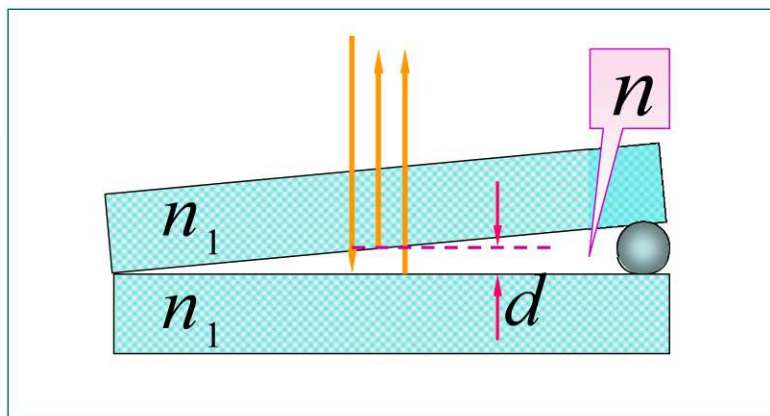
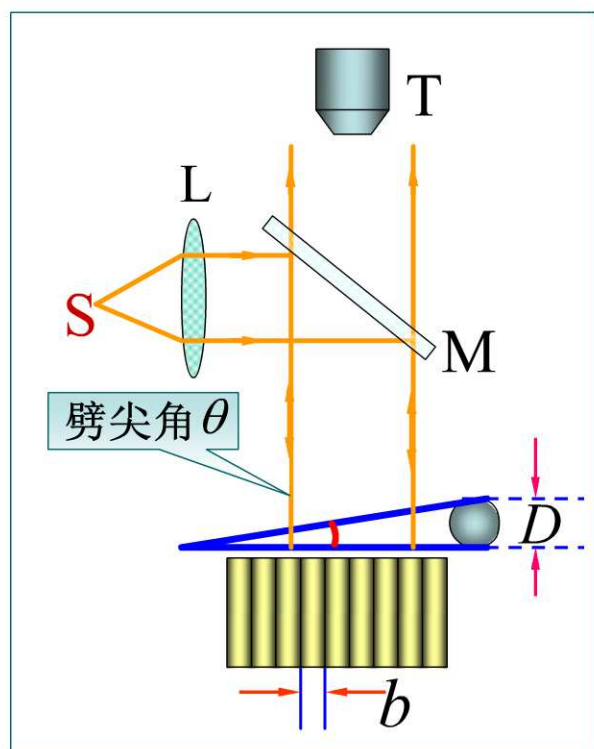


