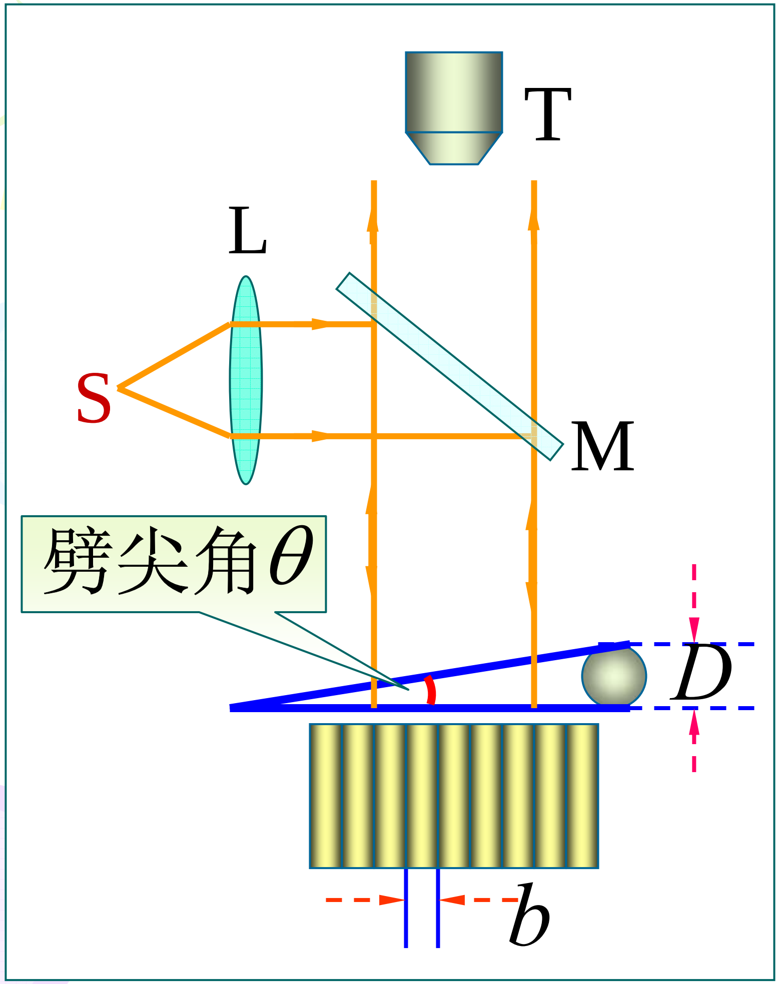
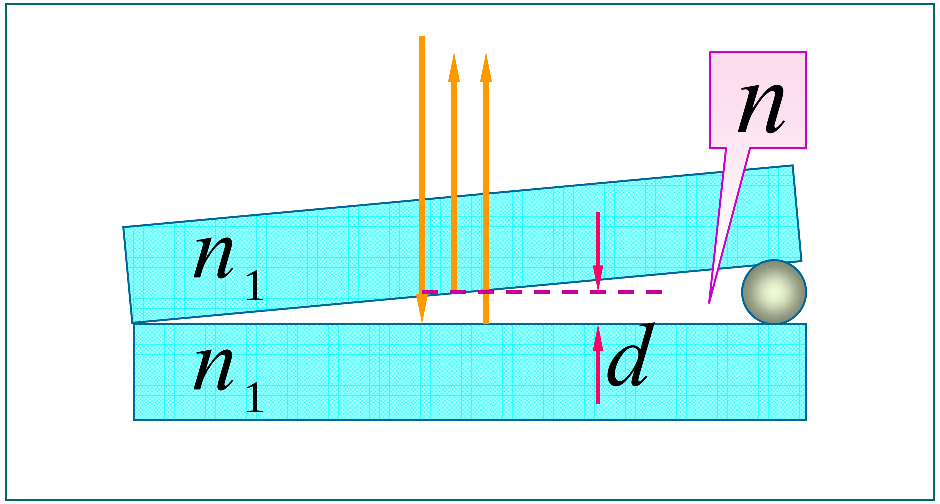
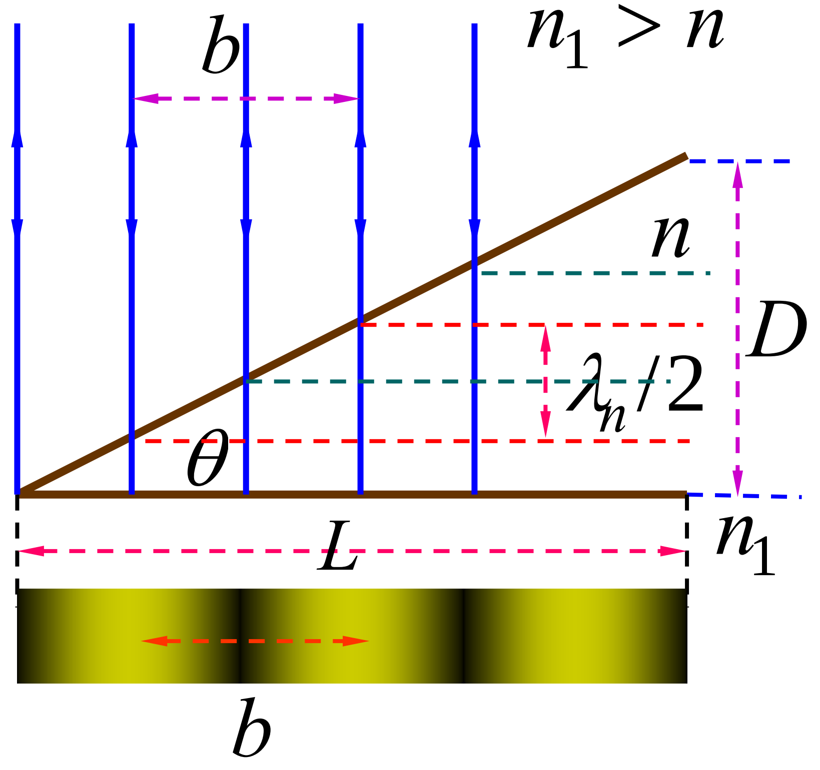
一 劈尖





$$\Delta = 2nd + \frac{\lambda}{2} \Leftarrow \because n < n_1$$

$$\Delta = \begin{cases} k\lambda, \quad k = 1,2,\cdots & \text{明纹} \\ (2k+1)\dfrac{\lambda}{2}, \quad k = 0,1,\cdots & \text{暗纹} \end{cases}$$



