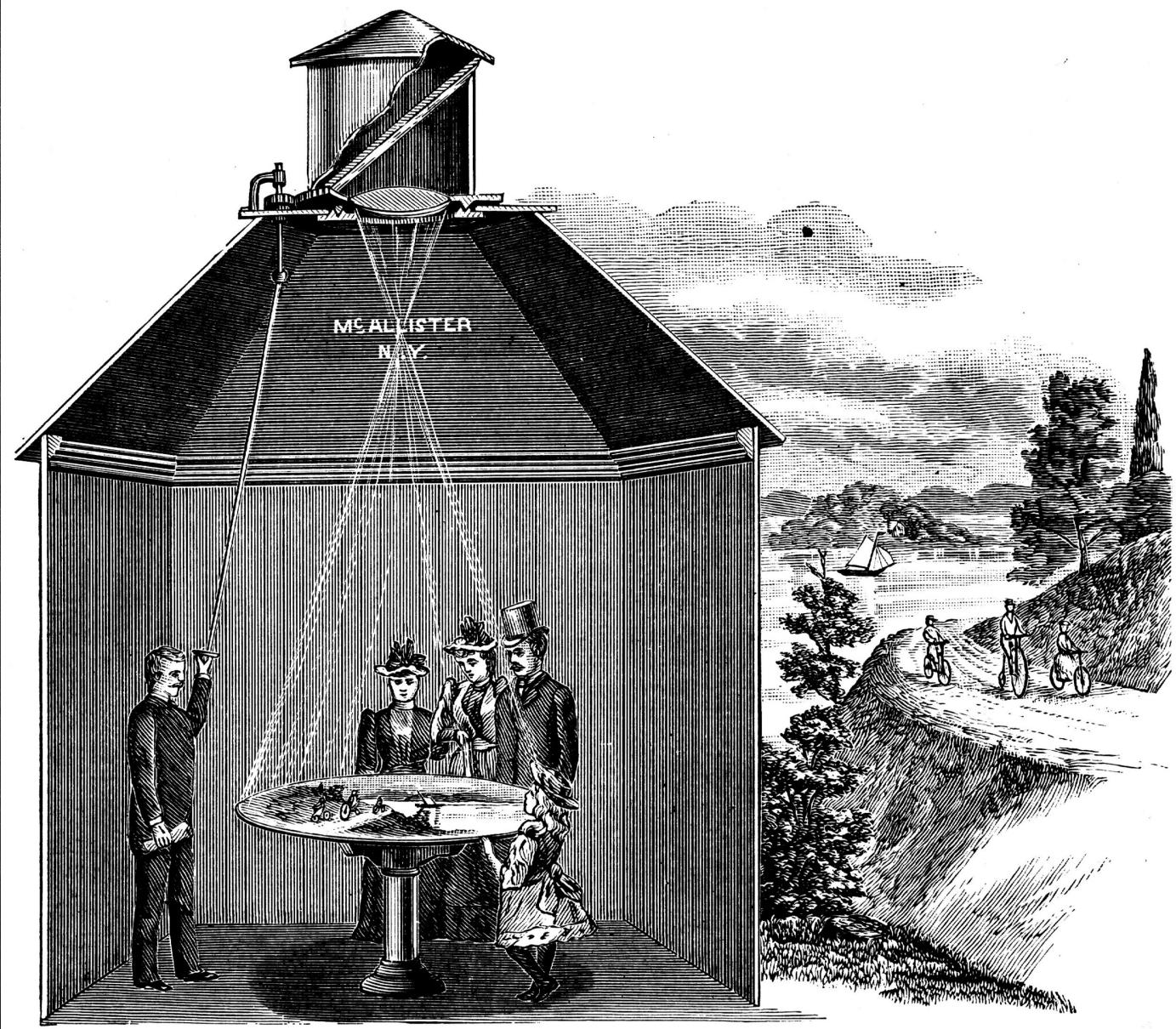
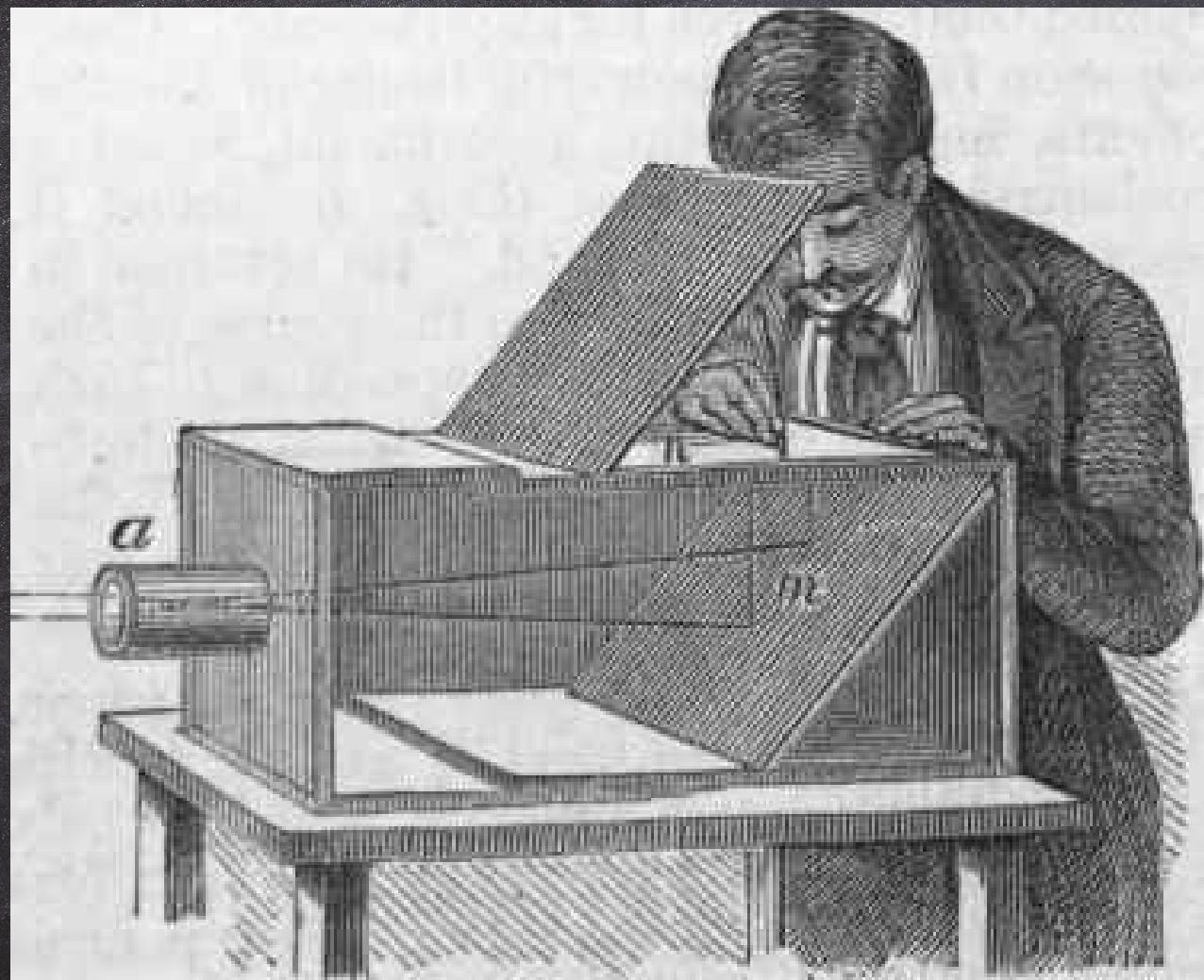


