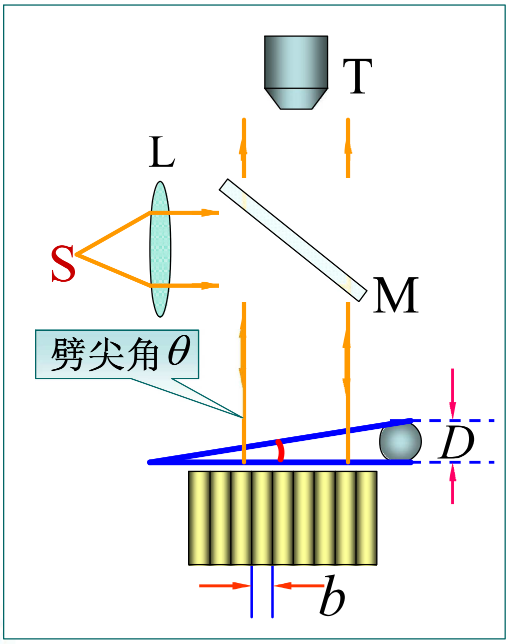
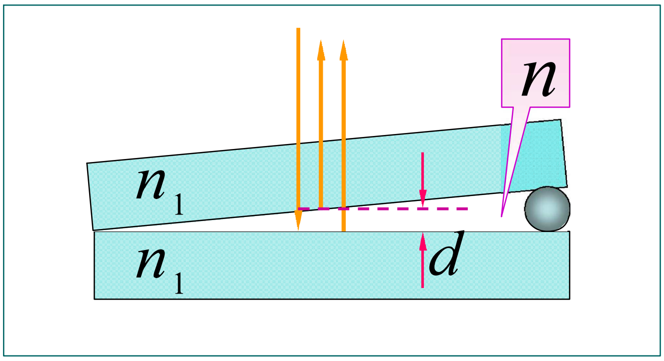
一 劈尖