劈尖干涉

讨论

1）劈尖 $d=0$

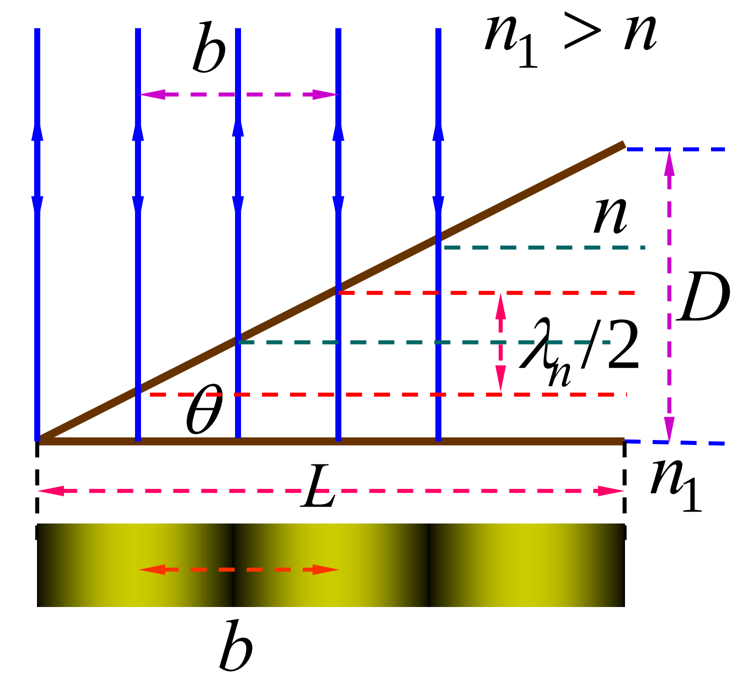
$$\Delta = \frac{\lambda}{2} \text{为暗纹.}$$

$$d = \begin{cases} (k-\frac{1}{2})\frac{\lambda}{2n} & \text{（明纹）} \\ k\lambda/2n & \text{（暗纹）} \end{cases}$$

2）相邻明纹（暗纹）间的厚度差

$$d_{i+1}-d_i=\frac{\lambda}{2n}=\frac{\lambda_n}{2}$$

$$\theta\approx D/L \qquad \theta\approx\frac{\lambda_n/2}{b}$$



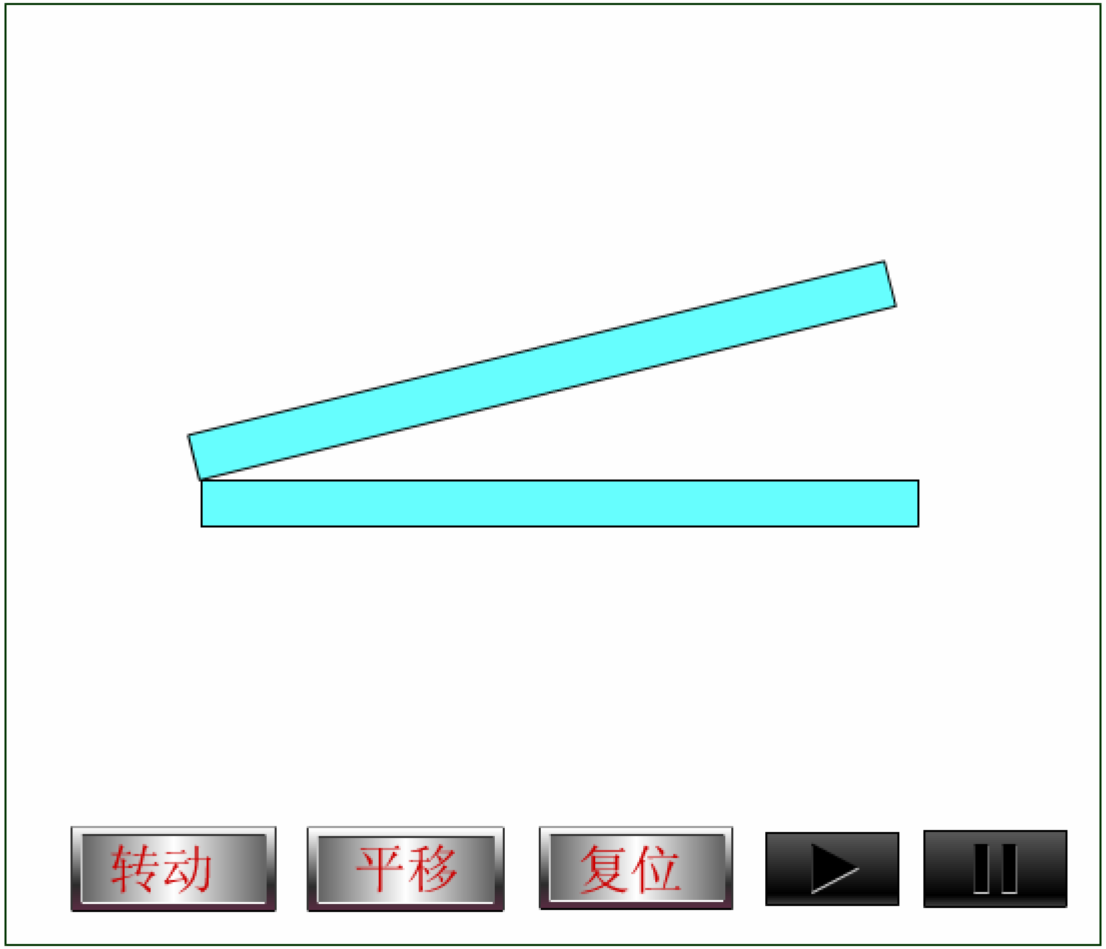
劈尖干涉

3）条纹间距（明纹或暗纹）

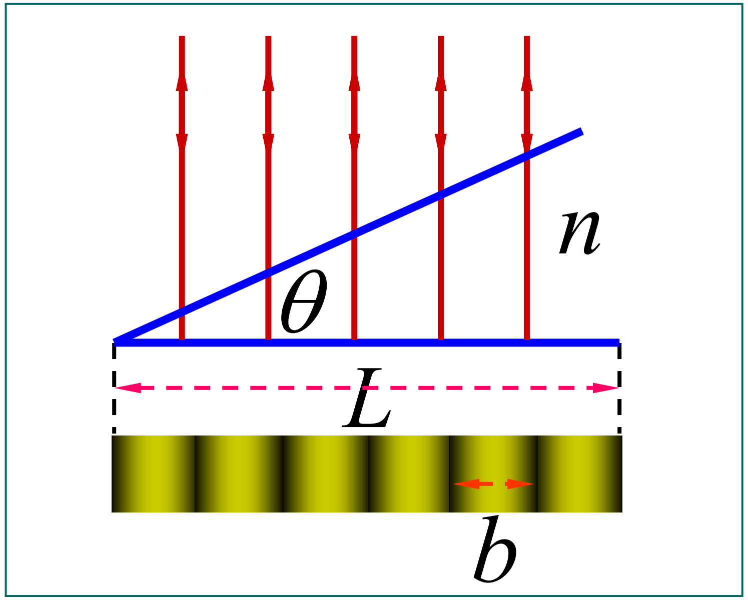
$$b=\frac{\lambda}{2n\theta} \qquad D=\frac{\lambda_n}{2b}L=\frac{\lambda}{2nb}L$$

4）干涉条纹的移动

每一条纹对应劈尖内的一个厚度，当此厚度位置改变时，对应的条纹随之移动.



