

第十九章 几何光学



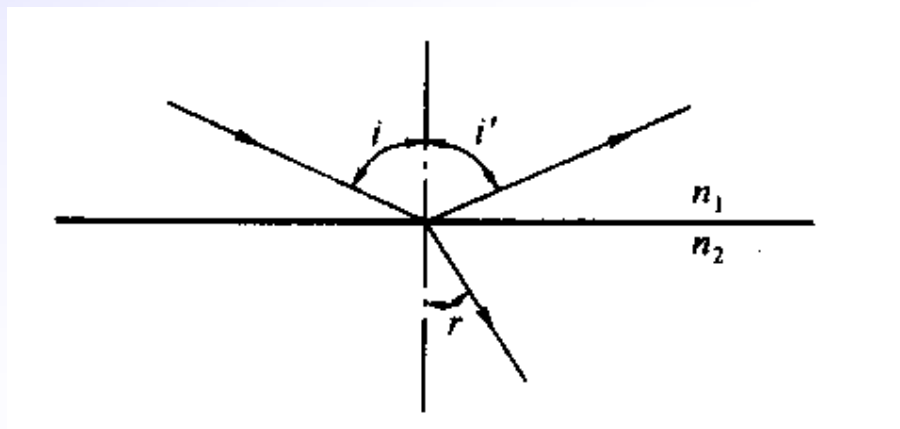
19-1 几何光学基本定律

一、几何光学基本定律

1.光的直线传播

2.反射定律 $i = i'$

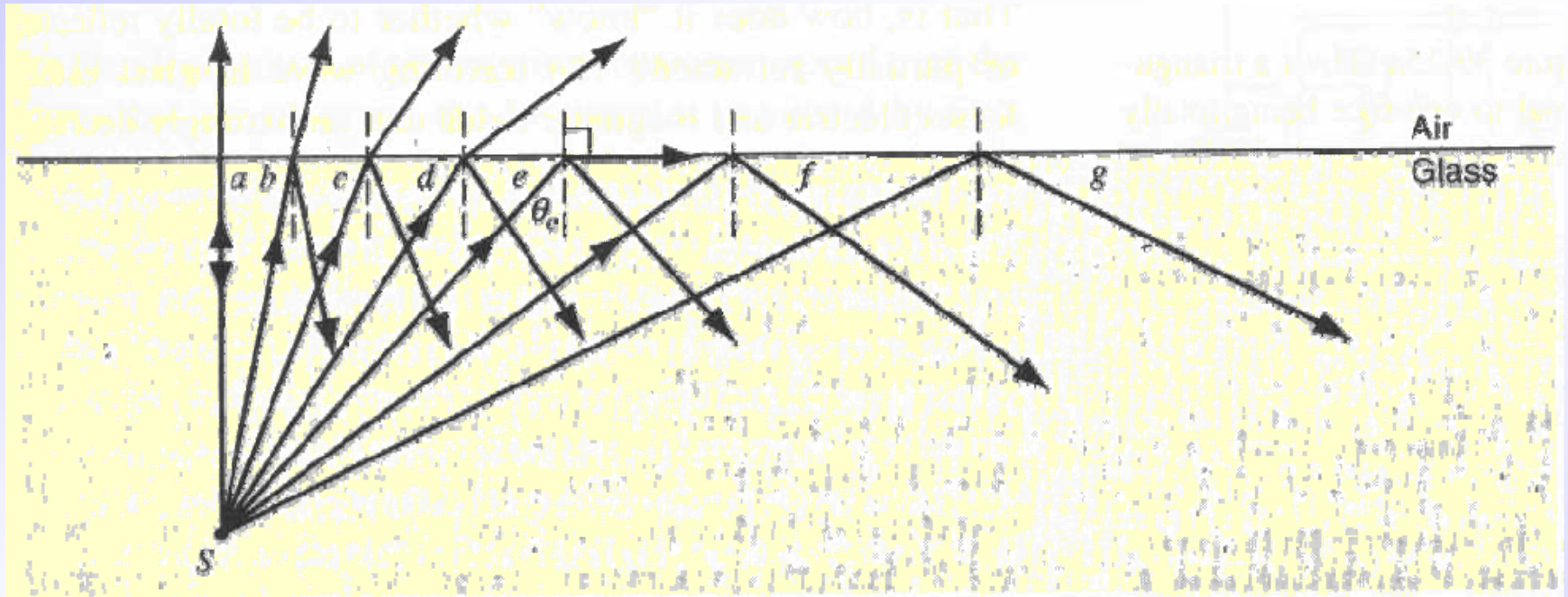
3.折射定律 $n_1 \sin i = n_2 \sin \gamma$



二、费马原理

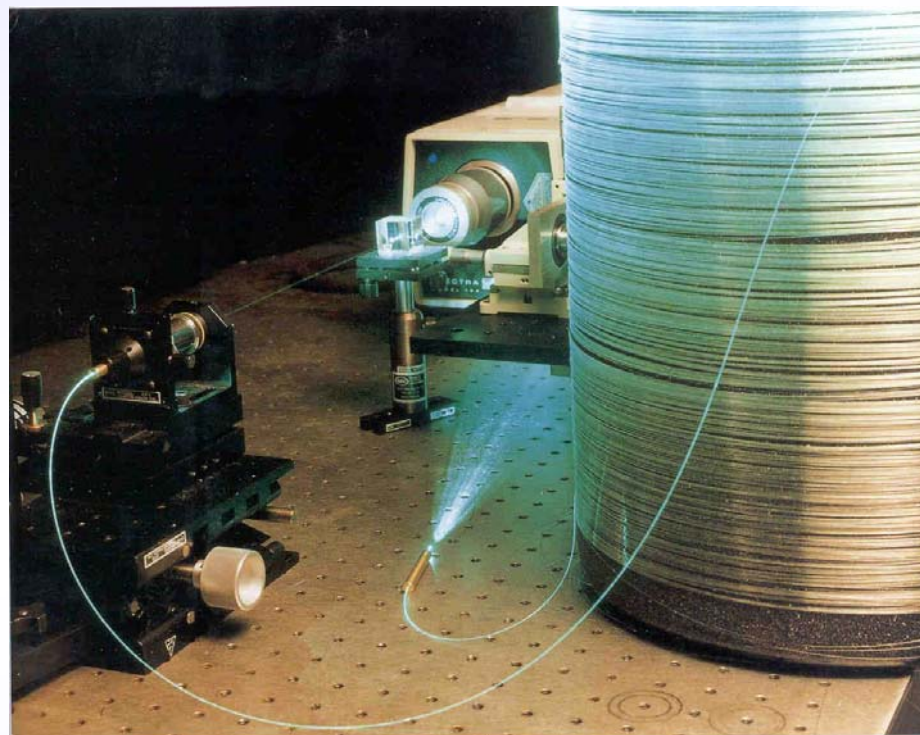