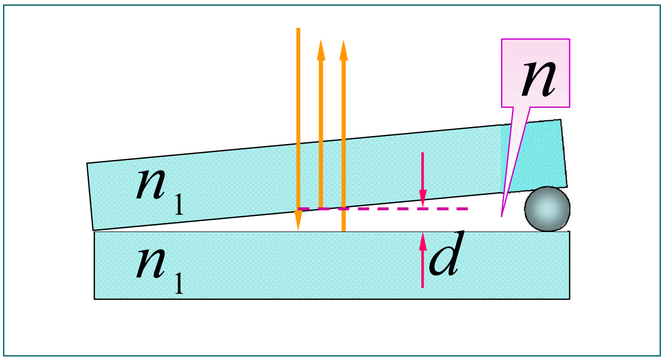


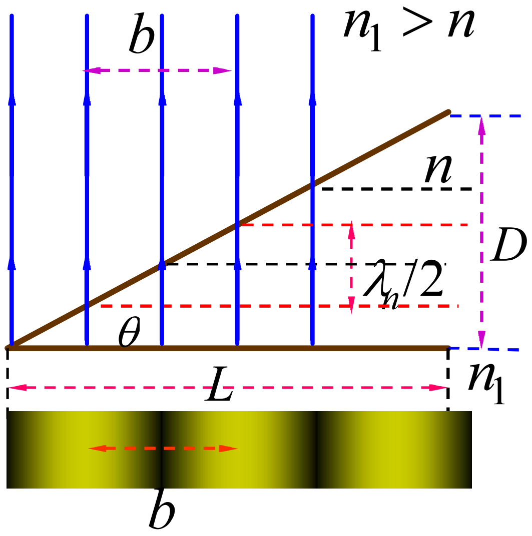
$$\Delta = 2nd + \frac{\lambda}{2}$$



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

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





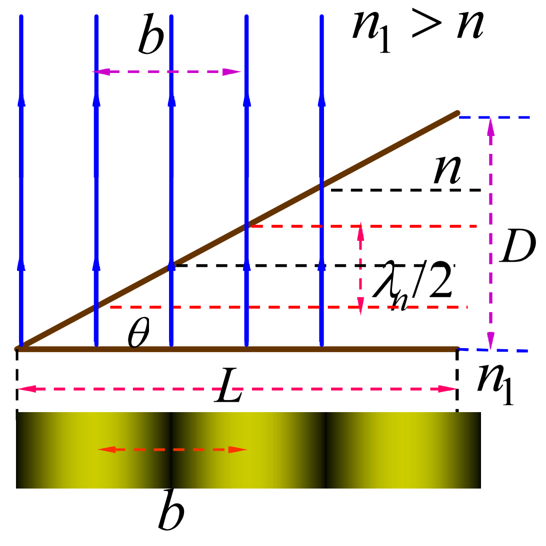
劈尖干涉

讨论

(1) 棱边处 $d = 0$

$\Delta = \frac{\lambda}{2}$ 为暗纹.

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



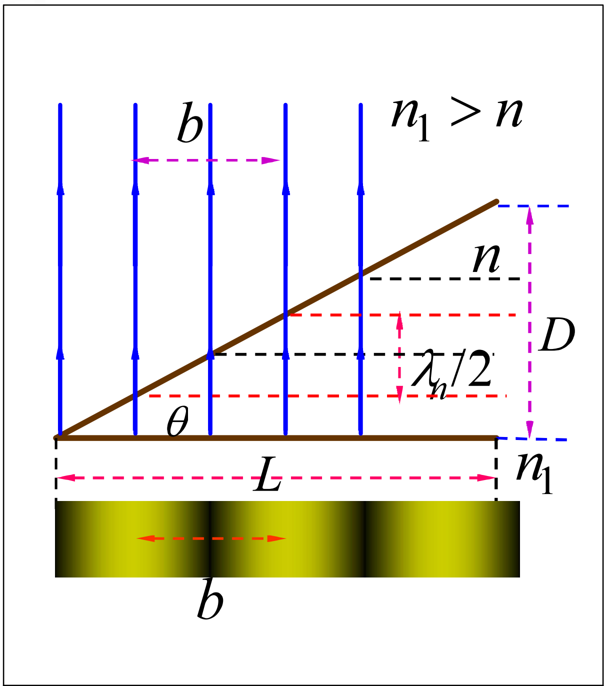
劈尖干涉

(2) 相邻明纹（暗纹）间的厚度差

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

$$\theta \approx D/L$$

$$\theta \approx \frac{\lambda_n/2}{b}$$



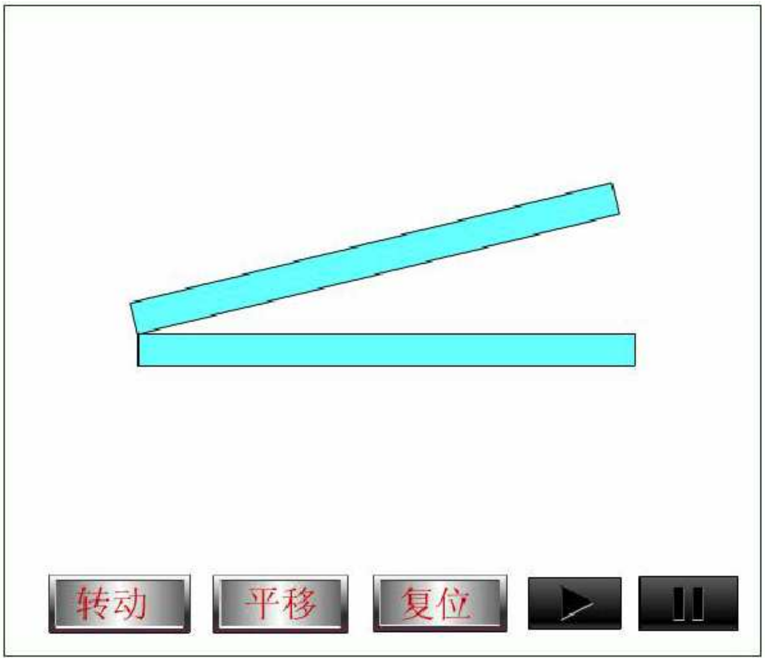
劈尖干涉

(3) 条纹间距

$$b = \frac{\lambda}{2n\theta}$$

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

（4）干涉条纹的移动



例 1 波长为680 nm的平行光照射到L=12 cm长的两块玻璃片上，两玻璃片的一边相互接触，另一边被厚度D=0.048 mm的纸片隔开．试问在这12 cm长度内会呈现多少条暗条纹？

