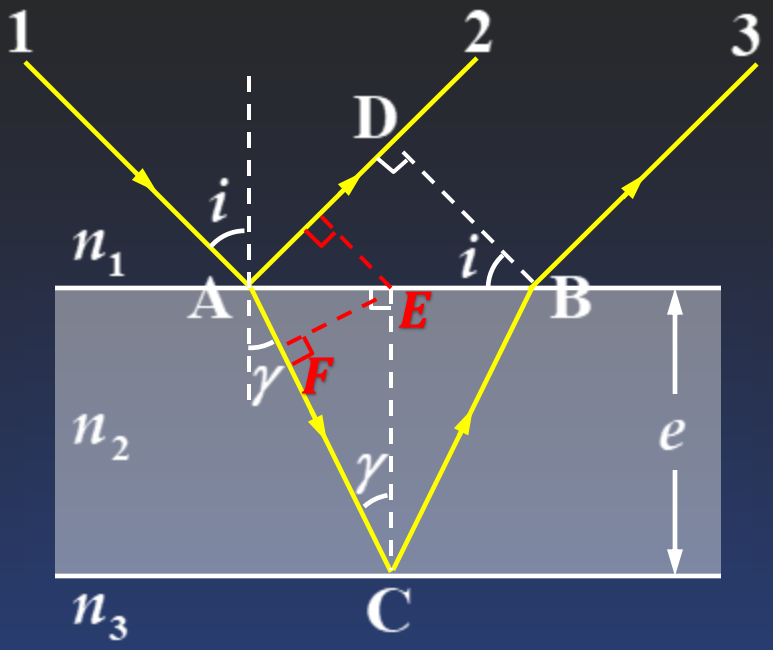
当$\theta < 5°$时，$\sin\theta \sim \theta \sim \tan\theta$　　$\delta = d\dfrac{x}{D} = \begin{cases} \pm 2k\dfrac{\lambda}{2} & \text{明纹} \\ \pm(2k+1)\dfrac{\lambda}{2} & \text{暗纹} \end{cases}$

2. 薄膜干涉

☆ 2、3两束光线的光程差：

$$\delta = 2n_2 e\cos\gamma + \frac{\lambda^*}{2}$$

$$\delta = 2e\sqrt{n_2^2 - n_1^2\cdot\sin^2 i} + \frac{\lambda}{2}$$



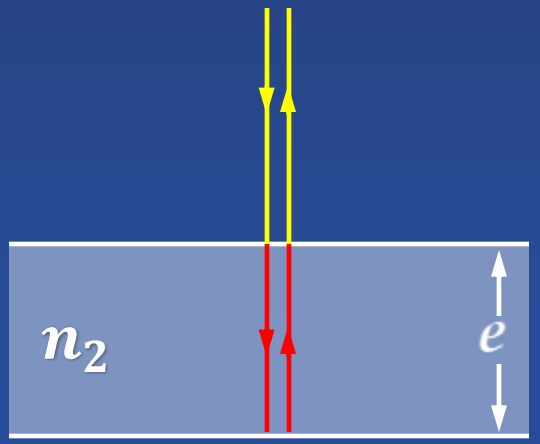
☆ 增透、增反问题

增透膜：使反射光干涉相消！

增反膜：使反射光干涉相长！

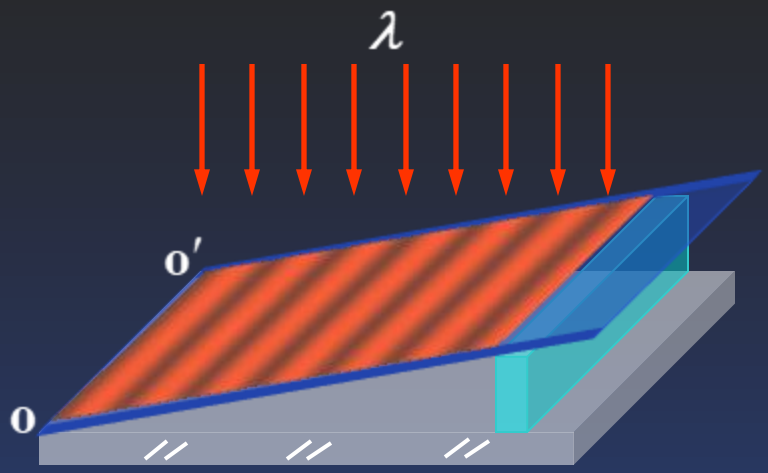
3. 等厚干涉

$$\delta = 2n_2 e + \frac{\lambda^*}{2} = \begin{cases} \pm 2k\dfrac{\lambda}{2} & \text{明} \\ \pm(2k+1)\dfrac{\lambda}{2} & \text{暗} \end{cases}$$