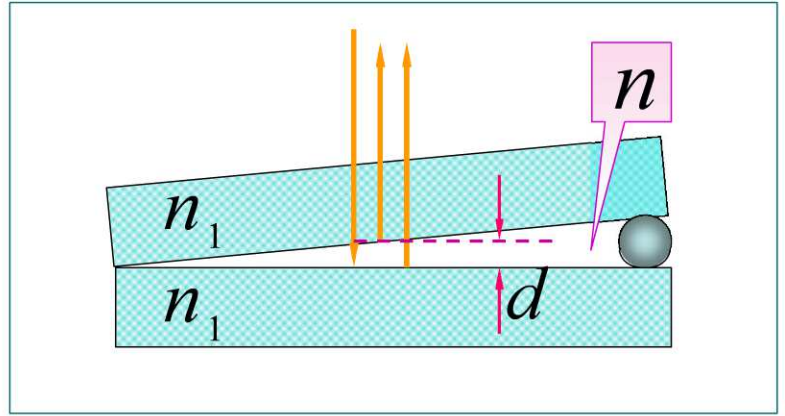
一 劈尖



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



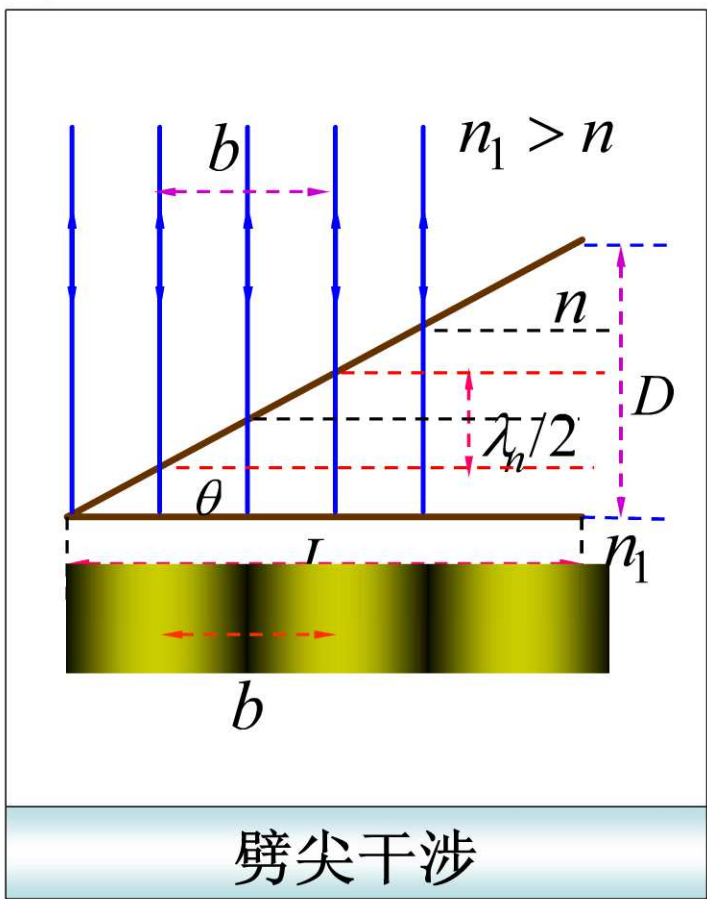
$$\Delta = 2nd + \frac{\lambda}{2}$$



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



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



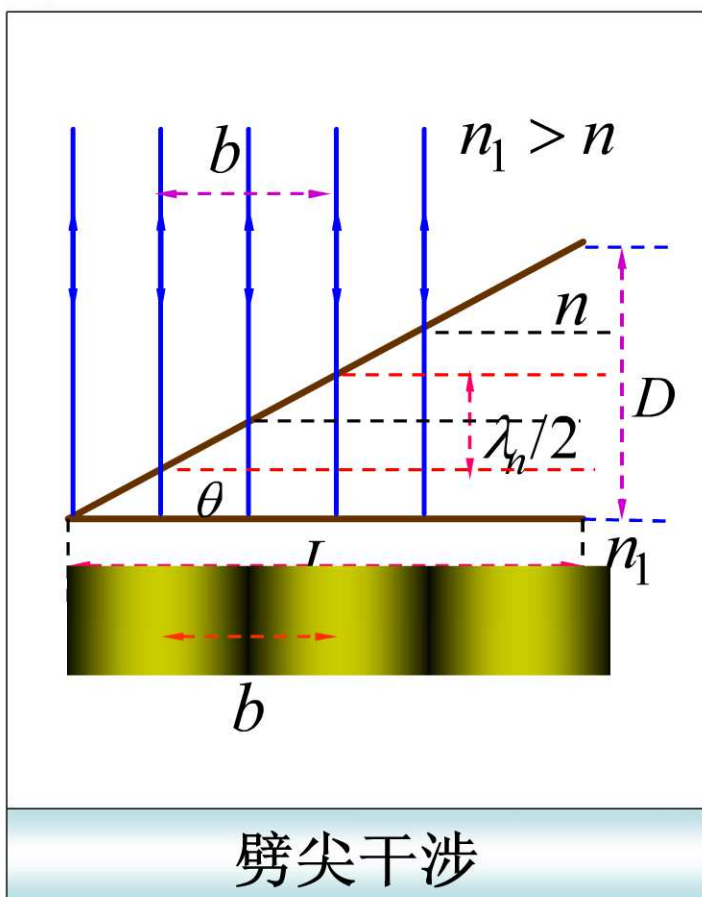
(2) 相邻明纹 (暗纹)

间的厚度差

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

$$\theta \approx D/L$$

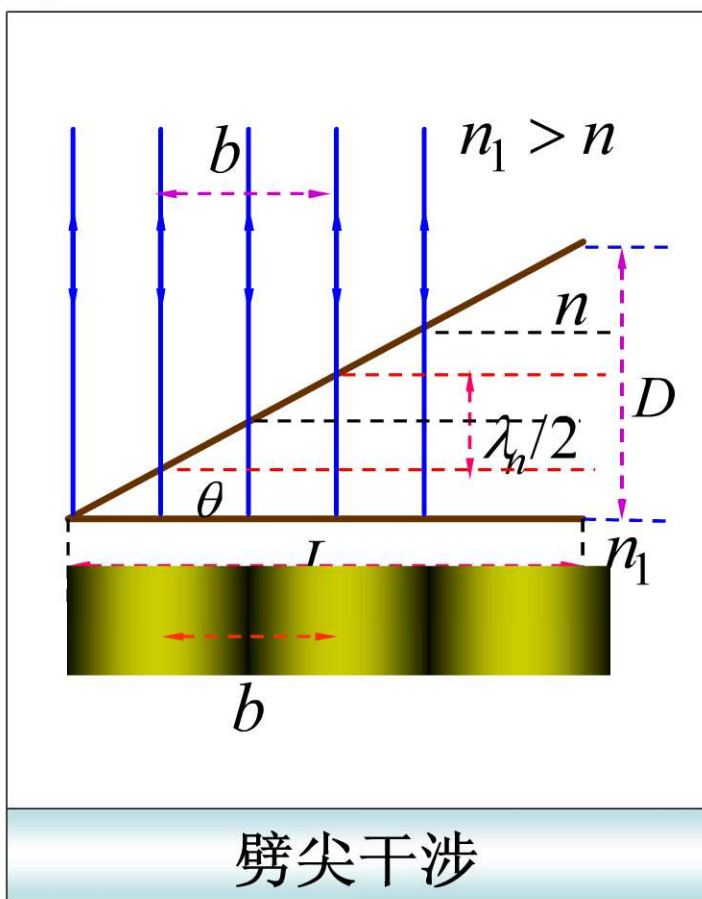
$$\theta \approx \frac{\lambda_n/2}{b}$$