解

$$2d+\frac{\lambda}{2}=(2k+1)\frac{\lambda}{2}$$

$$k=0,1,2,\cdots$$

$$2d+\frac{\lambda}{2}=(2k+1)\frac{\lambda}{2} \qquad k=0,1,2,\cdots$$

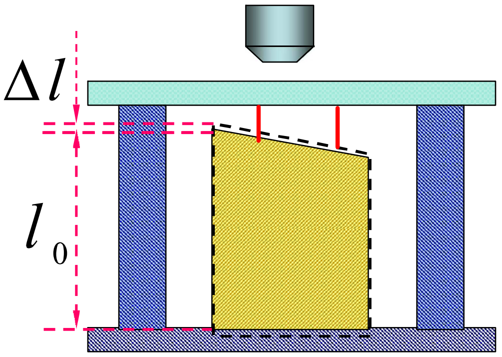
$$2D+\frac{\lambda}{2}=(2k_m+1)\frac{\lambda}{2}$$

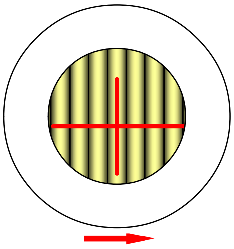
$$k_m=\frac{2D}{\lambda}=141.2$$

共有142条暗纹

劈尖干涉的应用

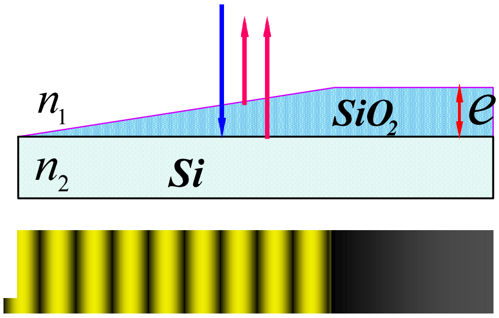
(1) 干涉膨胀仪





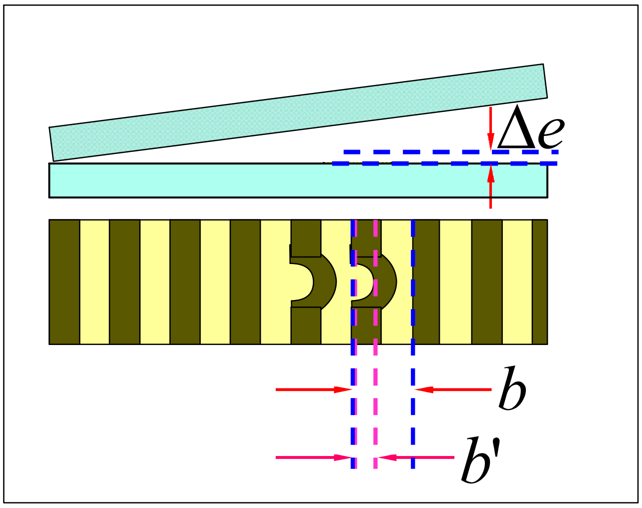
$$\Delta l = N\frac{\lambda}{2}$$

(2) 测膜厚



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

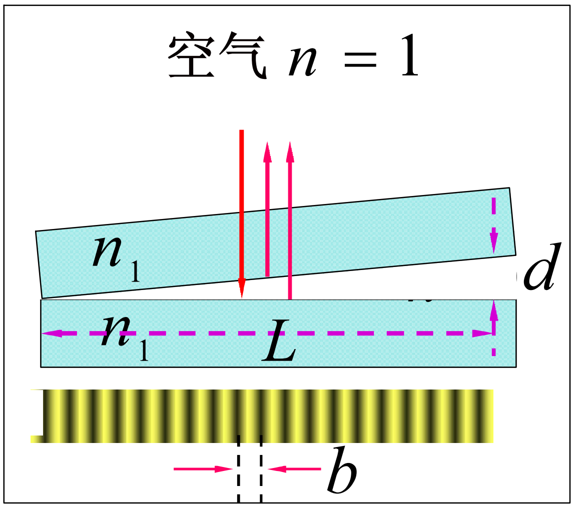
(3) 检验光学元件表面的平整度