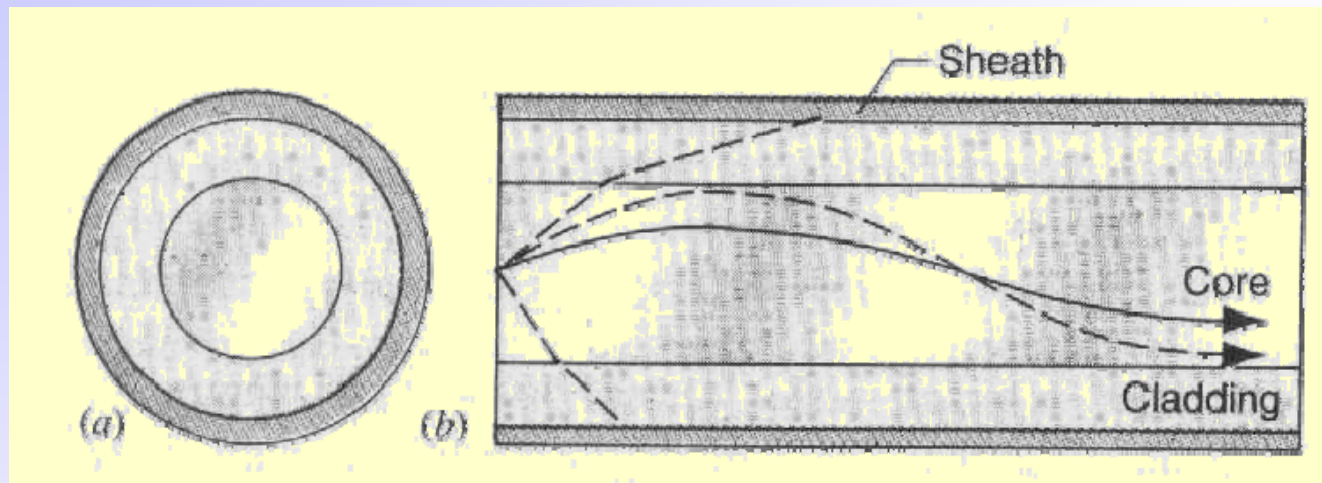
光从空间的一点到另一点是沿着光程为极值的路径传播的

19-2 全内反射



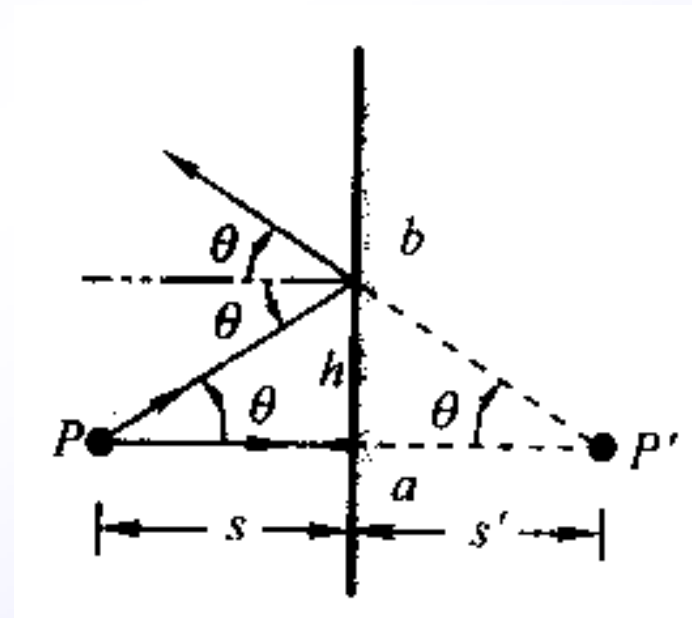
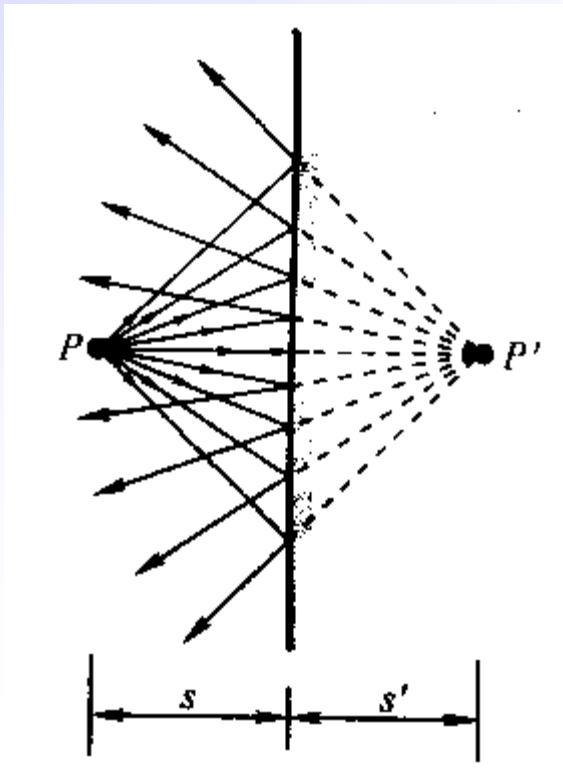
$$n_1 \sin \theta_c = n_2 \sin 90^\circ$$