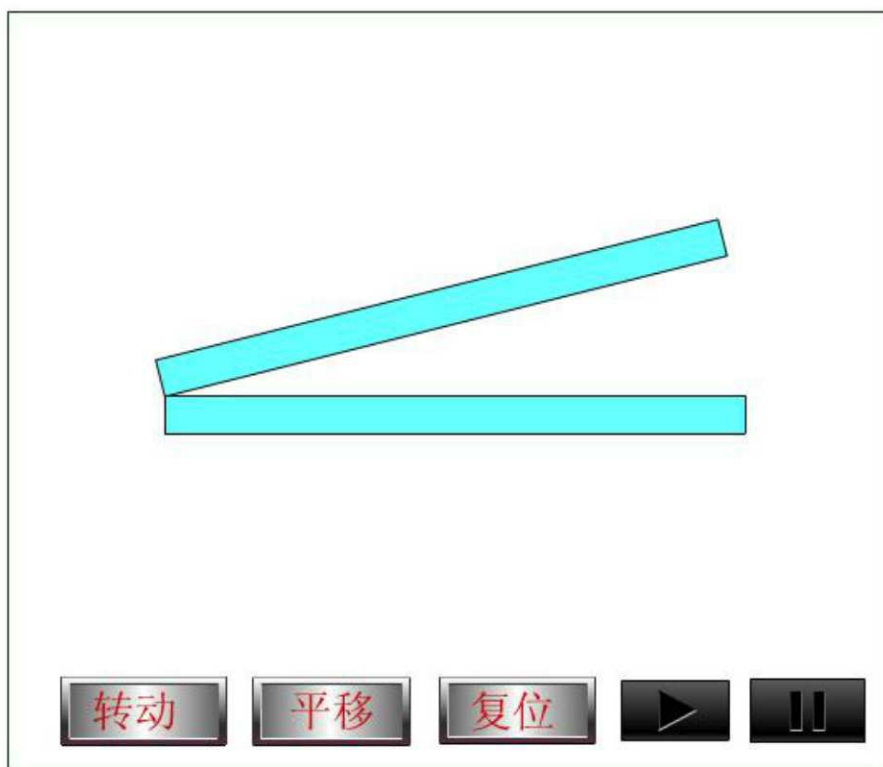
(3) 条纹间距

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

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



(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

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



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

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