4. 劈尖

$$\delta = 2ne + \frac{\lambda^*}{2} = \begin{cases} \pm 2k\dfrac{\lambda}{2} & \text{明} \\ \pm (2k+1)\dfrac{\lambda}{2} & \text{暗} \end{cases}$$

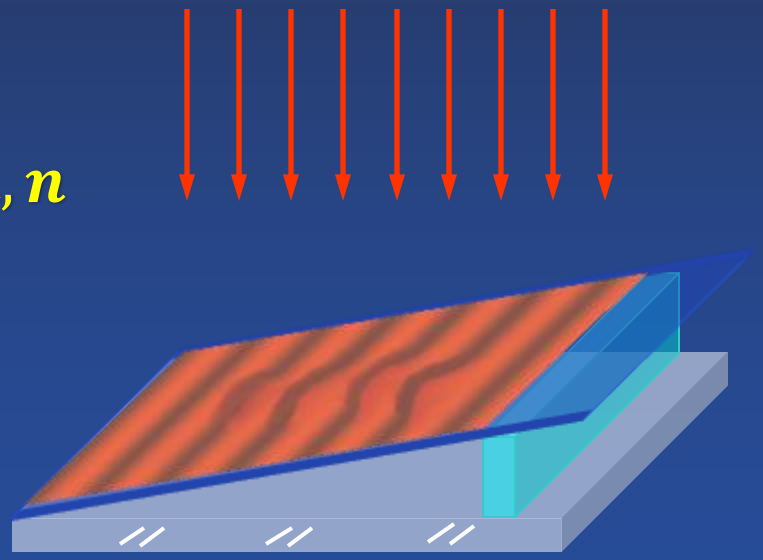


关键：空气厚度e与距离x的关系

$$\theta = \frac{e}{x}$$

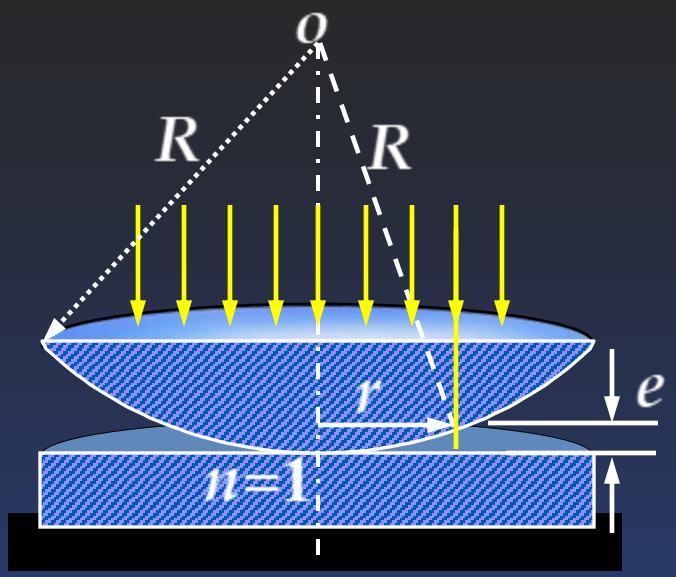
☆ 工件凹凸与移动问题

☆ 劈尖中物理量的计算：$x, \theta, e, k, \lambda, n$



5. 牛顿环

$$\delta = 2ne + \frac{\lambda^*}{2} = \begin{cases} \pm 2k\dfrac{\lambda}{2} & \text{明} \\ \pm (2k+1)\dfrac{\lambda}{2} & \text{暗} \end{cases}$$