$$\theta_c = \sin^{-1} \frac{n_2}{n_1}$$



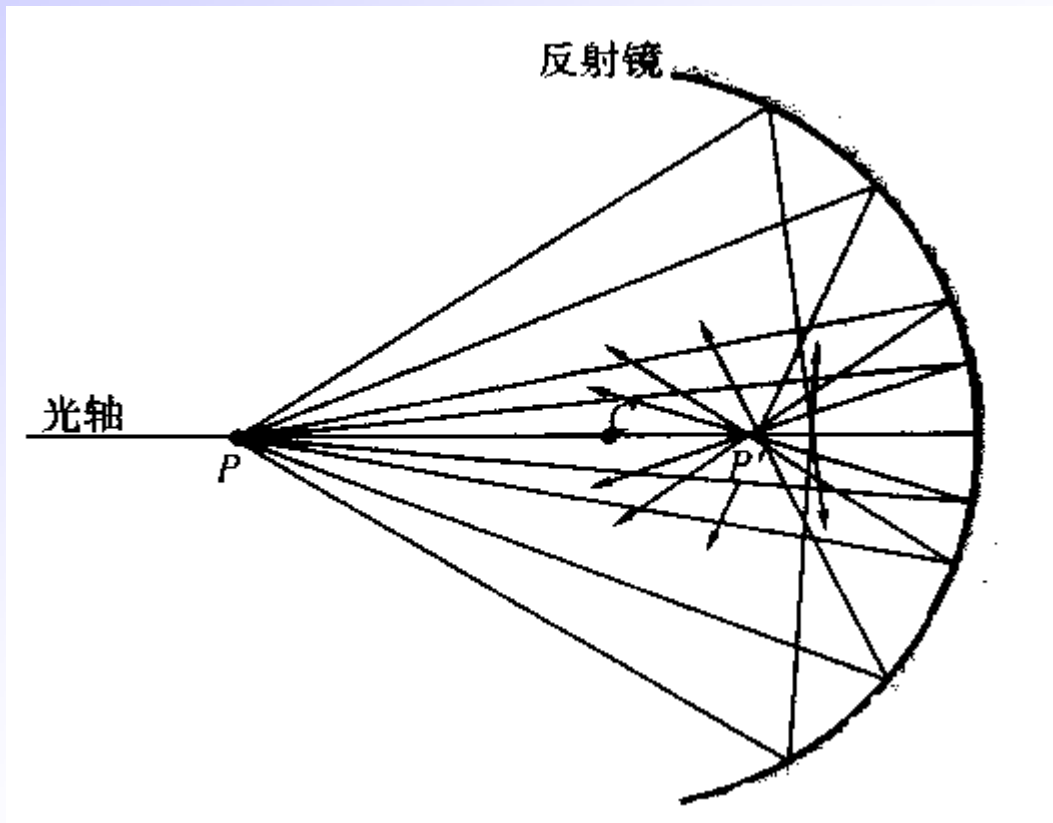
19-3 反射成像

一、平面镜反射成像



$$S = -S'$$

二、球面镜反射成像



光轴

傍轴光线

球面像差

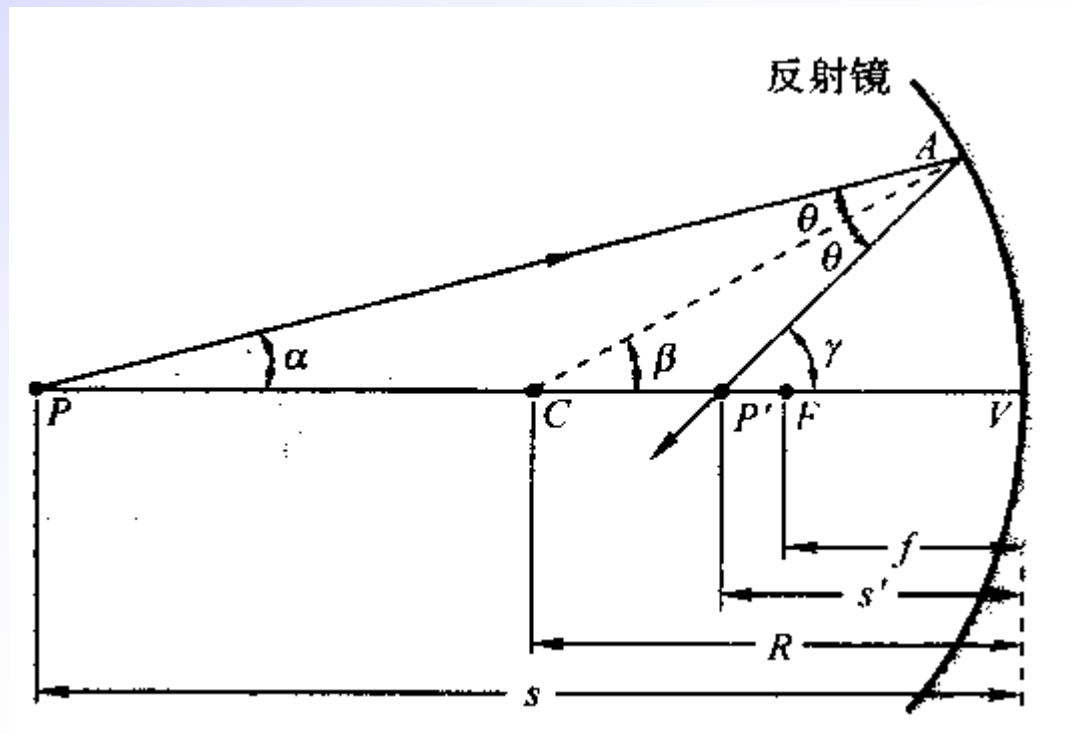
1. 镜像公式

$$\beta = \alpha + \theta, \quad \gamma = \alpha + 2\theta,$$

$$\therefore \alpha + \gamma = 2\beta$$

$$\alpha \approx \frac{l}{S}, \quad \beta = \frac{l}{R}, \quad \gamma \approx \frac{l}{S'}$$