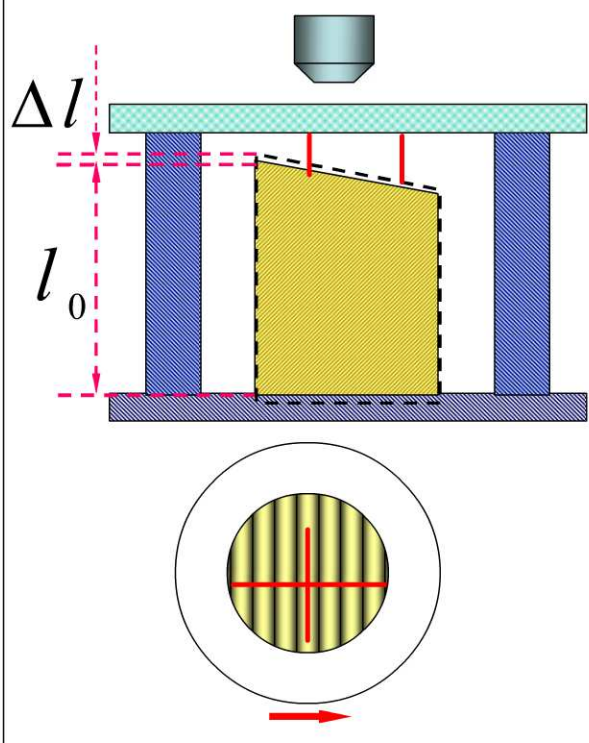
$$k_m = \frac{2D}{\lambda} = 141.1$$

共有142条暗纹



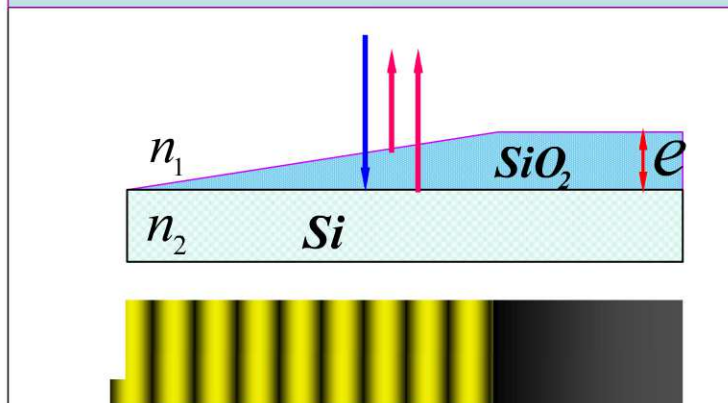
劈尖干涉的应用

(1) 干涉膨胀仪



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

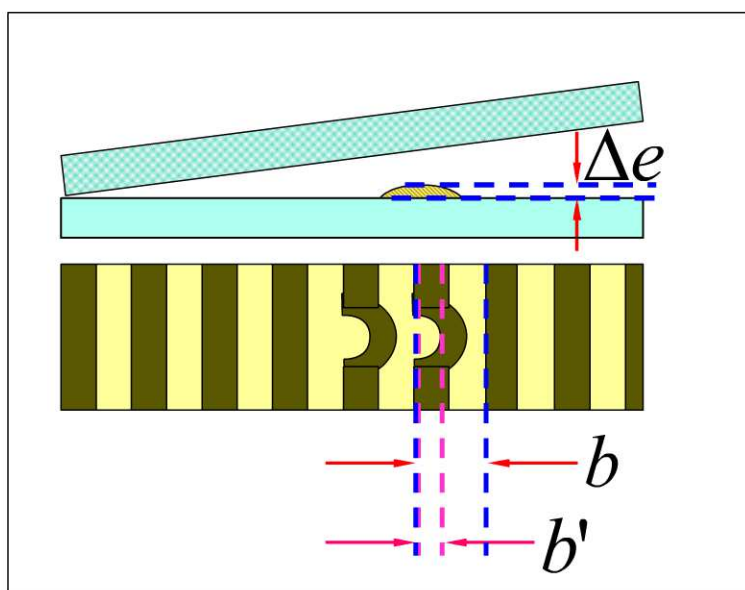
(2) 测膜厚



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



(3) 检验光学元件表面的平整度