关键：空气厚度e与条纹半径r的关系

$$r^2 = 2Re$$

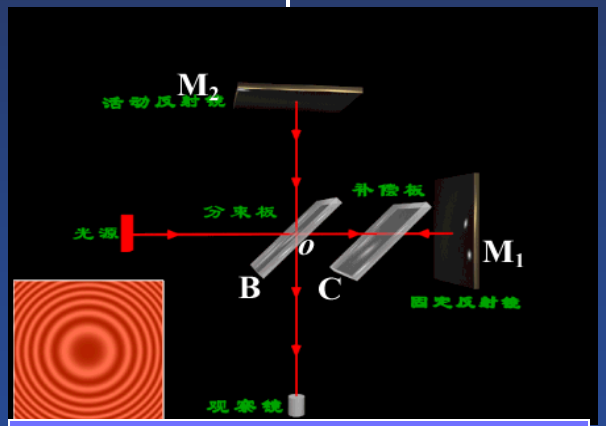
☆ 条纹移动问题

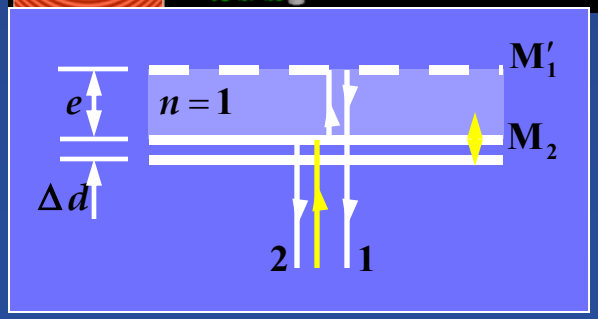
☆ 劈尖中物理量的计算：r, R, e, k, λ, n

6. 等倾干涉与迈克尔逊干涉仪

☆ 条纹移动问题

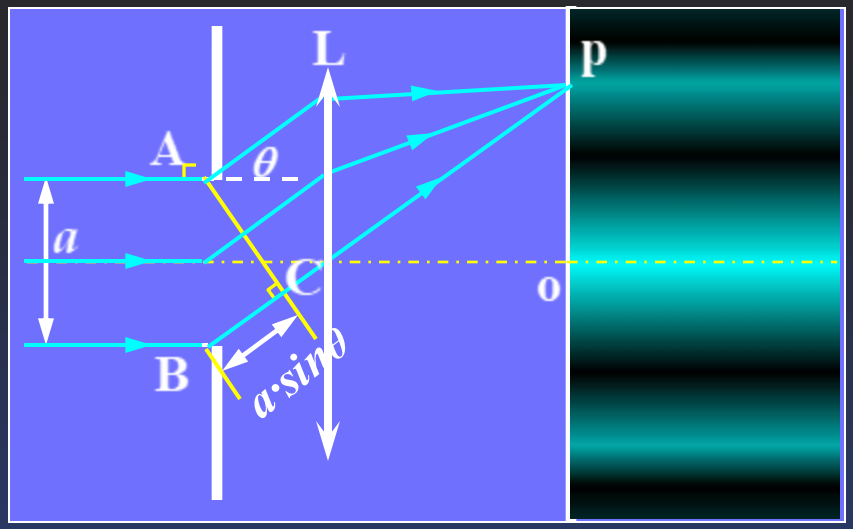
☆ 中央条纹的光程差最大，级次最高





二、衍射

1. 夫琅禾费单缝衍射



- 屏的中央是一条明纹:宽、亮。
- 衍射θ处的最大光程差:

  $a\ sin\theta$ 进行半波带分割。

$$\theta \neq 0^{\circ}:\ a\cdot sin\theta = \begin{cases} \pm 2k\dfrac{\lambda}{2} & \text{暗纹} \\ \pm(2k+1)\dfrac{\lambda}{2} & \text{明纹} \end{cases} \quad (k = 1, 2, 3, \ldots)$$