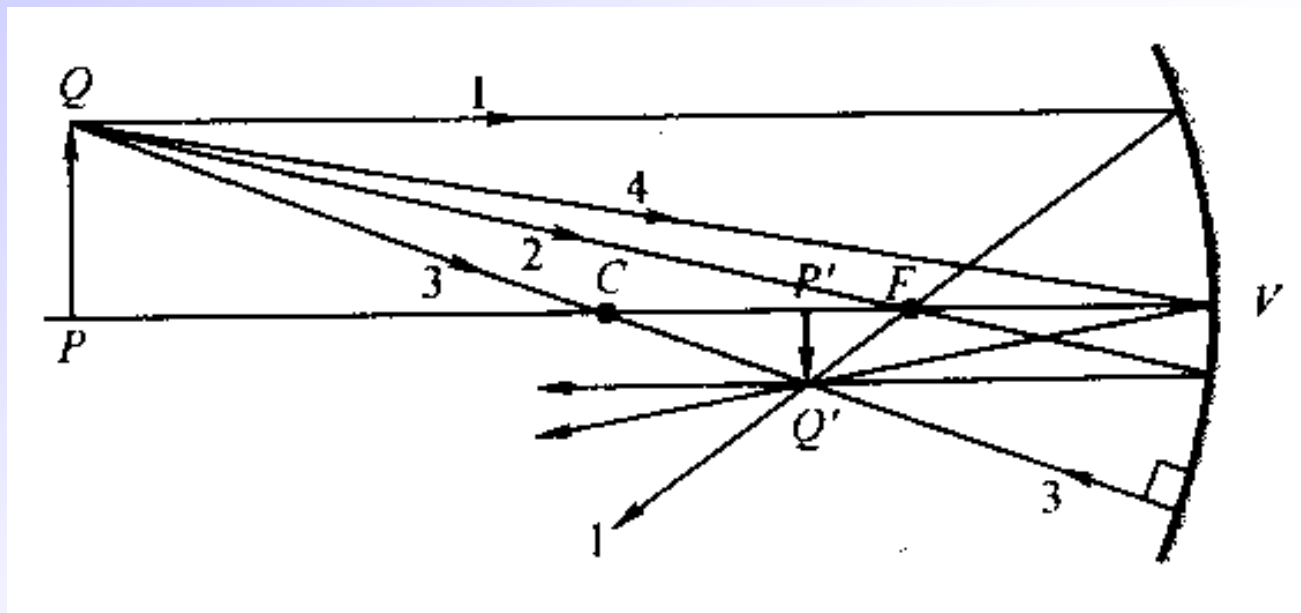
$$\therefore \frac{1}{S} + \frac{1}{S'} = \frac{2}{R}$$



$$S \rightarrow \infty, \quad S' = R/2 = f \qquad \therefore \frac{1}{S} + \frac{1}{S'} = \frac{1}{f}$$