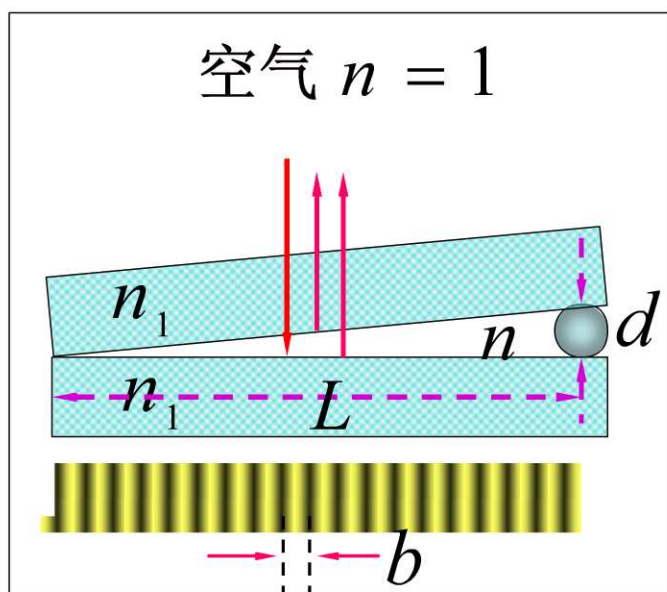


$$\Delta e = \frac{b'}{b} \frac{\lambda}{2}$$

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



(4) 测细丝的直径

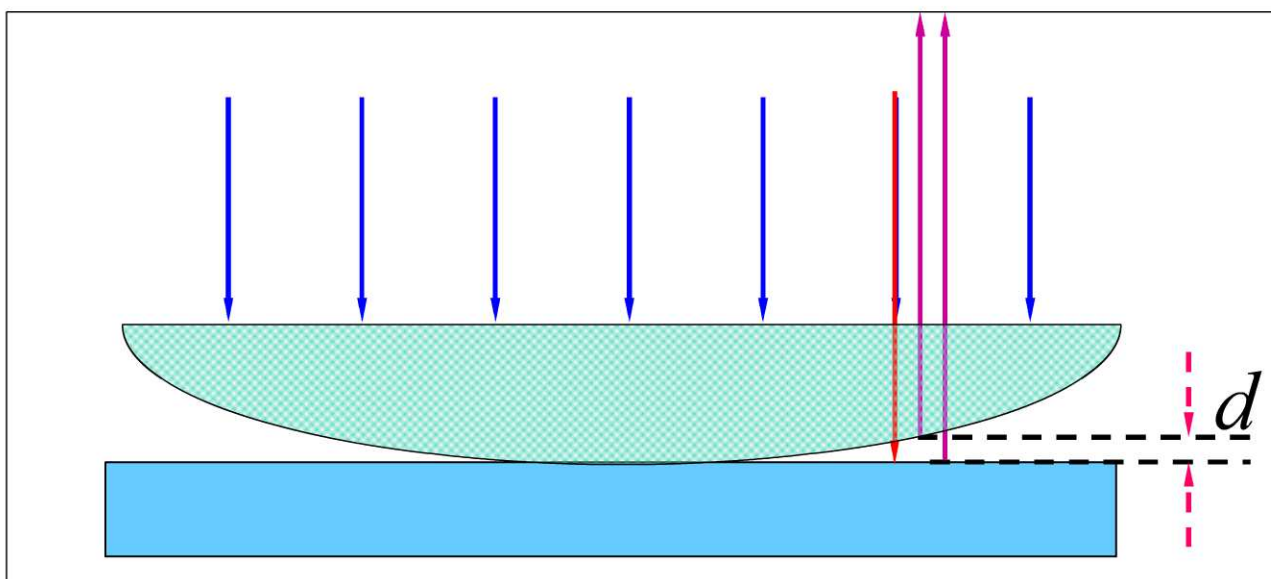


$$d = \frac{\lambda}{2n} \cdot \frac{L}{b}$$



二 牛顿环

由一块平板玻璃和一平凸透镜组成

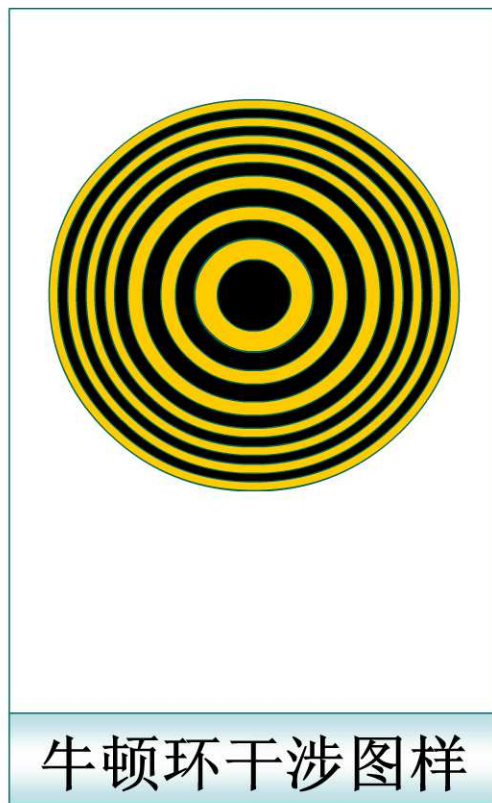
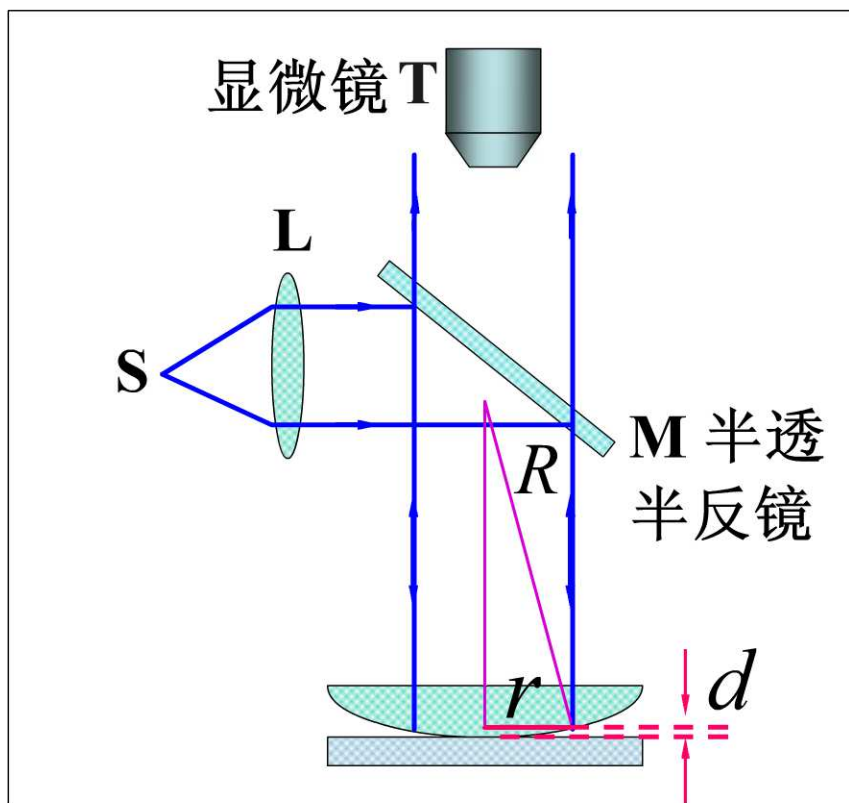