$$\Delta e = \frac{b'}{b}\frac{\lambda}{2}$$

$$\approx \frac{1}{3}\cdot\frac{\lambda}{2} = \frac{\lambda}{6}$$

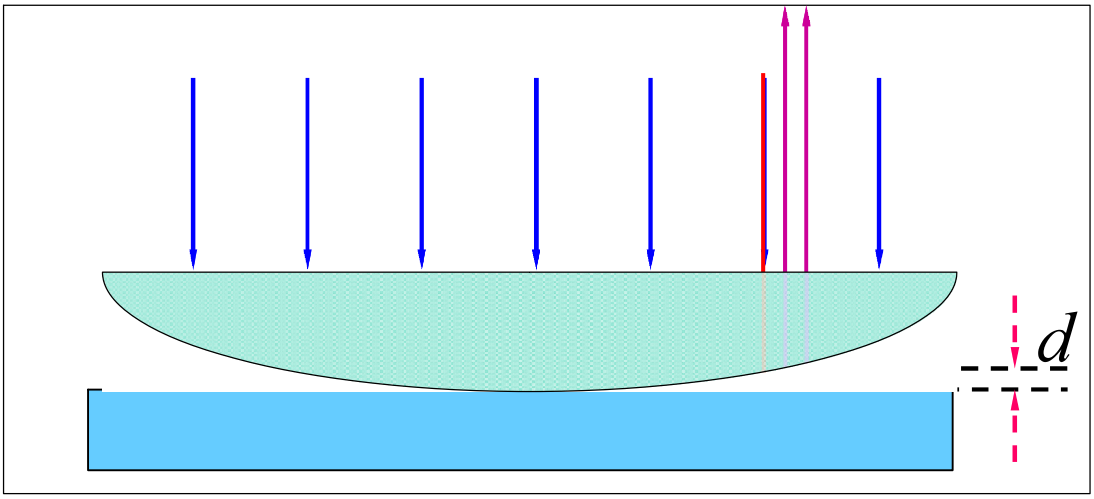
(4) 测细丝的直径



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

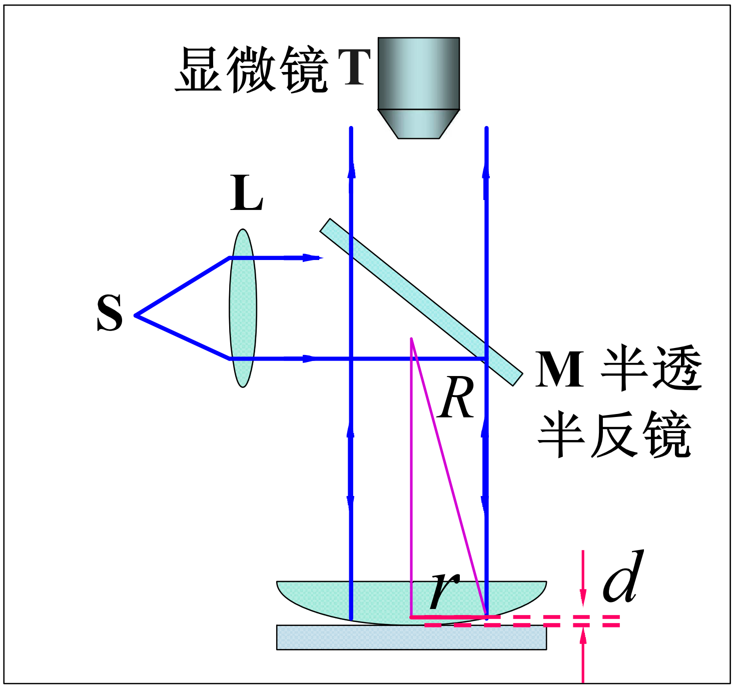
二 牛顿环

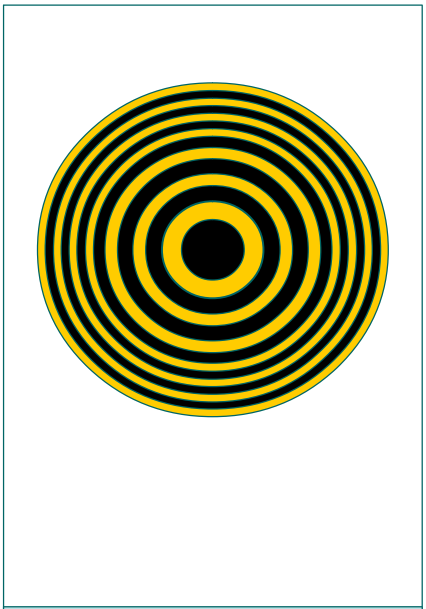
由一块平板玻璃和一平凸透镜组成



光程差 $\Delta = 2d + \dfrac{\lambda}{2}$

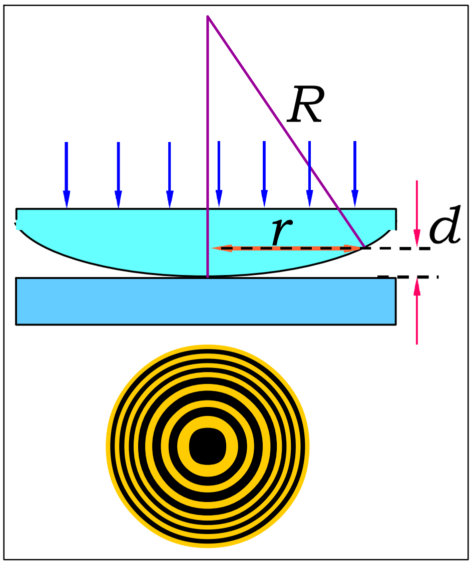
◆ 牛顿环实验装置





牛顿环干涉图样

光程差 $\Delta = 2d + \frac{\lambda}{2}$

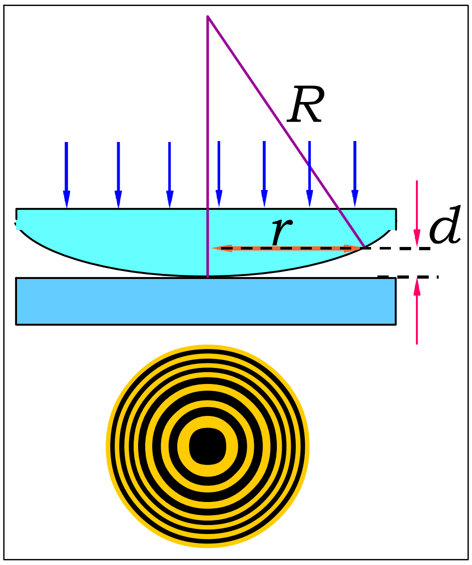


$$\Delta = \begin{cases} k\lambda \quad (k = 1,2,\cdots) & \text{明纹} \\ (k+\frac{1}{2})\lambda \quad (k = 0,1,\cdots) & \text{暗纹} \end{cases}$$

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

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

$$r = \sqrt{2dR} = \sqrt{(\varDelta - \frac{\lambda}{2})R}$$



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

讨论

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

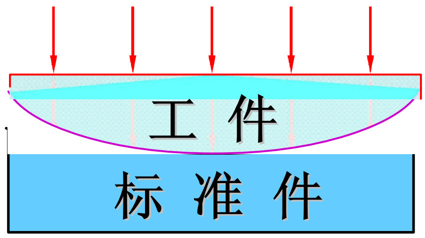
暗环半径 $r=\sqrt{kR\lambda}\quad (k=0,1,2,\cdots)$

(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 $n >$ 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.