计算视觉与模式识别







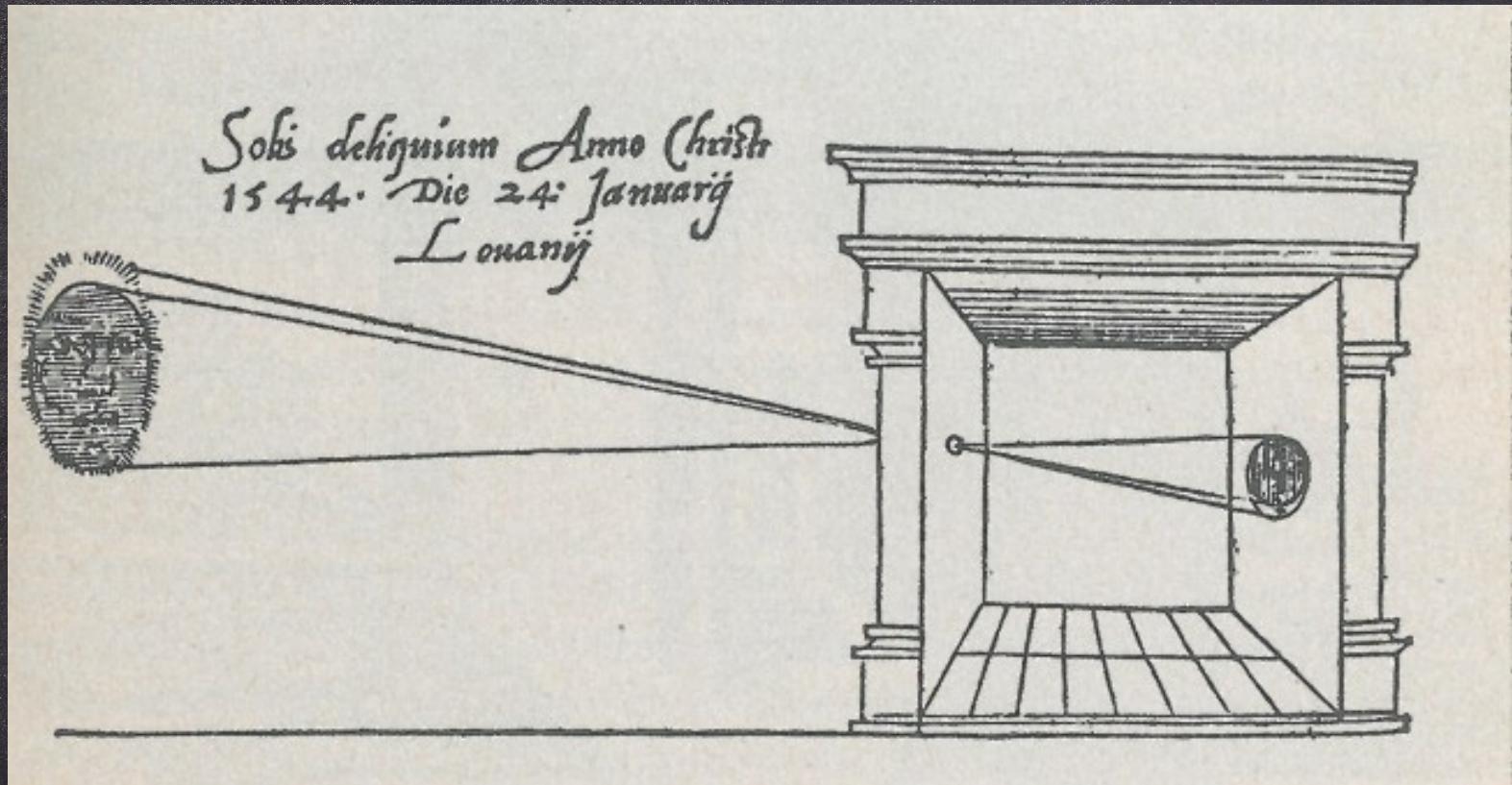
照相机与摄像机

1/1



针孔相机

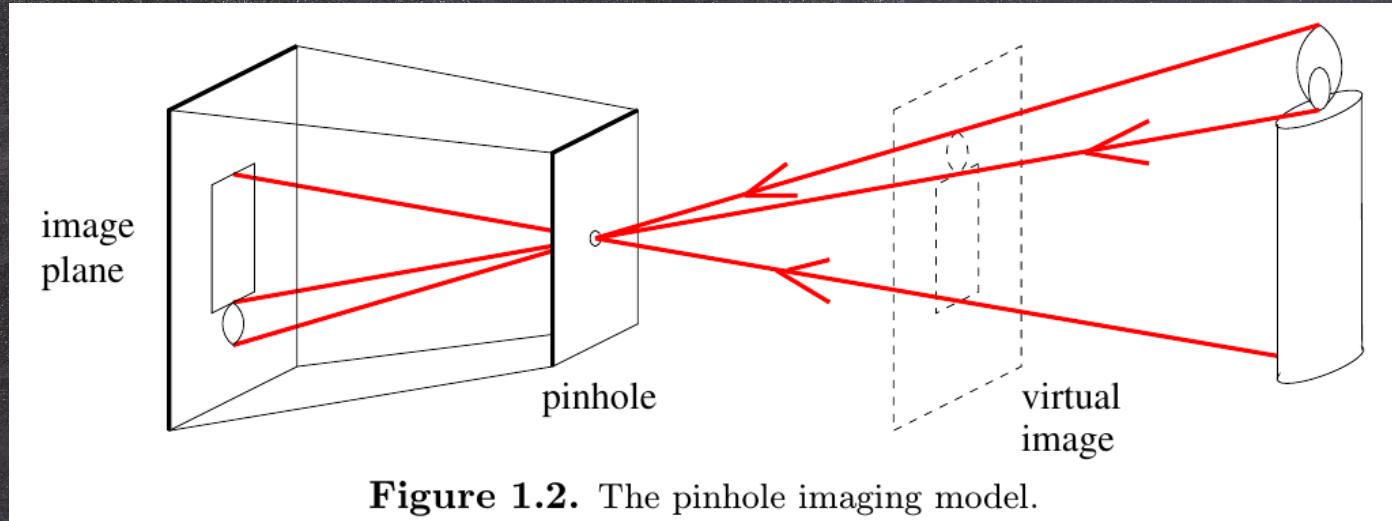
1/1

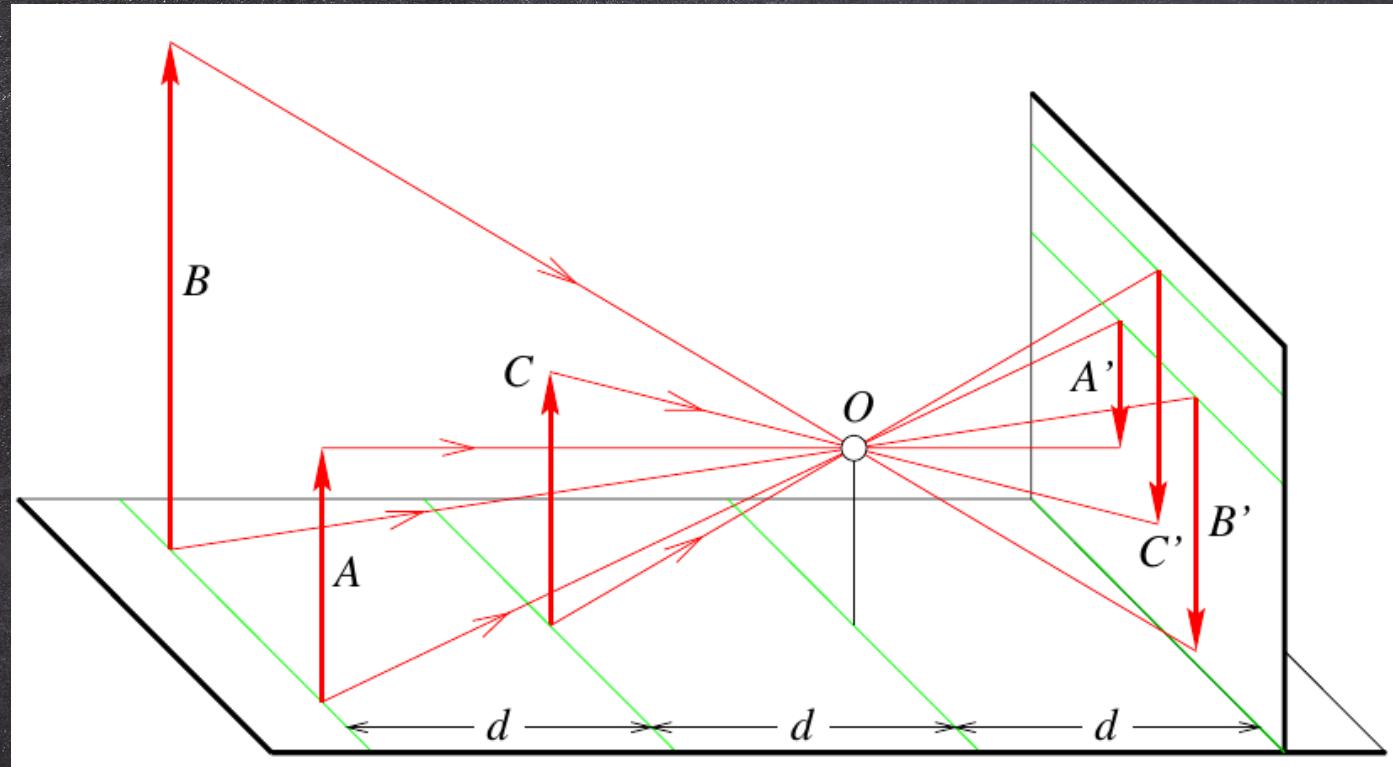


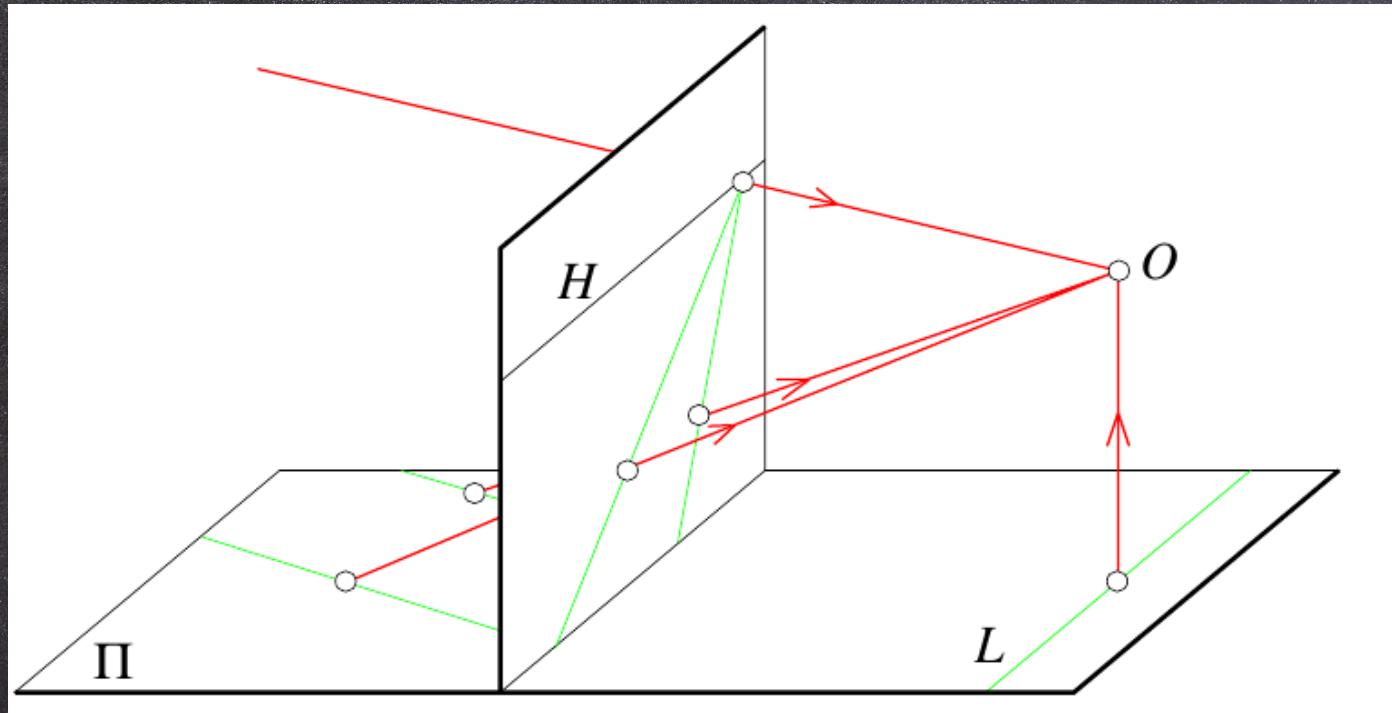
First published illustration of camera obscura in Gemma Frisius' book “De Radio Astronomica et Geometrica,” 1545 (Photo: Wikimedia Commons, Public domain)<https://mymodernmet.com/camera-obscura/>