光程差

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



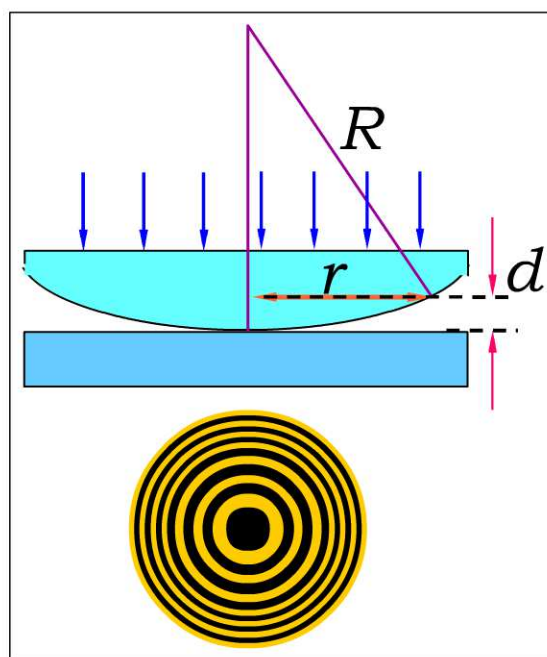
◆ 牛顿环实验装置



光程差

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

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

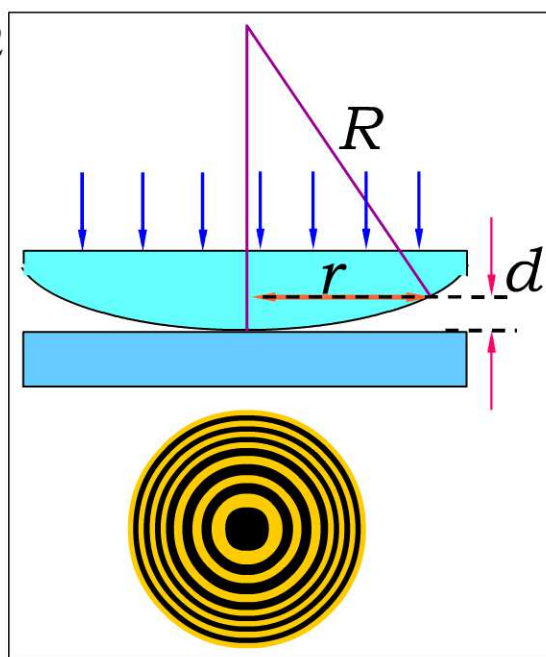


$$r^2 = R^2 - (R-d)^2 = 2dR - d^2$$

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

$$r = \sqrt{2dR} = \sqrt{\left(\Delta - \frac{\lambda}{2}\right)R}$$

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



讨论

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

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

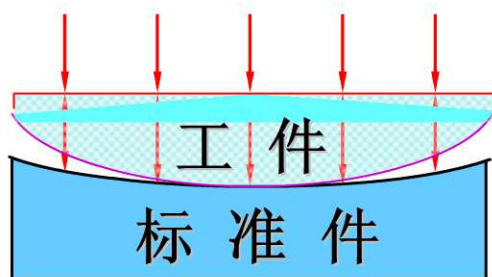
(1) 从反射光中观测，中心点是暗点还是亮点？从透射光中观测，中心点是暗点还是亮点？