例 1　有一玻璃劈尖，放在空气中，劈尖夹角 $\theta=8\times10^{-5}\text{rad}$，用波长 $\lambda=589\text{nm}$ 的单色光垂直入射时，测得干涉条纹的宽度 $b=2.4\text{mm}$，求这玻璃的折射率.



解　$\because \quad \theta=\dfrac{\lambda_n}{2b}=\dfrac{\lambda}{2nb}$

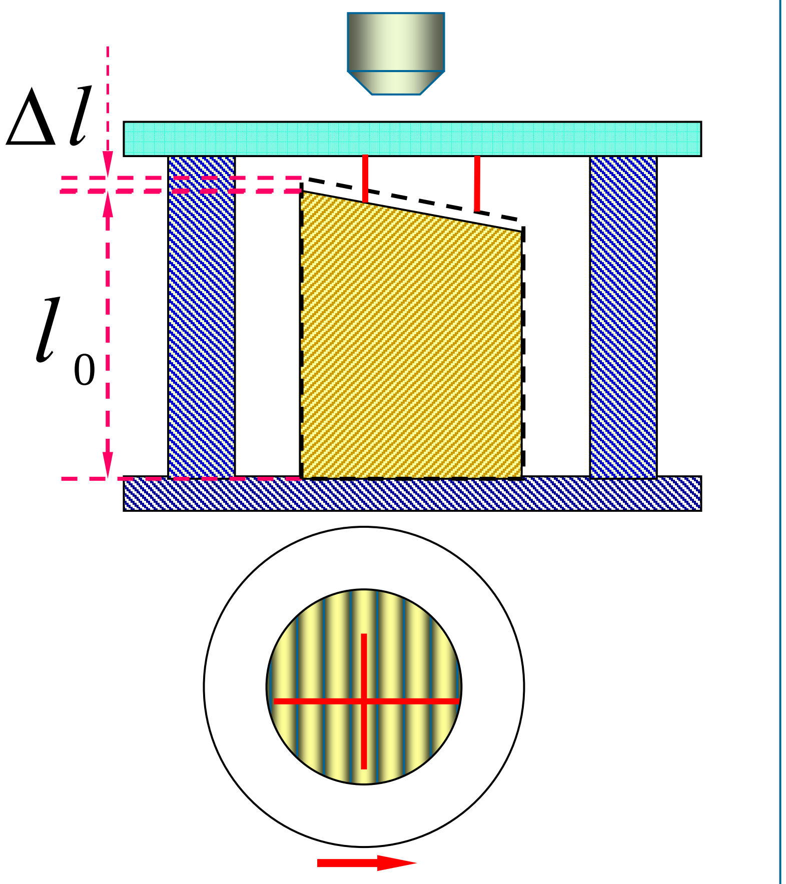
$\therefore \quad n=\dfrac{\lambda}{2\theta b}$

$$n=\frac{5.89\times10^{-7}\,\text{m}}{2\times8\times10^{-5}\times2.4\times10^{-3}\,\text{m}}=1.53$$