透视投影

1/1







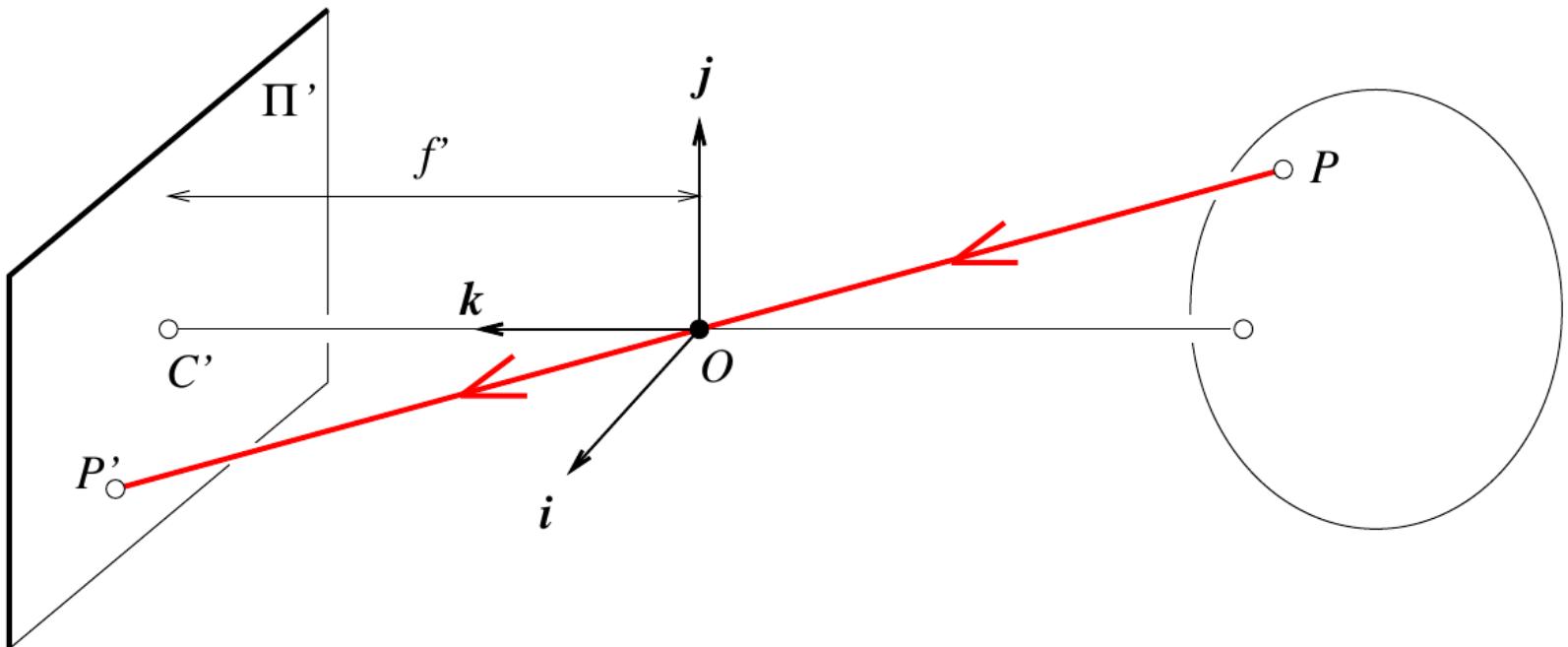


Figure 1.4. The perspective projection equations are derived in this section from the colinearity of the point P , its image P' and the pinhole O .

透视投影模型

$$\begin{pmatrix} x' \\ y' \\ f' \end{pmatrix} = \lambda \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

$$\lambda = \frac{x'}{x} = \frac{y'}{y} = \frac{f'}{z}$$

therefore

$$x' = f' \frac{x}{z}$$

$$y' = f' \frac{y}{z}$$

弱透视投影

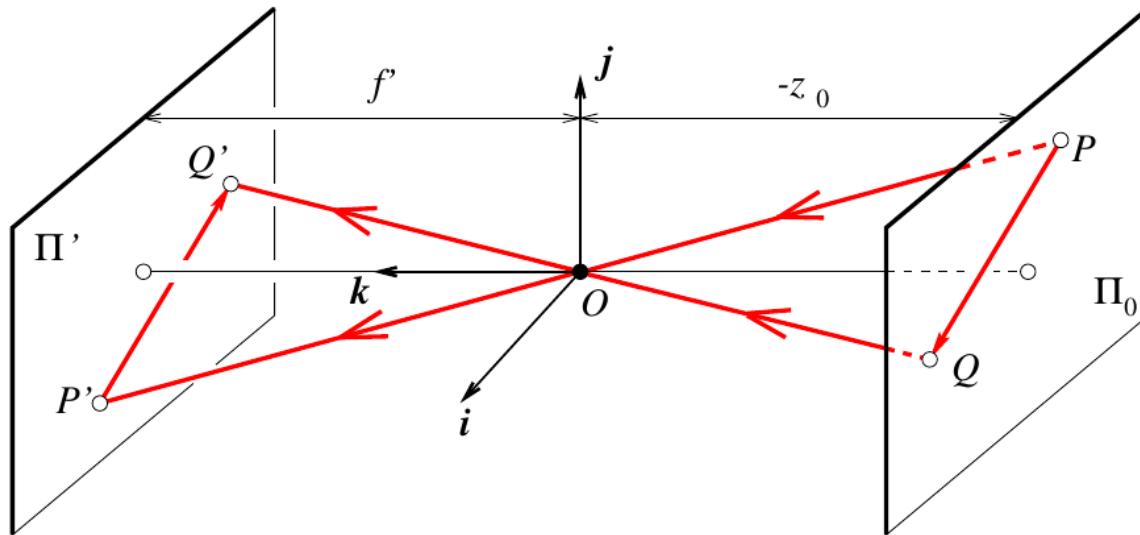


Figure 1.5. Weak-perspective projection: all line segments in the plane Π_0 are projected with the same magnification.