(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。

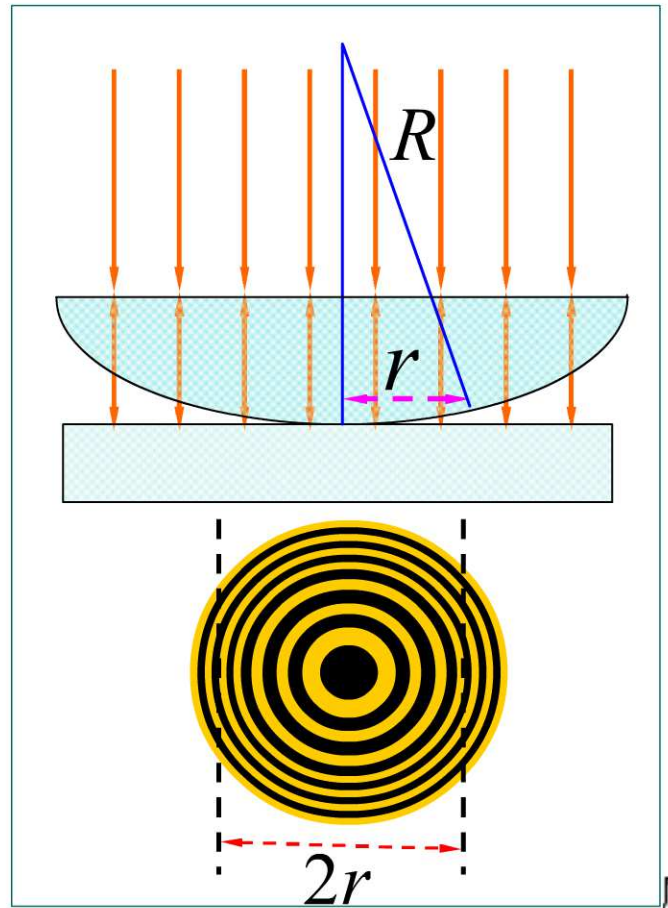


◆ 测量透镜的曲率半径

$$r_k^2 = kR \lambda$$

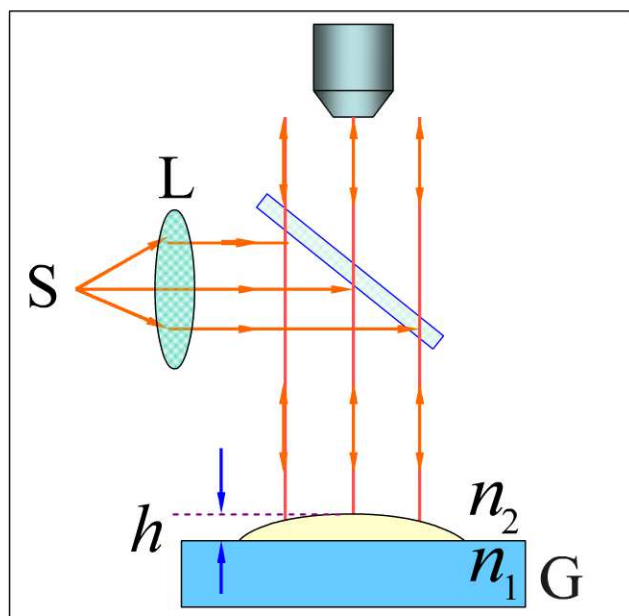
$$r_{k+m}^2 = (k + m)R \lambda$$

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

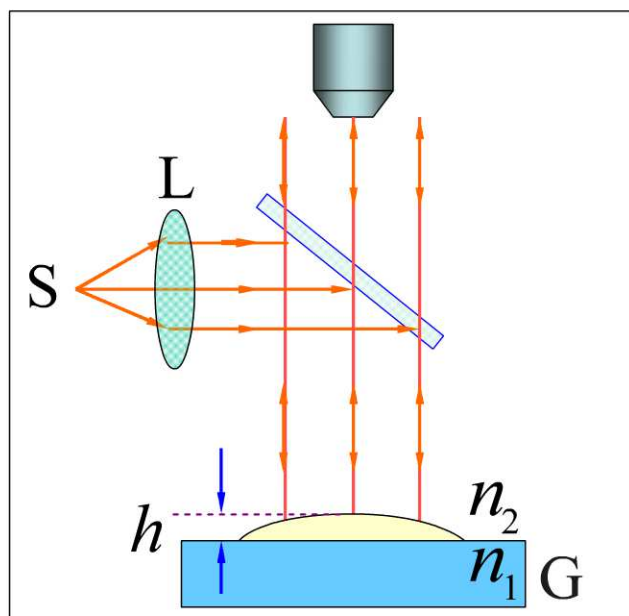


例2 如图所示为测量油膜折射率的实验装置，在平面玻璃片G上放一油滴，并展开成圆形油膜，在波长 $\lambda = 600 \text{ nm}$ 的单色光垂直入射下，从反射光中可观察到油膜所形成的干涉条纹。

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 $h = 8.0 \times 10^2 \text{ nm}$ 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？