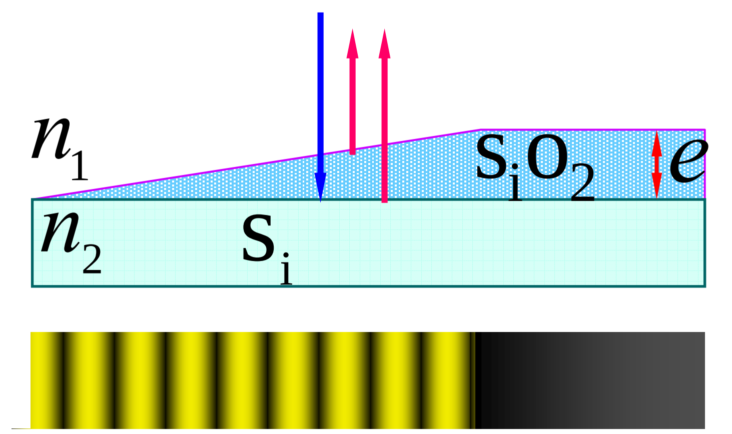
劈尖干涉的应用

$$\Delta l = N\frac{\lambda}{2}$$

1）干涉膨胀仪

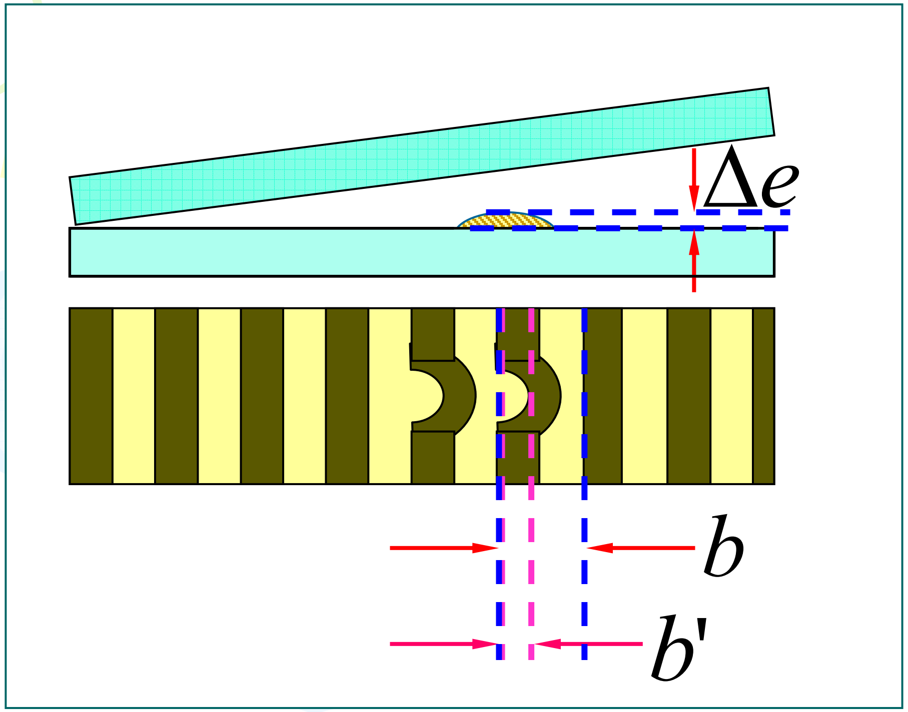


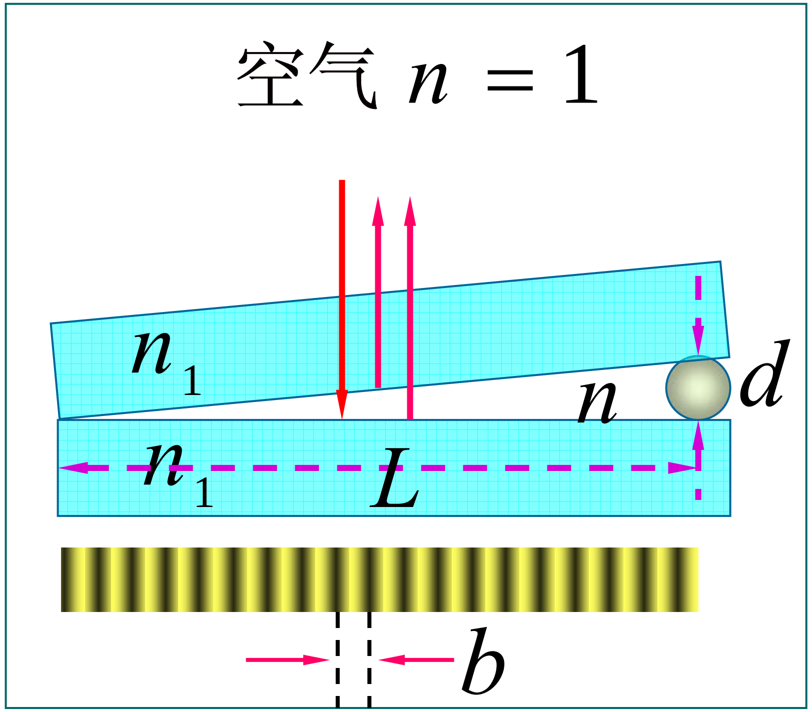
2）测膜厚



$$e = N\frac{\lambda}{2n_1}$$

3）检验光学元件表面的平整度 **4**）测细丝的直径



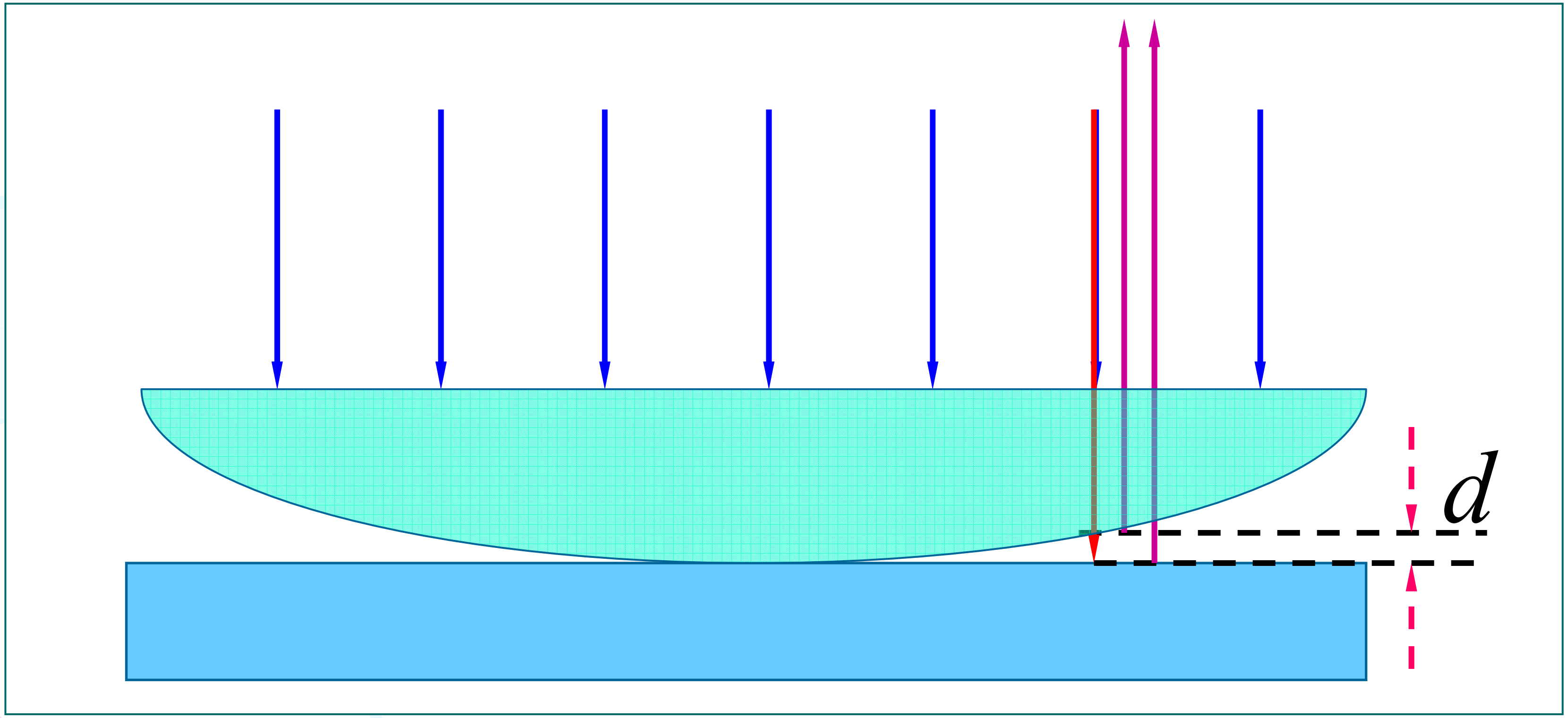


$$\Delta e=\frac{b'}{b}\frac{\lambda}{2}\approx\frac{1}{3}\cdot\frac{\lambda}{2}=\frac{\lambda}{6}$$