$$\tan\theta = \frac{x}{f}$$

☆ 衍射相关物理量的计算：$a, k, \lambda, \theta, x, f$

2. 圆孔衍射

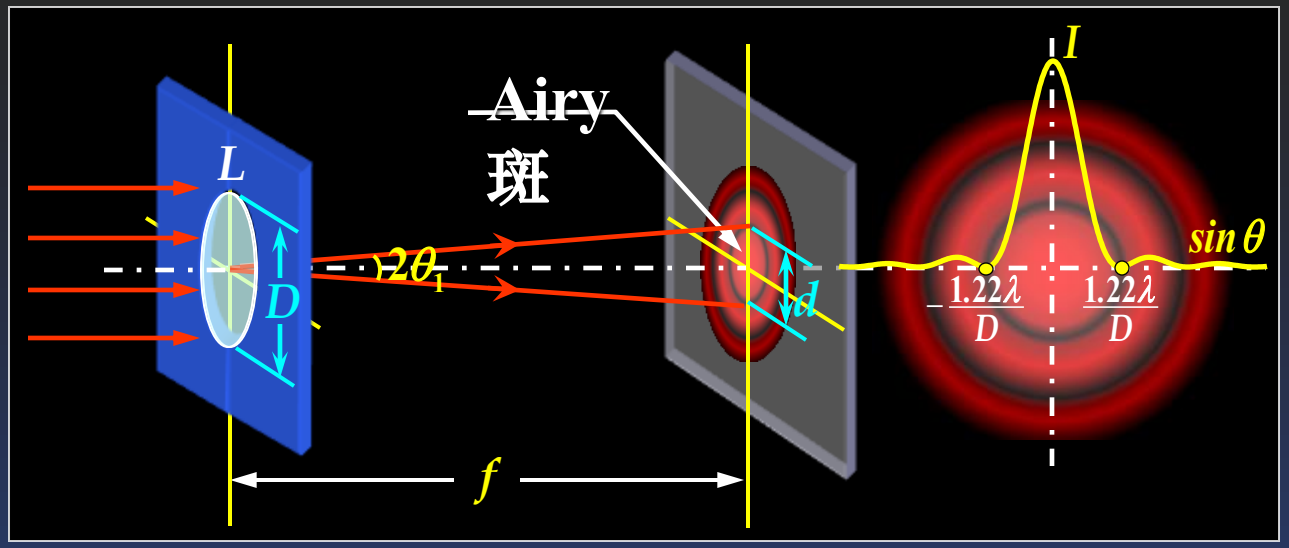
- 半角宽度：

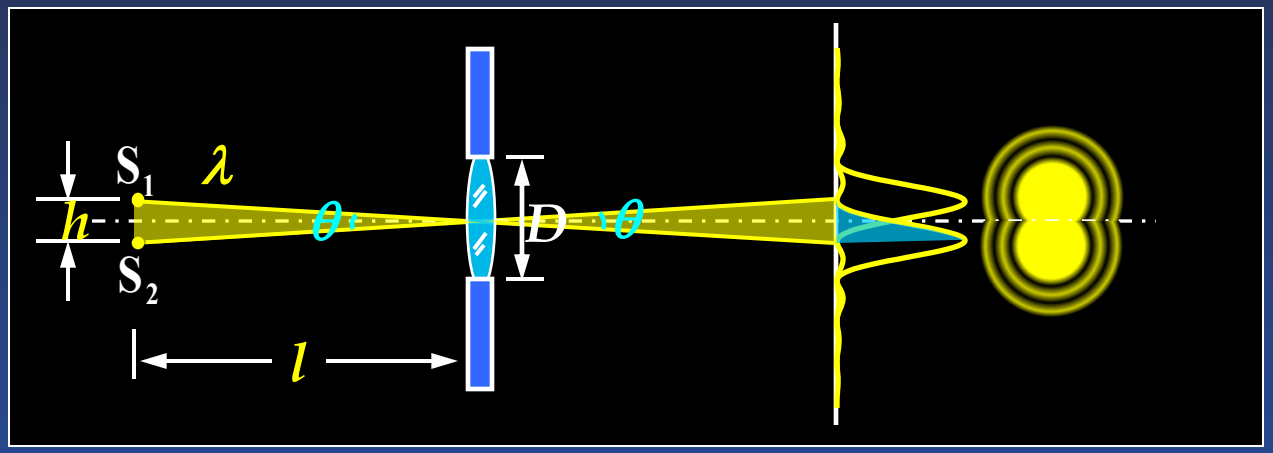
$$\theta_1 = \frac{1.22\lambda}{D}$$

- 最小分辨角：

$$\theta_c = \frac{1.22\lambda}{D}$$

可分辨：$\theta \geq \theta_c$

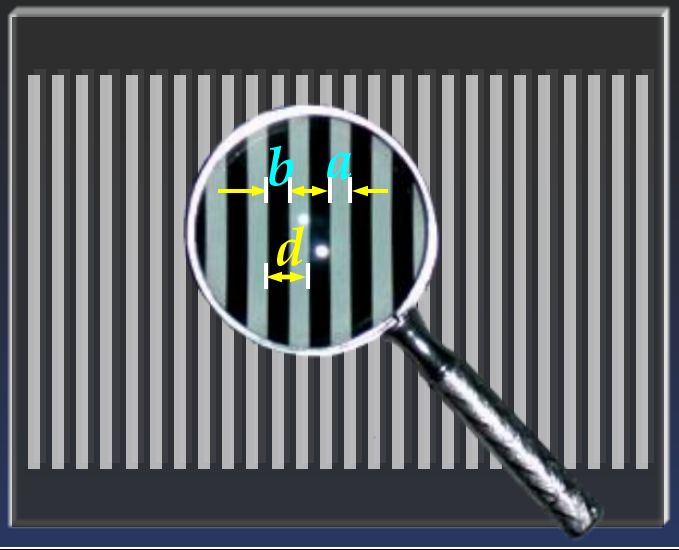




- 被观测物体的尺寸h，物体到透镜的距离L，物体的张角θ

$$h = L\theta_c$$

3. 光栅衍射



光栅常数：$d = a + b$

(1)不考虑缝宽 a ($a<\lambda$):