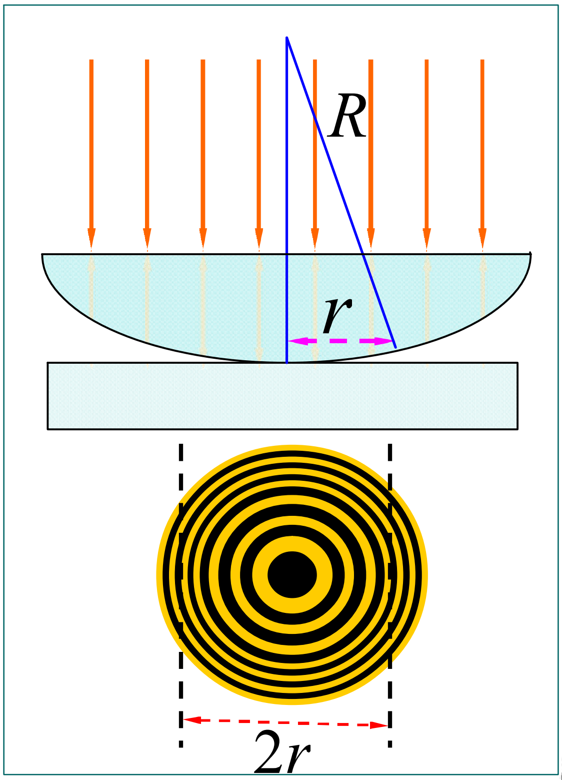


◆ 测量透镜的曲率半径

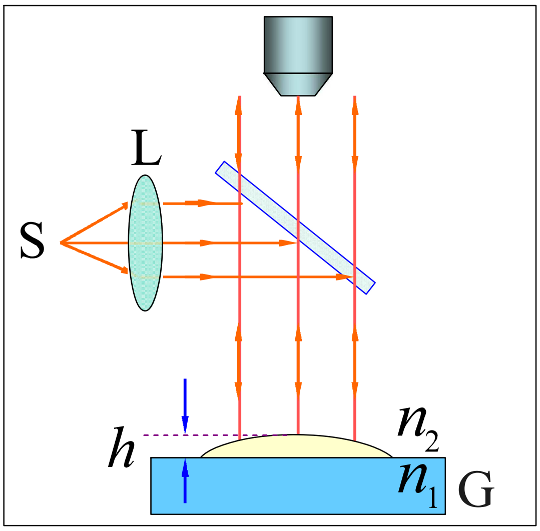
$$r_k^2 = kR\lambda$$

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

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

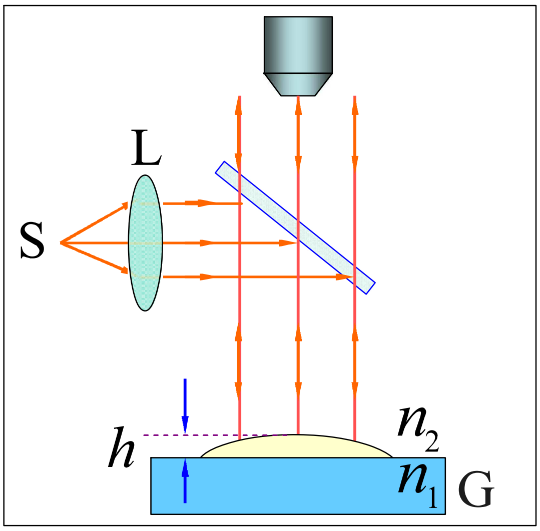


例2 如图所示为测量油膜折射率的实验装置，在平面玻璃片G上放一油滴，并展开成圆形油膜，在波长 $\lambda = 600\,\text{nm}$ 的单色光垂直入射



下，从反射光中可观察到油膜所形成的干涉条纹．已知玻璃的折射率为 $n_1 = 1.50$，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 $h = 8.0\times10^{2}\,\mathrm{nm}$ 时，干涉条纹是如何分布的？可看到几条明纹？明纹所在处的油膜厚度为多少？