$$d=\frac{\lambda}{2n}\cdot\frac{L}{b}$$

二 牛顿环

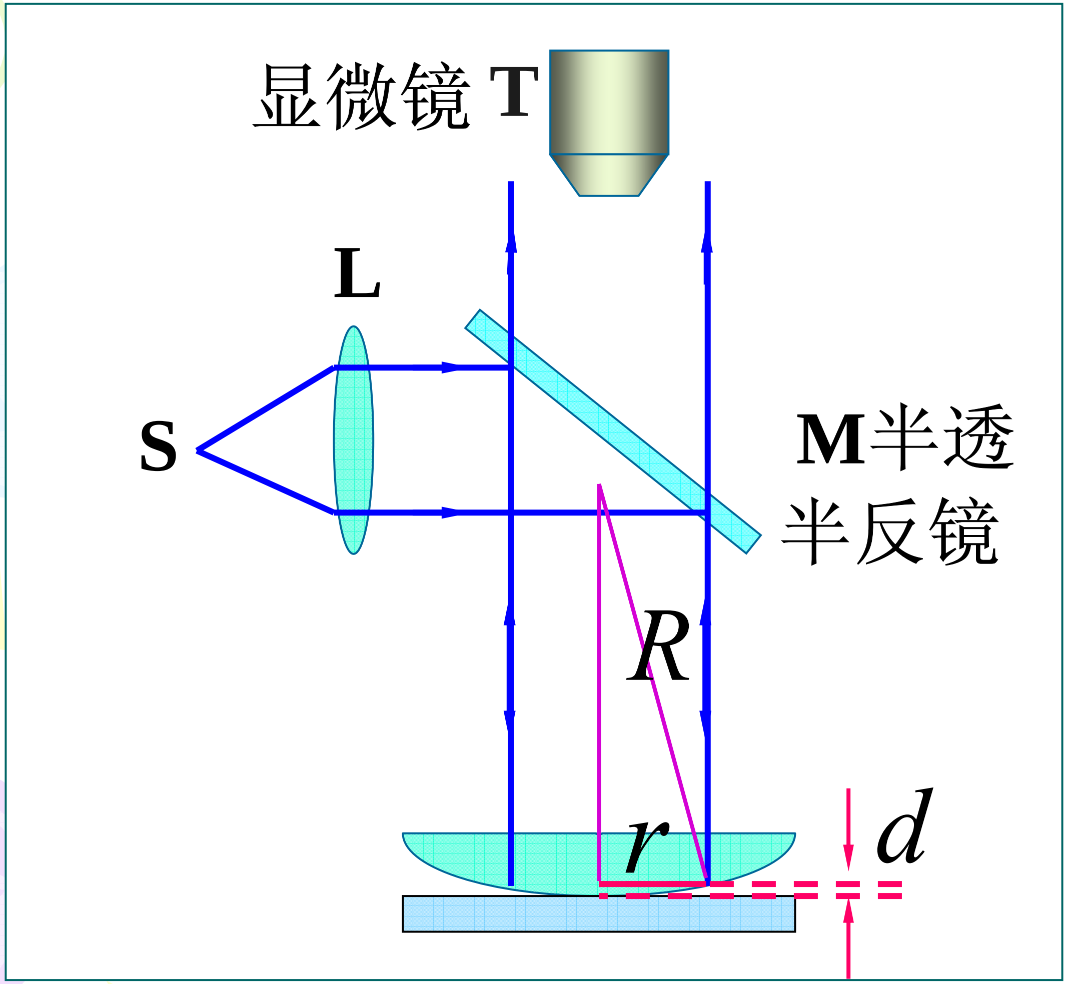
由一块平板玻璃和一平凸透镜组成

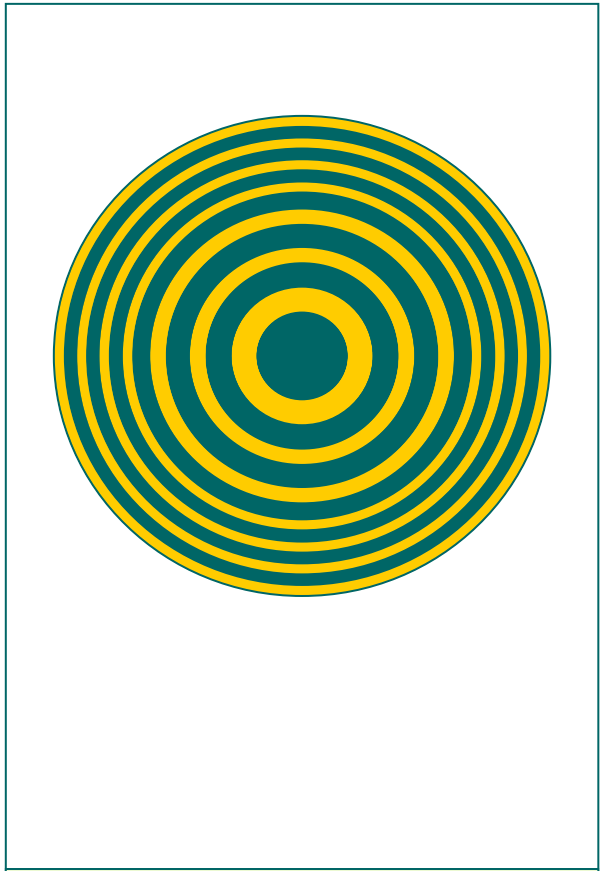


光程差

$$\Delta = 2d + \frac{\lambda}{2}$$

◆ 牛顿环实验装置

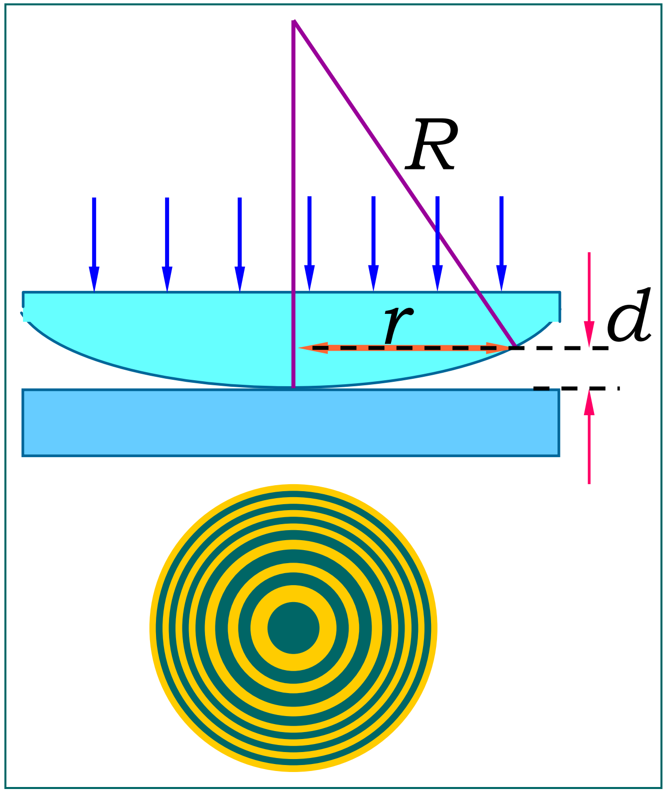




牛顿环干涉图样

光程差 $\Delta = 2d + \frac{\lambda}{2}$

$$\Delta = \begin{cases} k\lambda \quad (k=1,2,\cdots) & \text{明纹} \\ (k+\frac{1}{2})\lambda \quad (k=0,1,\cdots) & \text{暗纹} \end{cases}$$



$$r^2 = R^2 - (R-d)^2 = 2dR - d^2$$

$$\because R >> d \quad \therefore d^2 \approx 0$$

$$r = \sqrt{2dR} = \sqrt{(\Delta - \frac{\lambda}{2})R} \Rightarrow \begin{cases} r = \sqrt{(k-\frac{1}{2})R\lambda} & \text{明环半径} \\ r = \sqrt{kR\lambda} & \text{暗环半径} \end{cases}$$