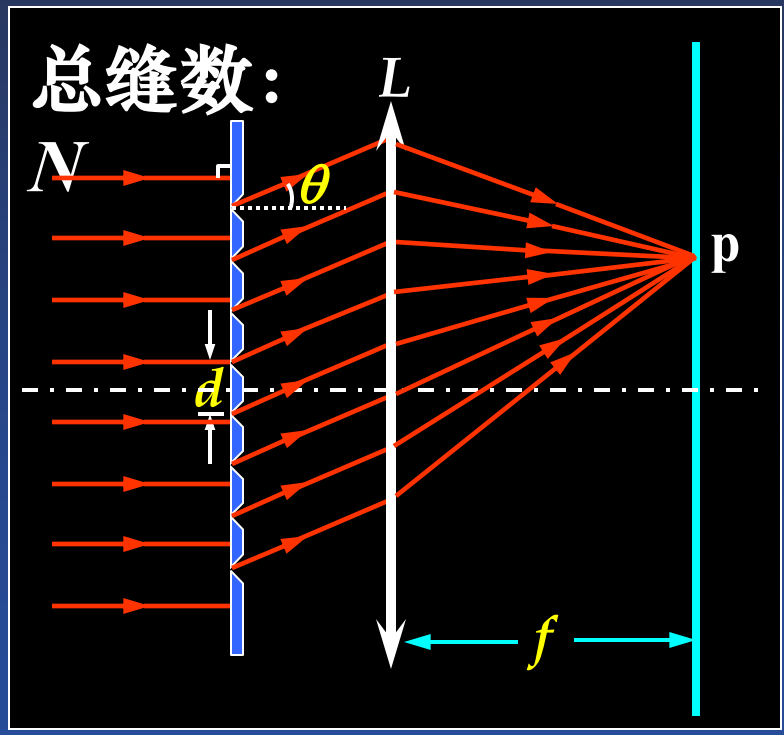
$d \cdot \sin\theta = \pm k\lambda$ 光栅方程

$d \cdot \sin\theta = \pm \dfrac{m}{N}\lambda$ 暗纹

$m = 1,2,\cdots,N-1,N+1,\cdots$

(2)考虑缝宽 a：

缺级：$\begin{cases} d \cdot \sin\theta = \pm k\lambda \\ a \cdot \sin\theta = \pm 2k' \cdot \dfrac{\lambda}{2} \end{cases}$



☆ 中央明纹带内的条纹数目与条纹总数的计算。

三、光的偏振现象

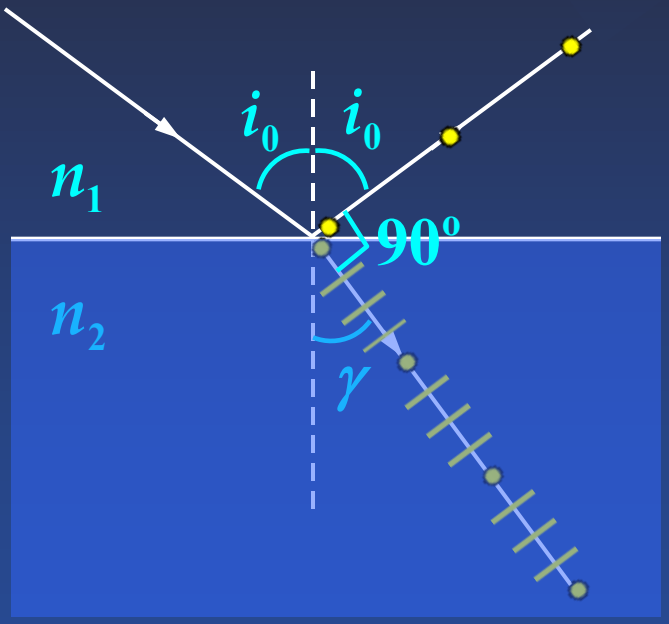
1. 马吕斯定律

$$I_2 = I_1 \cdot \cos^2\alpha$$

2. 反射、折射光的偏振

$$\tan i_0 = \frac{n_2}{n_1}$$

（布儒斯特定律）



3. 双折射光的偏振