弱透视投影模型

1/1

$$x' = -mx$$

$$y' = -my$$

where

$$m = -\frac{f'}{z_0}$$

正交投影

1/1

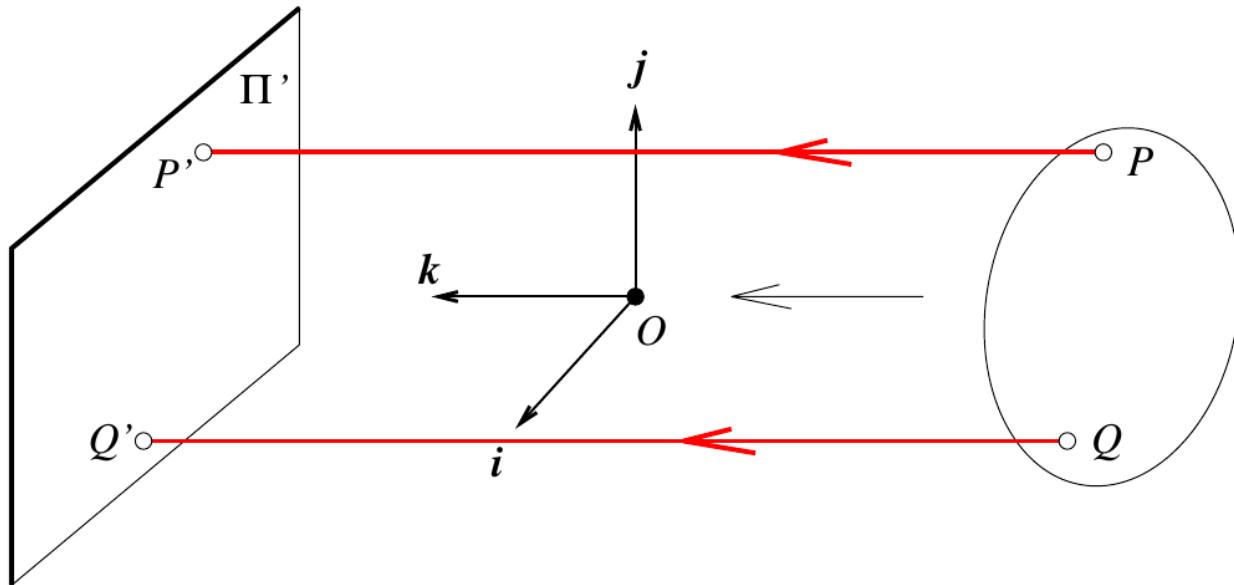


Figure 1.6. Orthographic projection. Unlike other geometric models of the image formation process, orthographic projection does not involve a reversal of image features. Accordingly, the magnification is taken to be negative, which is a bit unnatural but simplifies the projection equations.

正交投影模型

$$x' = x$$

$$y' = y$$

球面投影

1/1

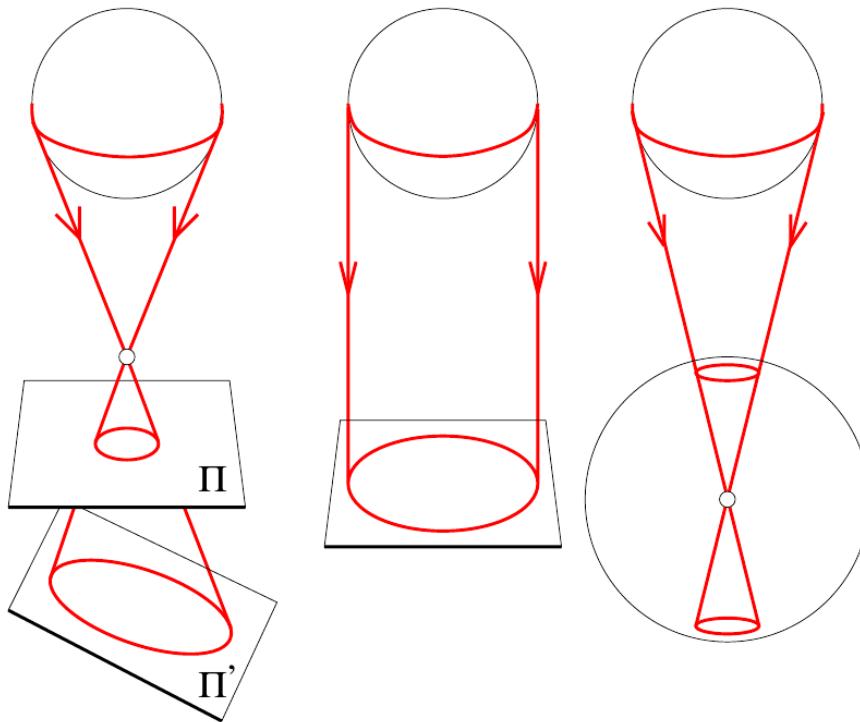


Figure 1.7. Different pictures of a sphere. Left: planar perspective projection. The shape of the sphere's silhouette depends on the orientation of the image plane: for a plane such as Π , which is orthogonal to the line passing through the sphere center and the pinhole, the silhouette is a circle. For oblique planes such as Π' , it is an ellipse (or possibly another conic section) instead. Middle: orthographic projection. Right: spherical perspective projection. The silhouette is always a circle under these two models.

带镜头的相机

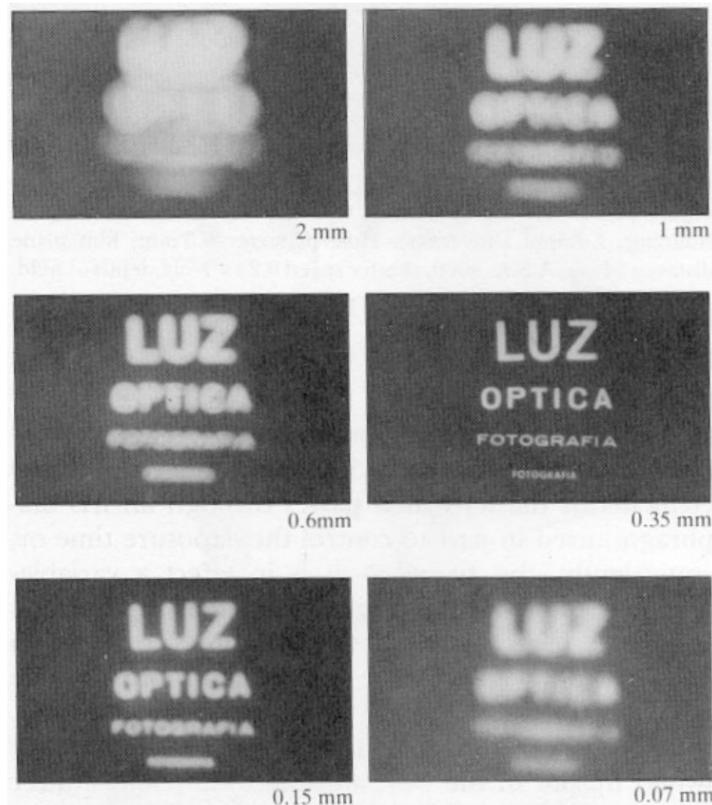


Figure 1.8. Images of some text obtained with shrinking pinholes: large pinholes give bright but fuzzy images but pinholes that are too small also give blurry images because of diffraction effects. Reprinted from [Hecht, 1987], Figure 5.108.

折射与反射

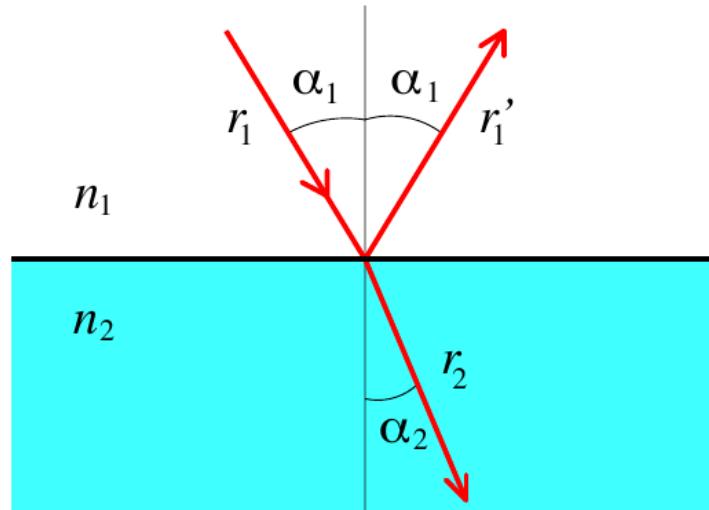


Figure 1.9. Reflection and refraction at the interface between two homogeneous media with indices of refraction n_1 and n_2 .