讨论

明环半径 $r=\sqrt{(k-\frac{1}{2})R\lambda}$ $(k=1,2,3,\cdots)$

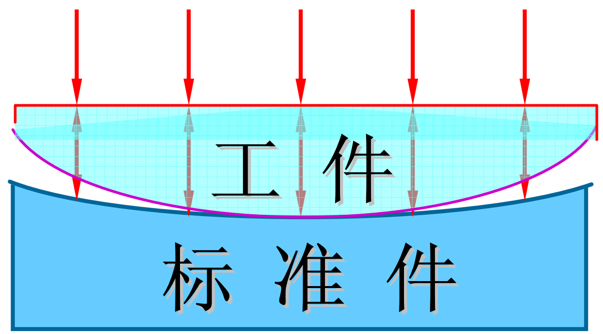
暗环半径 $r=\sqrt{kR\lambda}$ $(k=0,1,2,\cdots)$

1）从反射光中观测，中心点是暗点还是亮点？从透射光中观测，中心点是暗点还是亮点？

2）属于等厚干涉，条纹间距不等，为什么？

3）将牛顿环置于 $n>1$ 的液体中，条纹如何变？

4）应用例子:可以用来测量光波波长，用于检测透镜质量，曲率半径等.

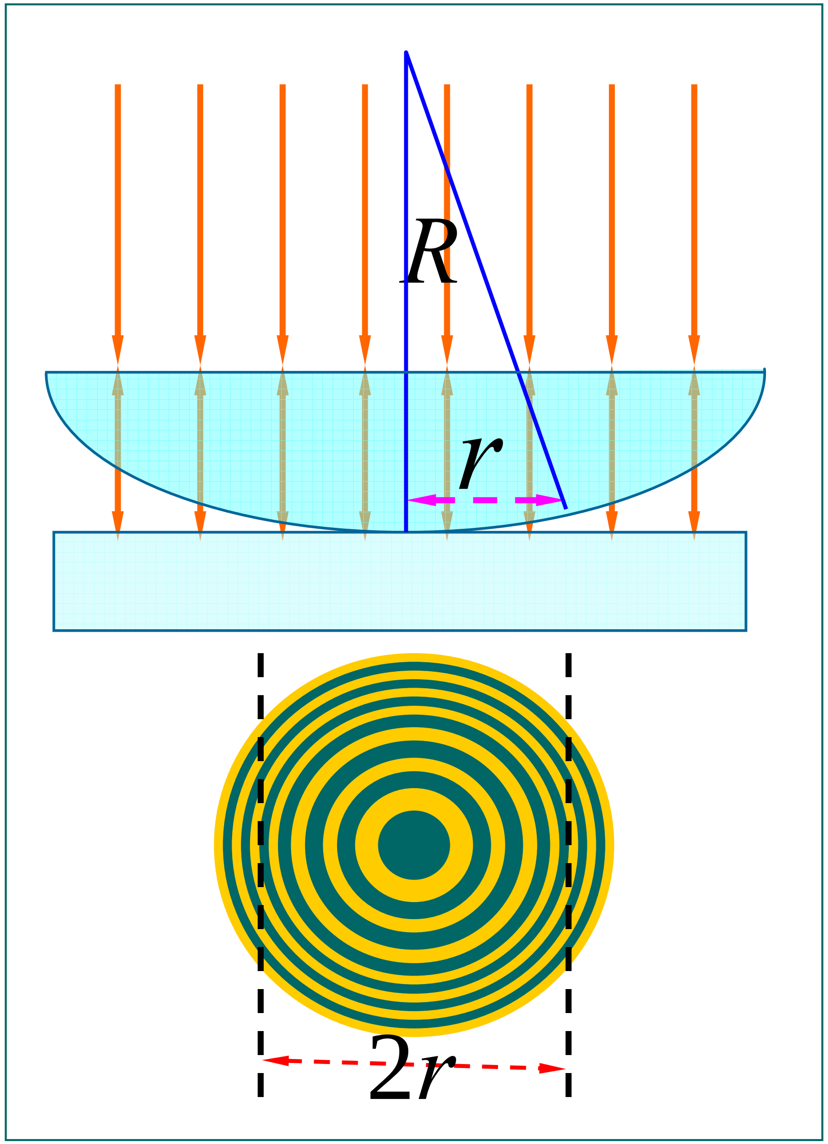


- 测量透镜的曲率半径

$$r_k^2 = kR\lambda$$

$$r_{k+m}^2 = (k+m)R\lambda$$

$$R = \frac{r_{k+m}^2 - r_k^2}{m\lambda}$$



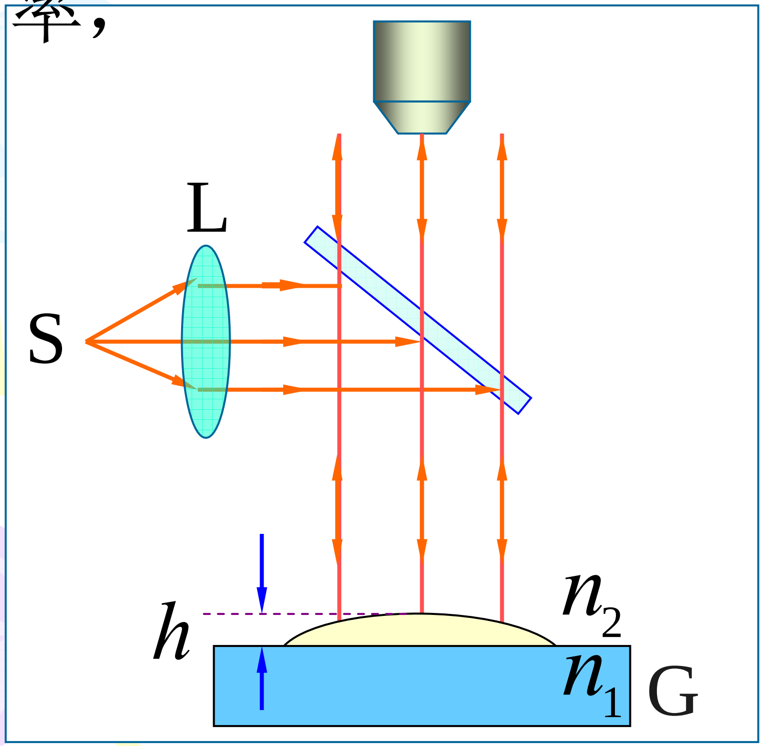
例2 用氦氖激光器发出的波长为633nm的单色光做牛顿环实验，测得第个 k 暗环的半径为5.63mm，第 k+5 暗环的半径为7.96mm，求平凸透镜的曲率半径R.