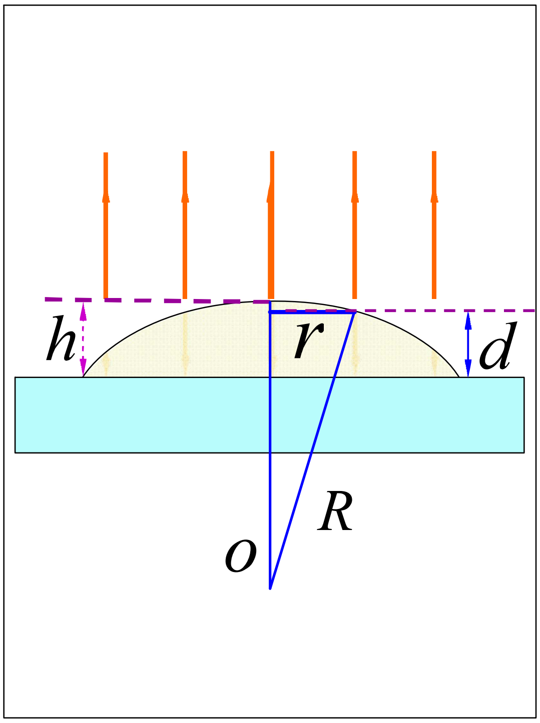


解 条纹为同心圆

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

$$d_k = k\frac{\lambda}{2n_2}$$

$$k = 0,1,2,\cdots$$



油膜边缘 $k=0, d_0=0$

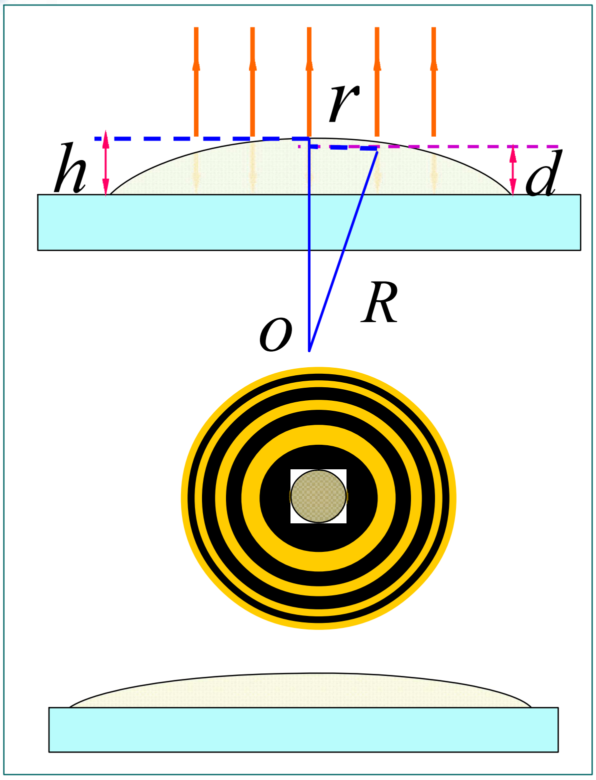
$k=1, \quad d_1=250\ \text{nm}$

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

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

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

由于 $h=8.0\times10^{2}\ \text{nm}$ 故可观察到四条明纹.



讨论

油滴展开时，条纹间距变大，条纹数减少

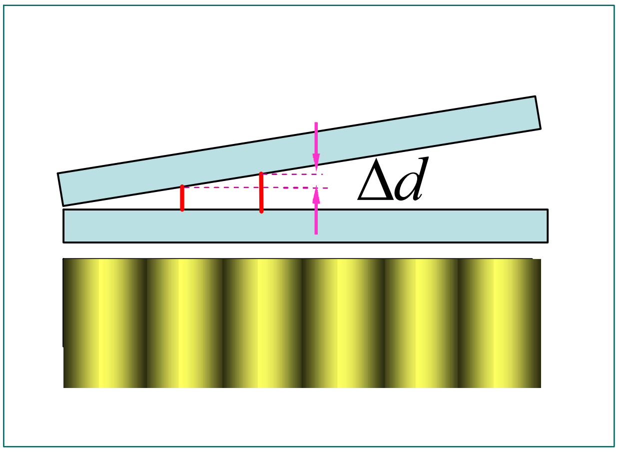
$$R^2 = r^2 + [R-(h-d)]^2$$

$$r^2 \approx 2R(h-d)$$

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

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.