$$n_1 \sin \alpha_1 = n_2 \sin \alpha_2$$

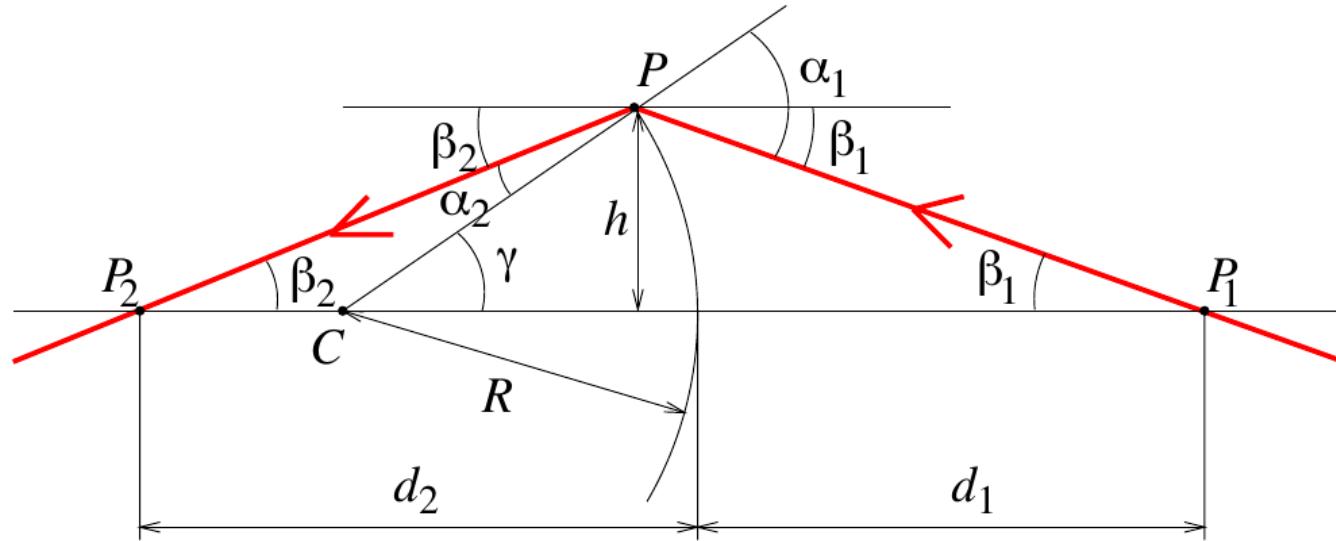


Figure 1.10. Paraxial refraction: a light ray passing through the point P is refracted at the point P_1 where it intersects a circular interface. The refracted ray intersects the optical axis in P_2 . The center of the interface is at the point C of the optical axis, and its radius is R . The angles α_1 , β_1 , α_2 and β_2 are all assumed to be small.

$$\begin{aligned}\alpha_1 &= \gamma + \beta_1 \\ &\approx h\left(\frac{1}{R} + \frac{1}{d_1}\right)\end{aligned}$$

$$\begin{aligned}a_2 &= \gamma - \beta_2 \\ &\approx h\left(\frac{1}{R} - \frac{1}{d_2}\right)\end{aligned}$$

$$\begin{aligned}n_1\alpha_1 &\approx n_2\alpha_2 \\ \frac{n_1}{d_1} + \frac{n_2}{d_2} &= \frac{n_2 - n_1}{R}\end{aligned}$$

薄透镜

1/1

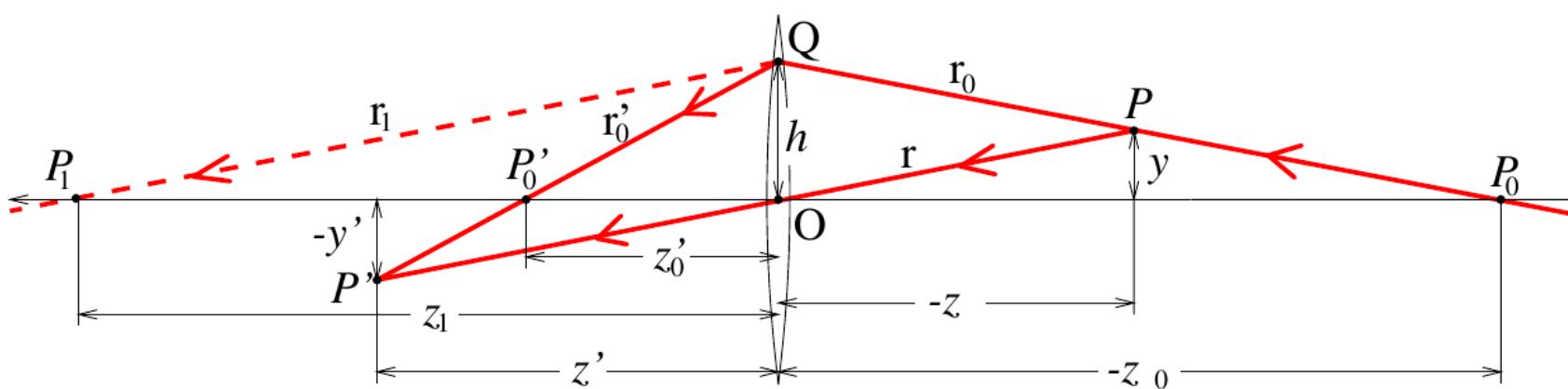


Figure 1.11. Image formation in the case of a thin lens. The ray r_1 is dashed to indicate that it will never actually reach the point P_1 since it will be refracted by the left boundary of the lens before that. Note that the z axis is oriented from right to left to ensure consistency with the previous figures, thus P and P_0 have negative depths z and z_0 .

$$\frac{1}{R} + \frac{1}{-z_0} = n \left(\frac{1}{R} - \frac{1}{z_1} \right)$$

$$n \left(\frac{1}{R} + \frac{1}{z_1} \right) = \frac{1}{R} + \frac{1}{z'_0}$$

$$\frac{1}{z'_0} + \frac{1}{-z_0} = \frac{2n-2}{R}$$

$$\frac{1}{z'_0} - \frac{1}{z_0} = \frac{1}{f} \quad f = \frac{R}{2n-2}$$

凸透镜成像

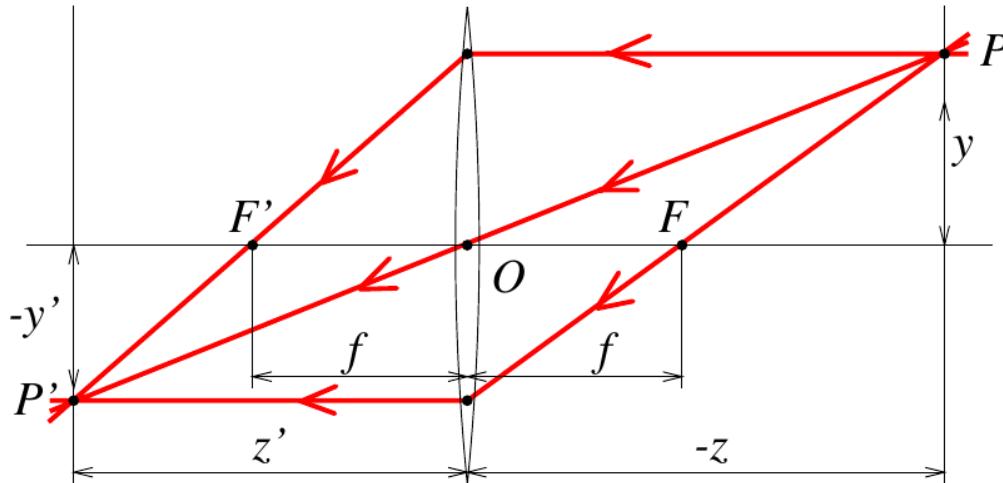


Figure 1.12. The focal points of a thin lens.