解 $r_k = \sqrt{kR\lambda}$ $r_{k+5} = \sqrt{(k+5)R\lambda}$

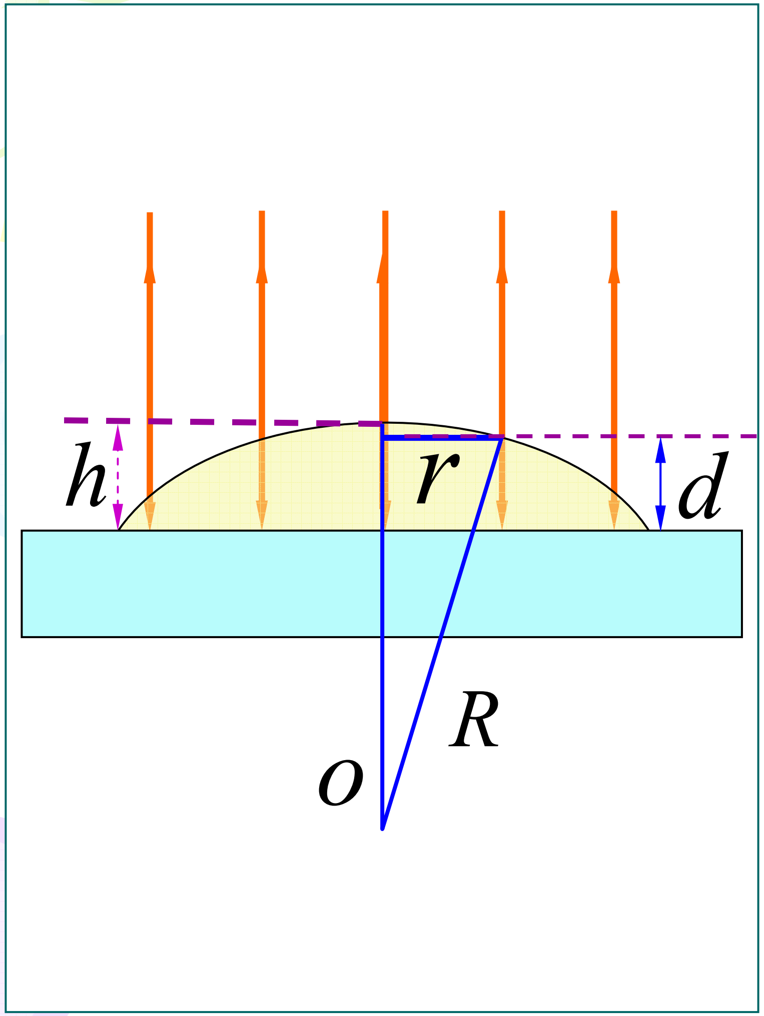
$$5R\lambda = \left(r_{k+5}^2 - r_k^2\right)$$

$$R = \frac{r_{k+5}^2 - r_k^2}{5\lambda} = \frac{(7.96\text{mm})^2 - (5.63\text{mm})^2}{5\times633\text{nm}} = 10.0\text{m}$$

例3 如图所示为测量油膜折射率的实验装置，在平面玻璃片G上放一油滴，并展开成圆形油膜，在波长 $\lambda = 600\text{nm}$ 的单色光垂直入射下，从反射光中可观察到油膜所形成的干涉条纹．已知玻璃的折射率，



$n_1 = 1.50$，油膜的折射率 $n_2 = 1.20$　问：当油膜中心最高点与玻璃片的上表面相距 $h = 8.0\times10^2\text{nm}$ 时，干涉条纹如何分布？可见明纹的条数及各明纹处膜厚？中心点的明暗程度如何？若油膜展开条纹如何变化?



解 1）条纹为同心圆

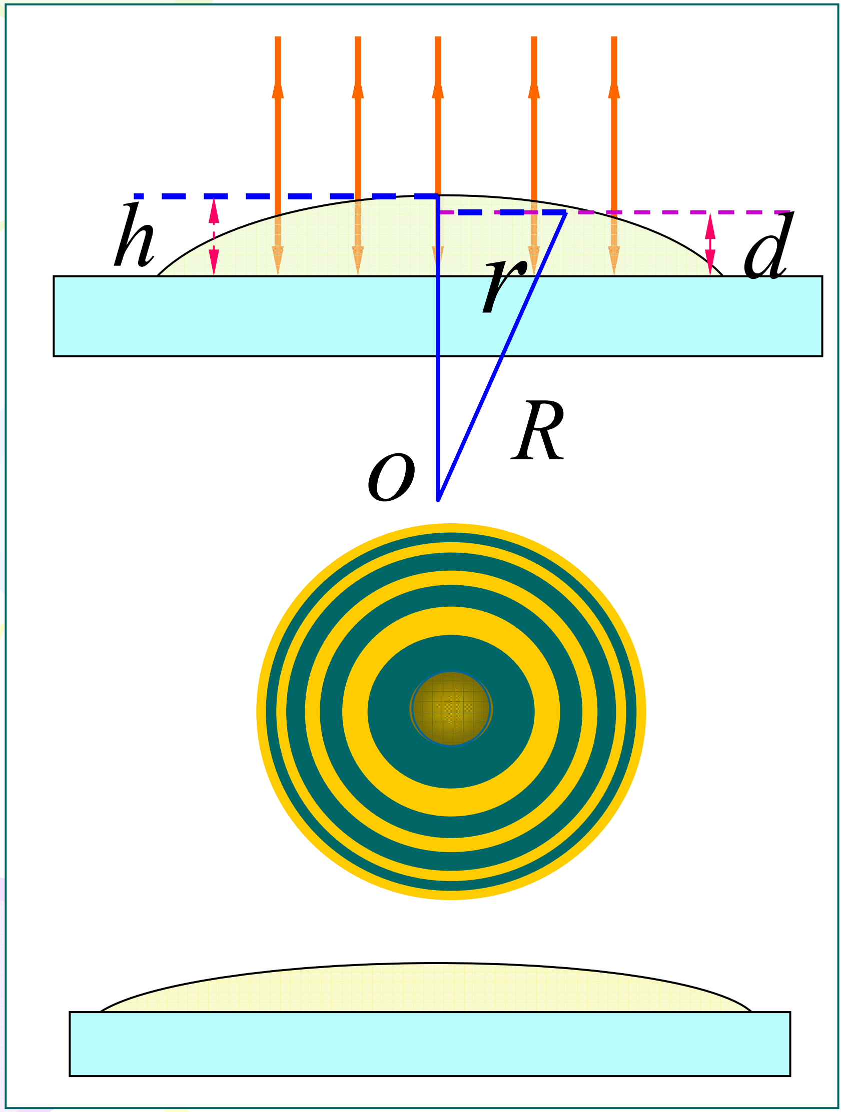
$$\Delta = 2n_2 d_k = k\lambda \quad \text{明纹}$$