$$R \rightarrow \infty, \quad S = -S'$$

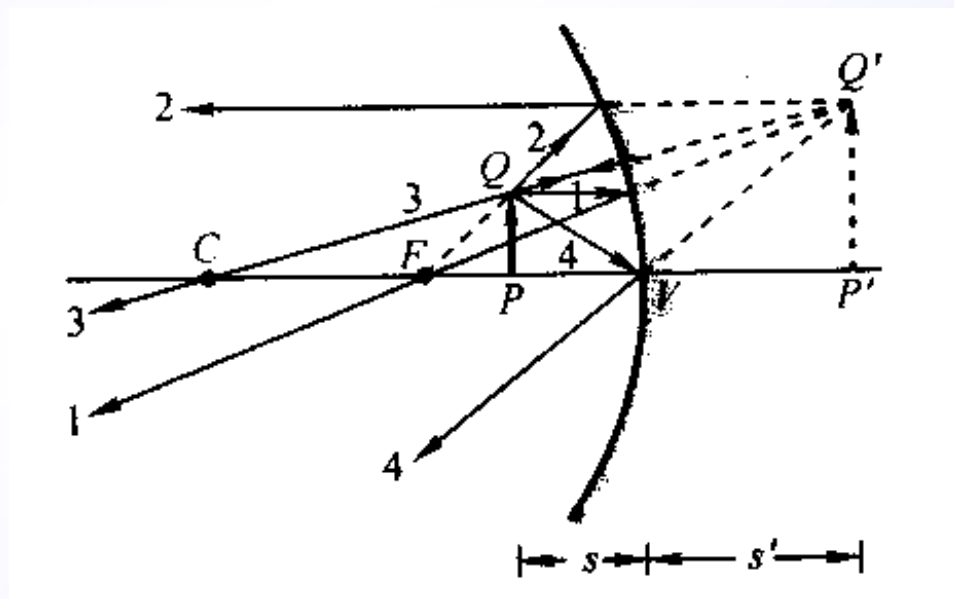
2.作图法



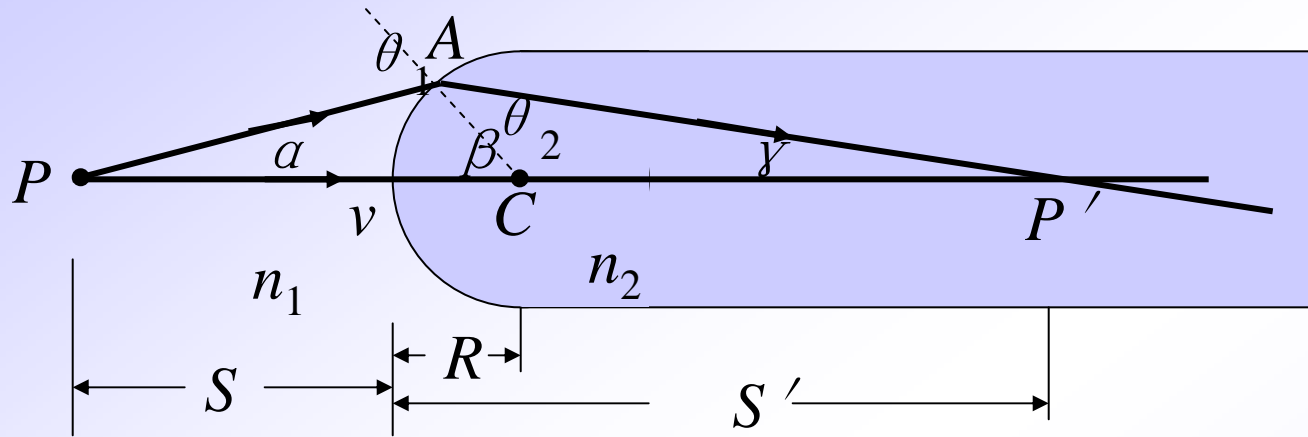
横向放大率

$$m = \frac{P'Q'}{PQ} = \frac{y'}{y}$$

三、符号法则



19-4 单球面折射成像



$$n_1 \sin \theta_1 = n_2 \sin \theta_2, \Rightarrow n_1 \theta_1 = n_2 \theta_2, \quad \theta_1 = \alpha + \beta \quad \beta = \theta_2 + \gamma$$

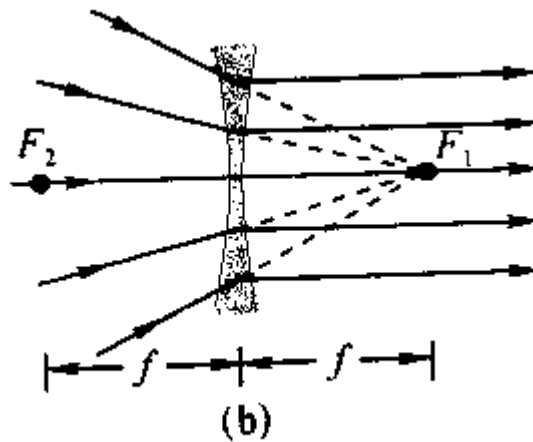
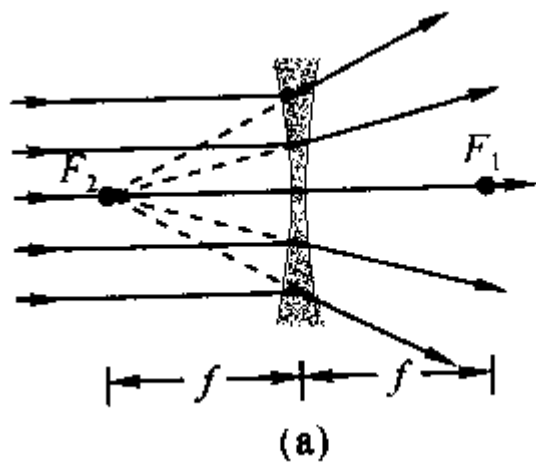
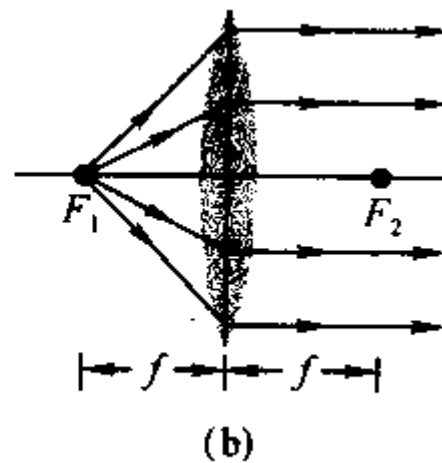
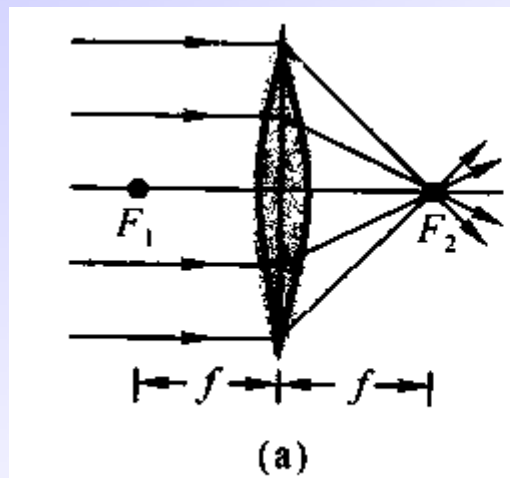
$$\therefore n_1 \alpha + n_2 \gamma = (n_2 - n_1) \beta \quad \because \alpha \approx \frac{l}{S}, \quad \beta = \frac{l}{R}, \quad \gamma \approx \frac{l}{S'}$$