$$\frac{1}{z'} - \frac{1}{z} = \frac{1}{f}$$

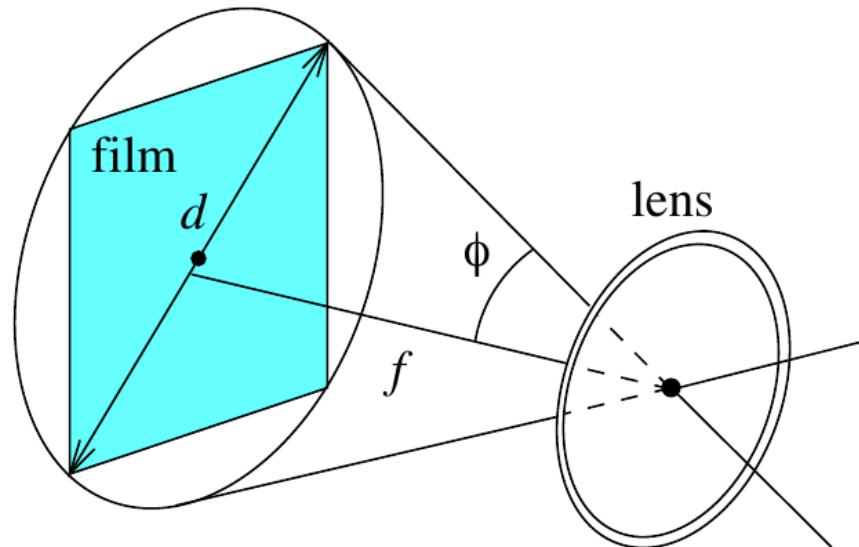


Figure 1.13. The field of view of a camera. It can be defined as 2ϕ , where $\phi \stackrel{\text{def}}{=} \arctan \frac{d}{2f}$, d is the diameter of the sensor (film or CCD chip) and f is the focal length of the camera.

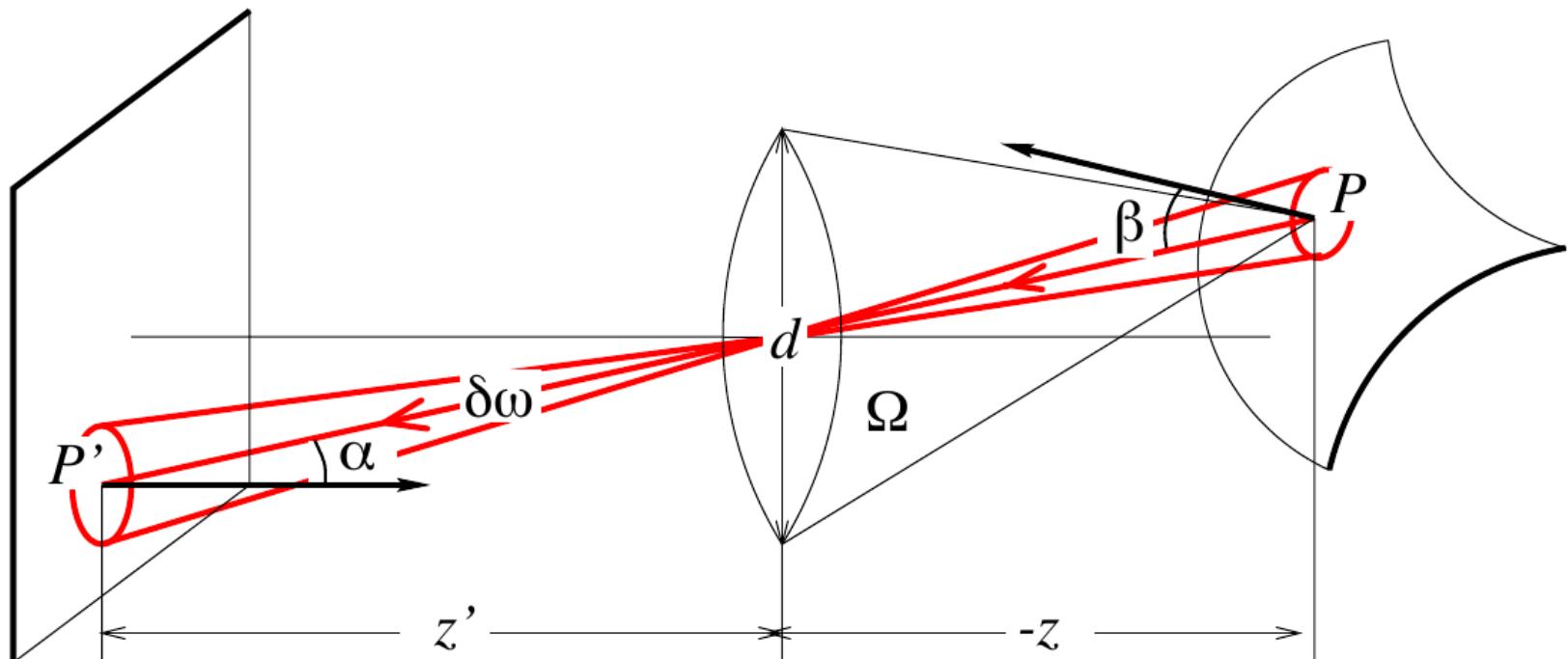


Figure 1.14. Object radiance and image irradiance.

$$\begin{aligned}\Omega &= \frac{\pi d^2}{4} \cdot \text{co}\alpha \cdot \frac{1}{|\vec{OP}|^2} \\ &= \frac{\pi d^2}{4} \cdot \frac{\cos^3\alpha}{z^2} \\ \delta P &= L\Omega\delta A \cos\beta \\ &= \frac{\pi d^2}{4} \cdot \frac{\cos^3\alpha}{z^2} L \cos\beta \delta A \\ E &= \frac{\delta P}{\delta A'} \\ &= \frac{\pi d^2}{4} \cdot \frac{\cos^3\alpha}{z^2} L \cos\beta \frac{\delta A}{\delta A'}\end{aligned}$$

$$\frac{\delta A \cos \beta}{|\vec{OP}|^2} = \frac{\delta A' \cos \alpha}{|\vec{OP'}|^2}$$

$$\delta A \cos \beta \cdot \frac{\cos^2 \alpha}{z} = \delta A' \cos^3 \alpha \cdot \frac{\cos^2 \alpha}{z'}$$

$$\frac{\delta A}{\delta A'} = \frac{\cos \alpha}{\cos \beta} \left(\frac{z}{z'} \right)^2$$

$$\begin{aligned} E &= \frac{\pi d^2}{4} \cdot \frac{\cos^3 \alpha}{z^2} L \cos \beta \frac{\delta A}{\delta A'} \\ &= \frac{\pi}{4} \left(\frac{d}{z'} \right)^2 \cos^4 \alpha L \end{aligned}$$