$$d_k = k\frac{\lambda}{2n_2} \quad k = 0,1,2,\cdots$$

油膜边缘 $k = 0, d_0 = 0$ 明纹

$$k = 1, \quad d_1 = 250\ \text{nm}$$

$$k = 2, \quad d_2 = 500\ \text{nm}$$



$$k = 3,\quad d_3 = 750\,\text{nm}$$

$$k = 4,\quad d_4 = 1000\,\text{nm}$$

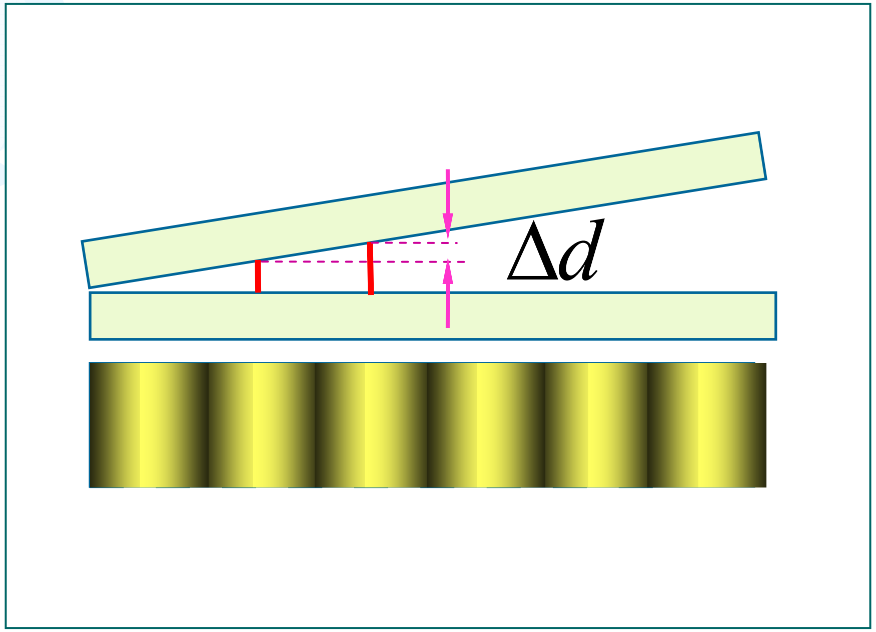
由于$h = 8.0\times 10^2\,\text{nm}$故可观察到四条明纹．当油滴展开时，条纹间距变大，条纹数减少.

$$R^2 = r^2 + [R-(h-d)]^2$$

$$r^2 \approx 2R(h-d) \quad R \approx \frac{r^2}{2(h-d)}$$

总结

1）干涉条纹为光程差相同的点的轨迹，即厚度相等的点的轨迹

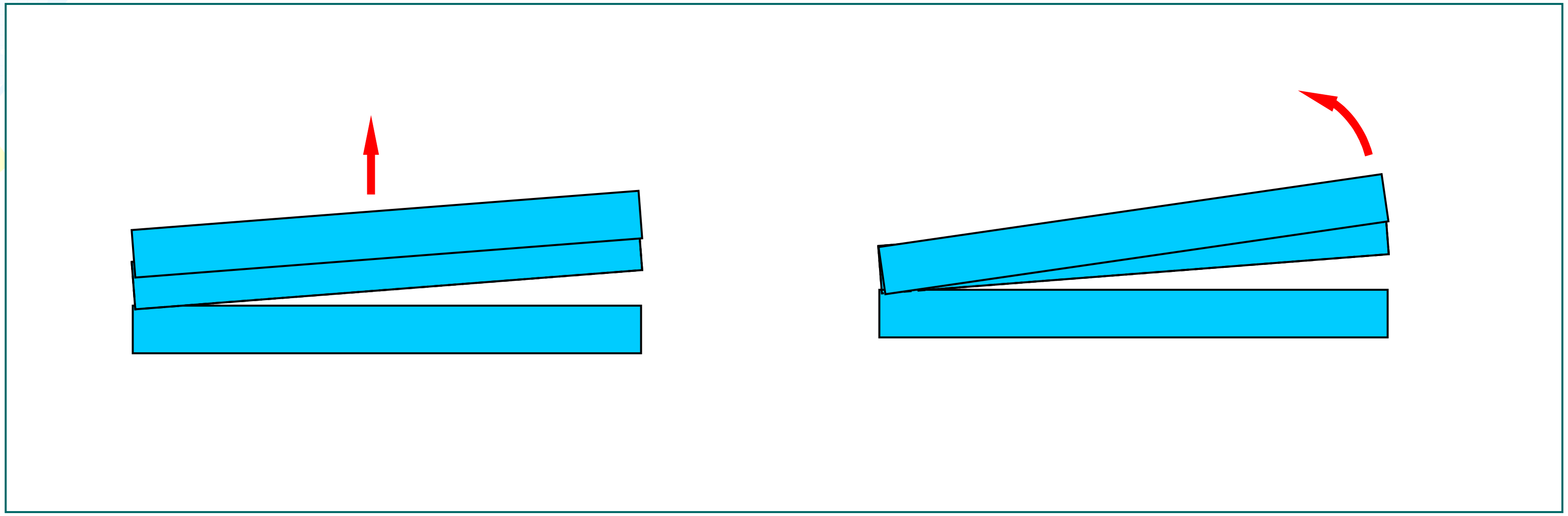


$$\Delta k = 1$$

$$\Delta d = \frac{\lambda}{2n}$$

2）厚度线性增长条纹等间距，厚度非线性增长条纹不等间距

3）条纹的动态变化分析（ n,λ,θ 变化时）



4）半波损失需具体问题具体分析