$$\therefore \frac{n_1}{S} + \frac{n_2}{S'} = \frac{n_2 - n_1}{R}$$

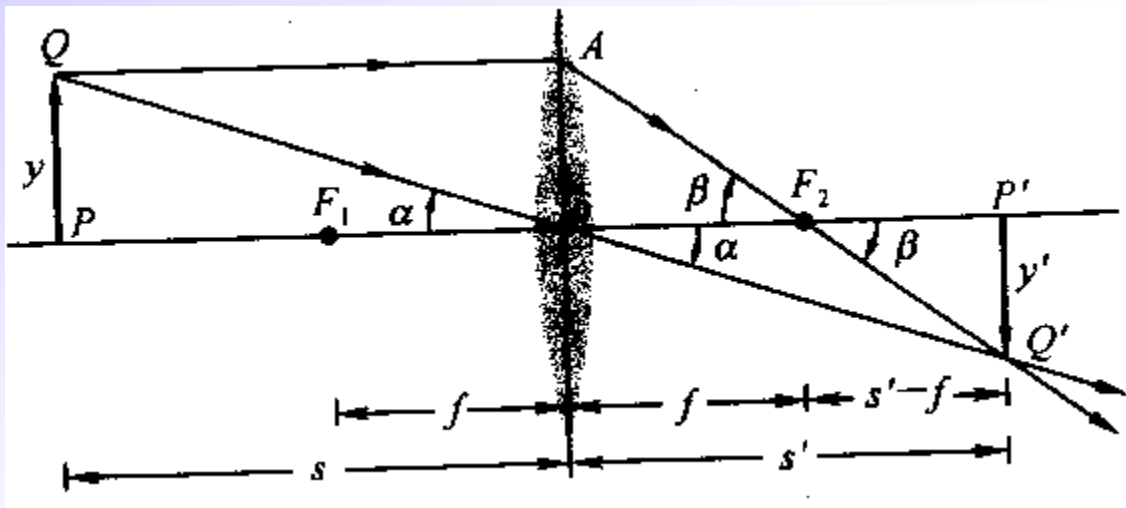
单球面折射成像的高斯公式

19- 5 薄透镜

一、正透镜 负透镜



二、薄透镜公式

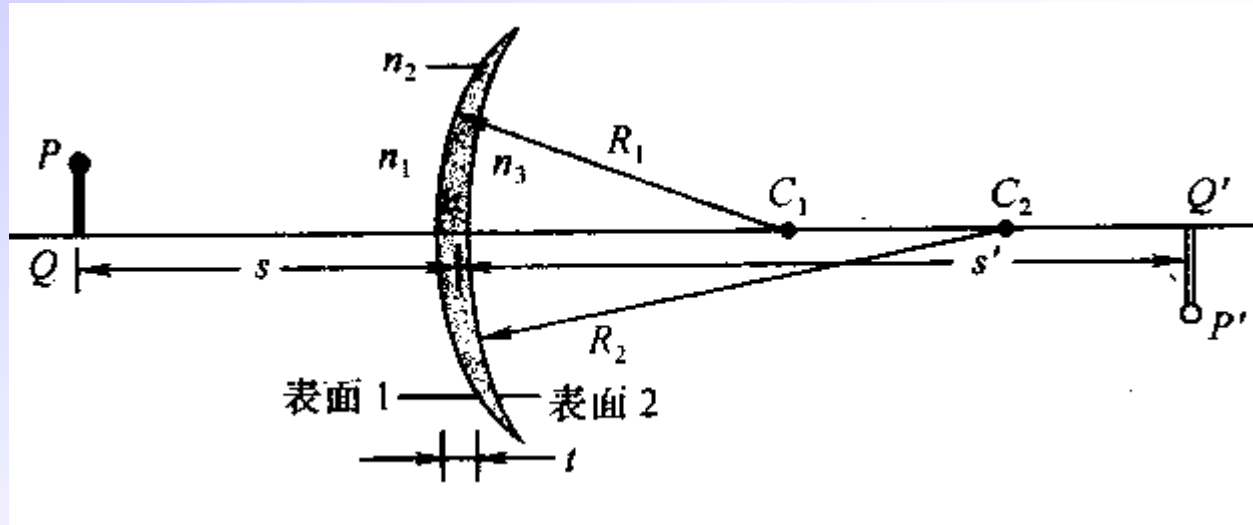


$$\frac{y}{S} = -\frac{y'}{S'} \quad \frac{y}{f} = -\frac{y'}{S' - f} \quad \therefore \frac{1}{S} + \frac{1}{S'} = \frac{1}{f}$$

薄透镜横向放大率

$$m = \frac{y'}{y} = -\frac{S'}{S}$$

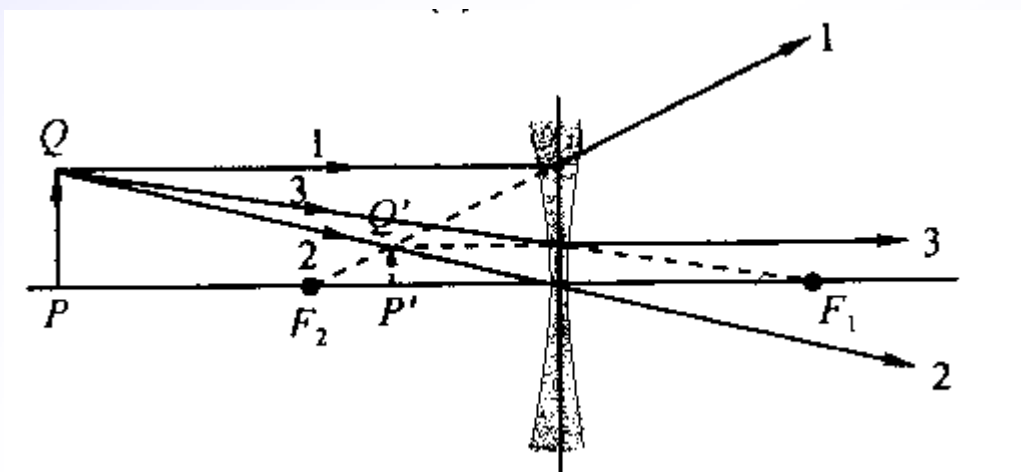
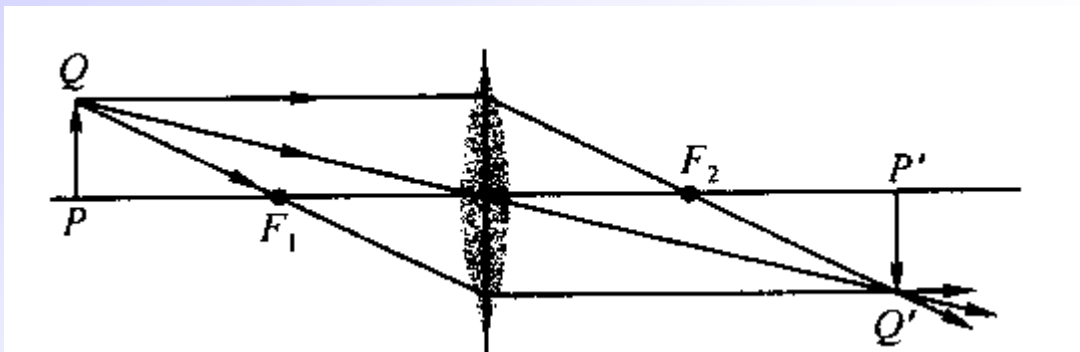
三、磨镜者公式