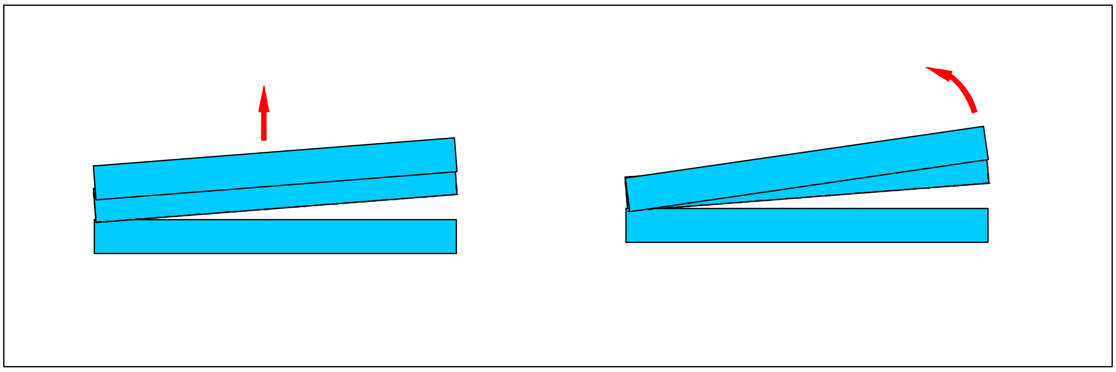


$$\Delta k = 1$$

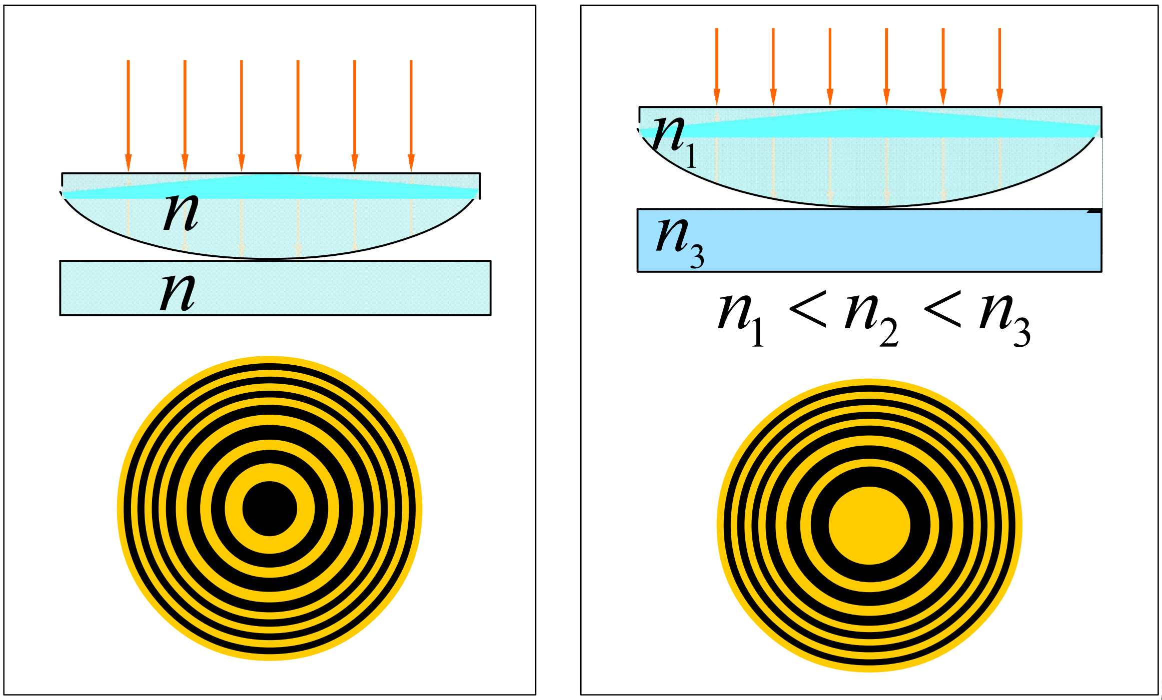
$$\Delta d = \frac{\lambda}{2n}$$

(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.



选择进入下一节：

END