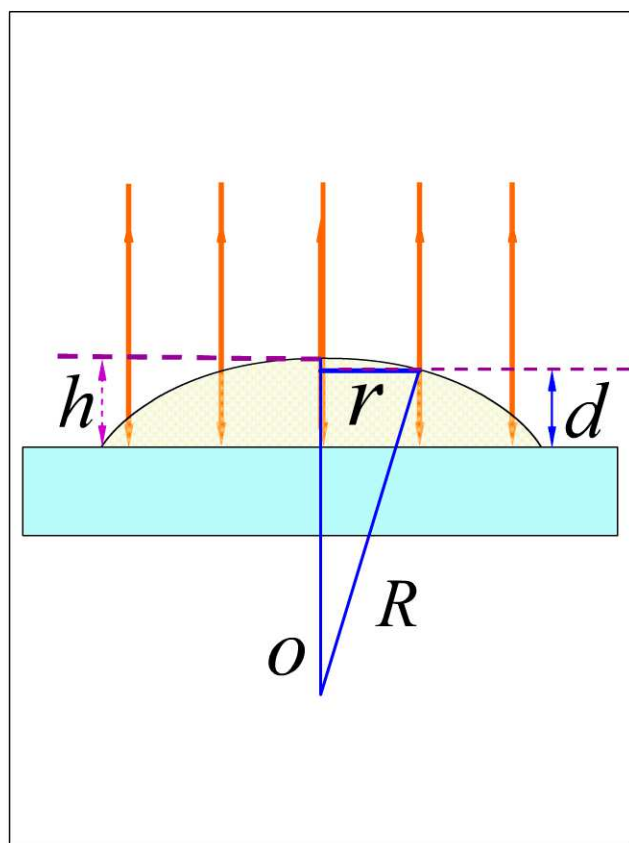
解 条纹为同心圆

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

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

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





油膜边缘 $k = 0, d_0 = 0$

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

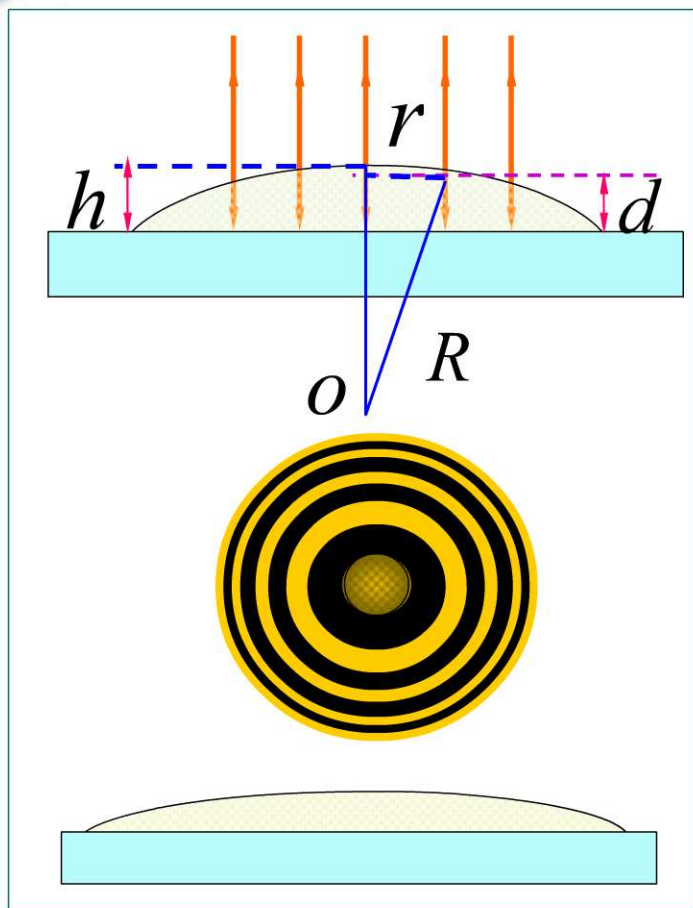
$$k = 2, d_2 = 500 \text{ nm}$$

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

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

由于 $h = 8.0 \times 10^2 \text{ nm}$ 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

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

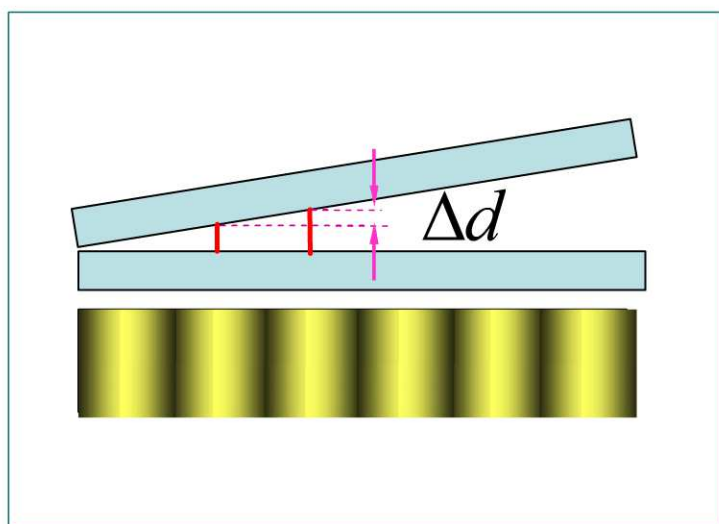
$$r^2 \approx 2R(h - d)$$

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



◆ 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。



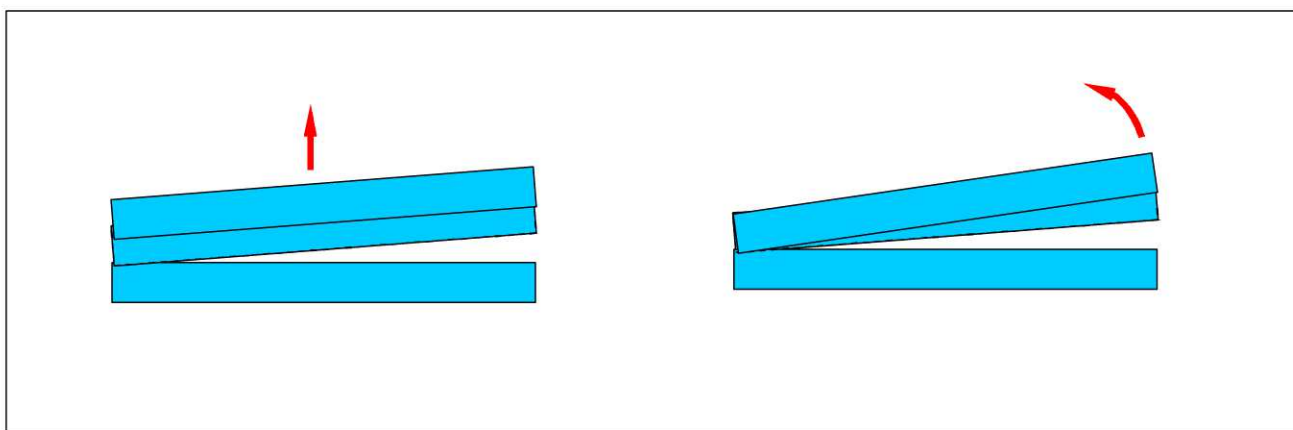
$$\Delta k = 1$$

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



(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.