$$\frac{n_1}{S_1} + \frac{n_2}{S_1'} = \frac{n_2 - n_1}{R_1} \quad \frac{n_2}{S_2} + \frac{n_3}{S_2'} = \frac{n_3 - n_2}{R_2} \quad S_2 = -S_1'$$

$$\frac{1}{S} + \frac{1}{S'} = \frac{1}{f} \quad \frac{1}{f} = (n - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

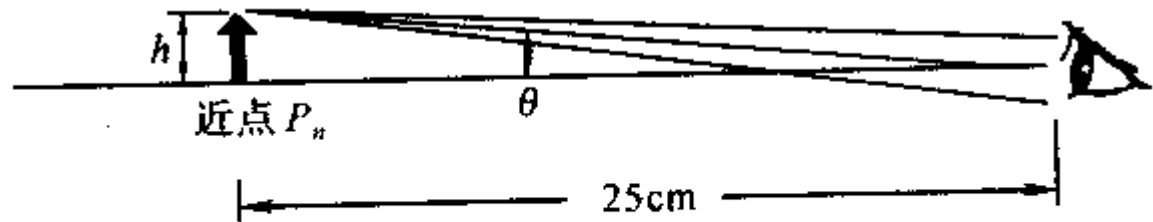
四、透镜作图法



19-6 光学器件

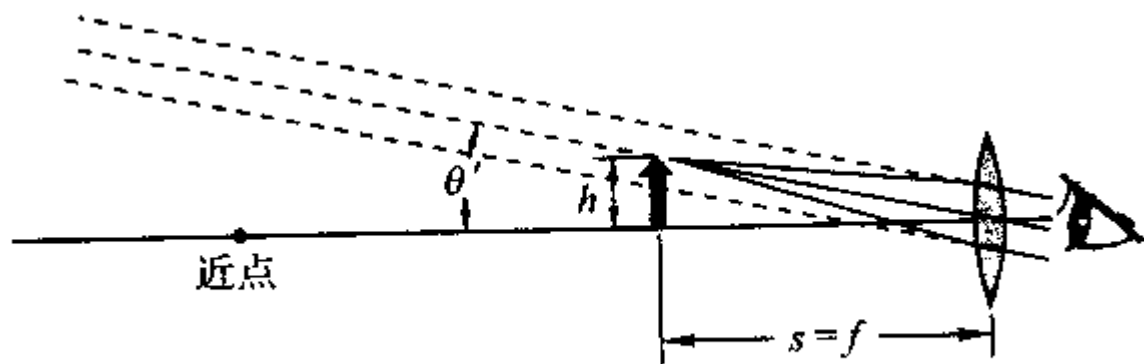
一、放大镜

$$\theta = \frac{h}{25\text{cm}}$$



(a) 物体在25cm处的近点所张角度 θ

$$\theta' = \frac{h}{f}$$

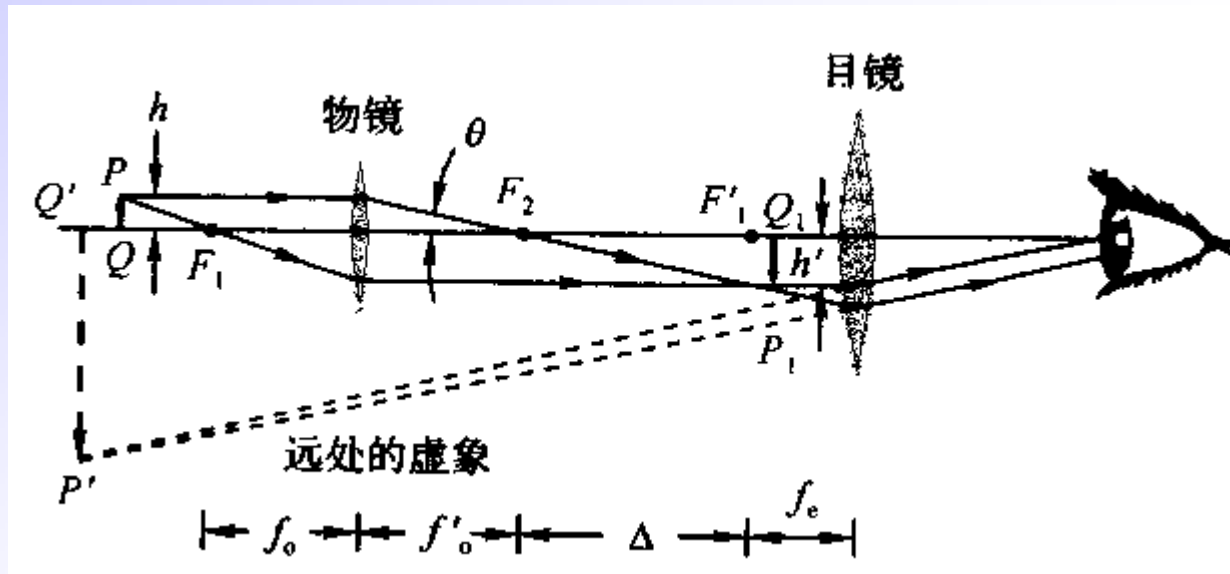


(b) 用焦距 f 的会聚透镜观看时，物的虚像所张角度 θ'

角放大率

$$m_\theta = \frac{\theta'}{\theta} = \frac{25\text{cm}}{f}$$

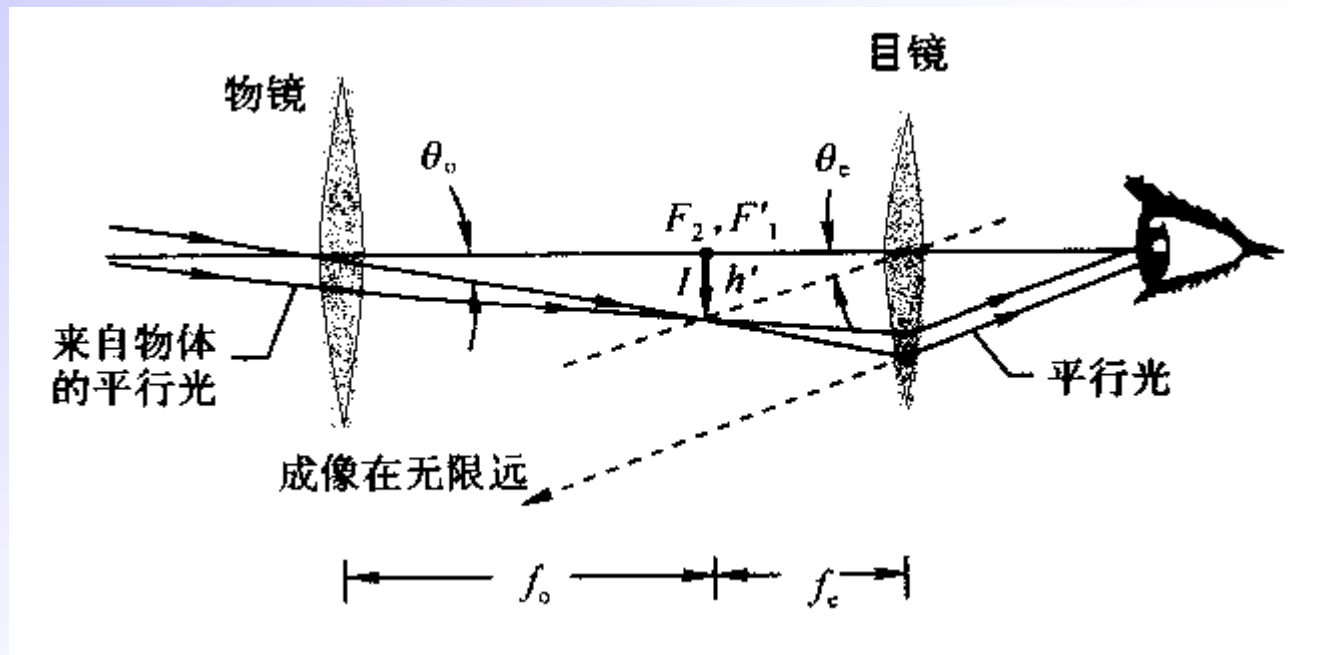
二、 显微镜



$$m = -\frac{S'}{S} \quad m_\theta = \frac{25\text{cm}}{f_e}$$

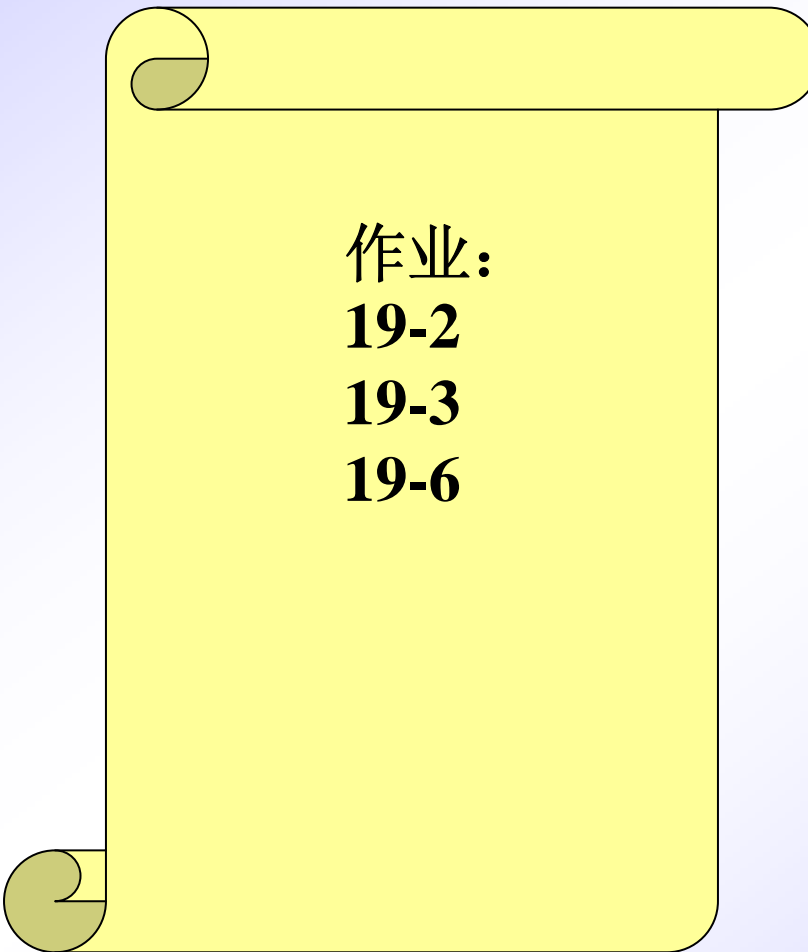
$$M = m \times m_\theta = -\left(\frac{S'}{S}\right)\left(\frac{25\text{cm}}{f_e}\right) \quad M = m \times m_\theta = -\left(\frac{f_0 + \Delta}{f_0}\right)\left(\frac{25\text{cm}}{f_e}\right)$$

三、望远镜



$$M = -\frac{\theta_e}{\theta_o} \quad \theta_o = \frac{h'}{f_o} \quad \theta_e = \frac{h'}{f_e}$$

$$M = -\frac{f_o}{f_e}$$



作业:

19-2

19-3

19-6