真实透镜

1/1

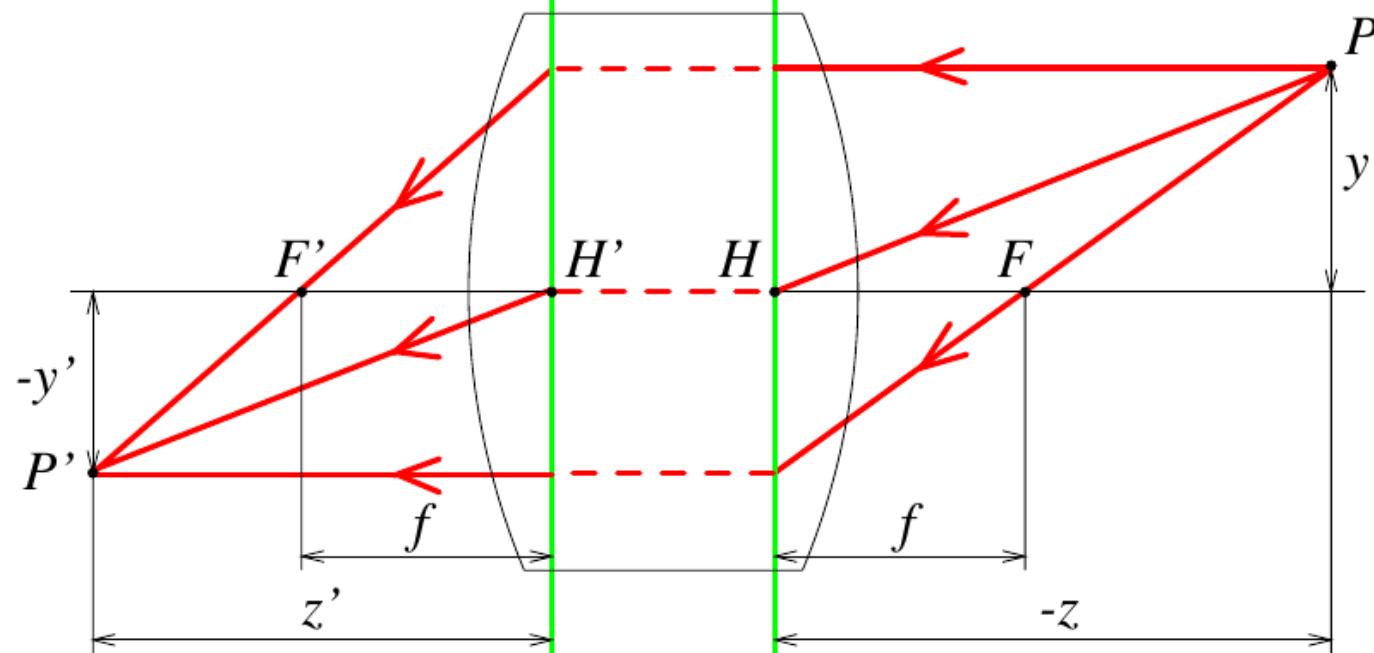
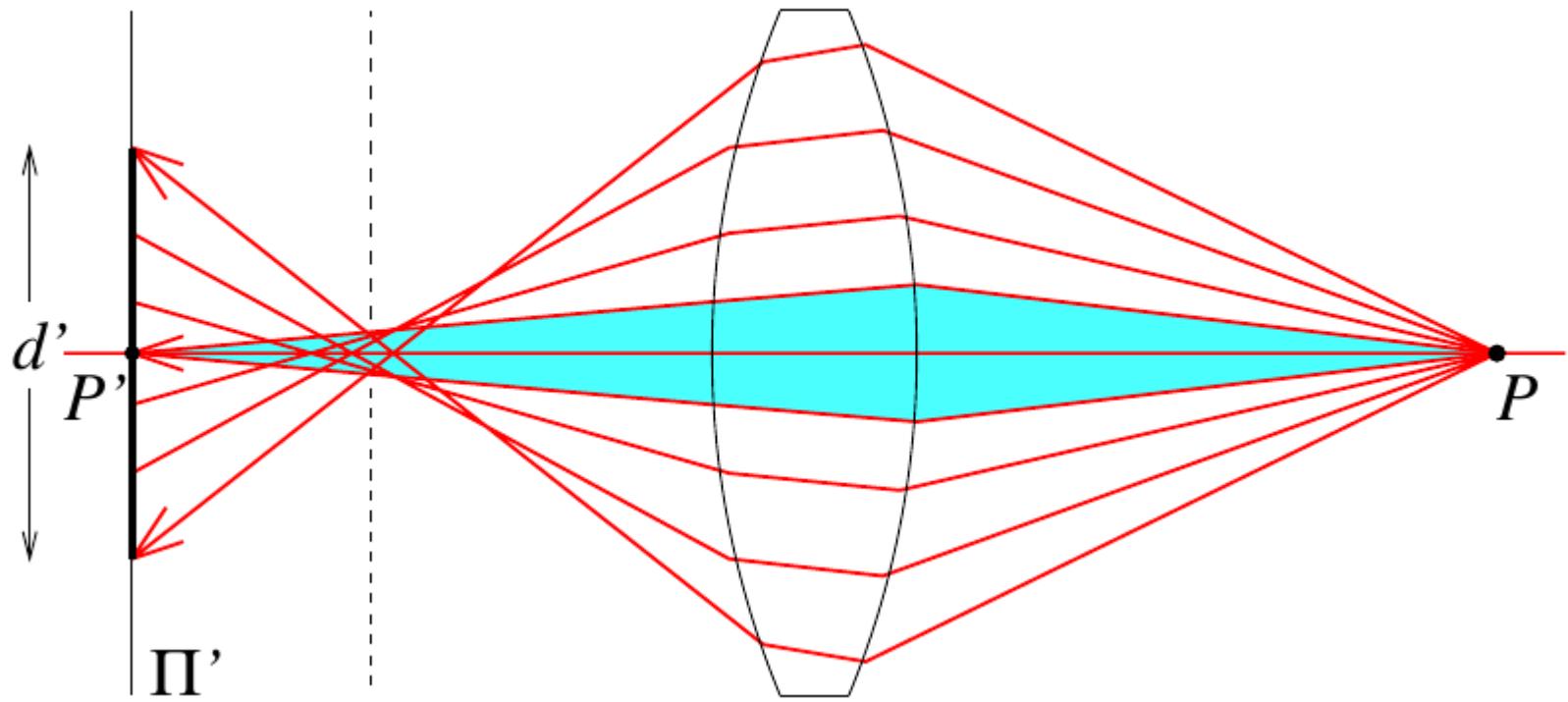


Figure 1.15. A simple thick lens with two spherical surfaces.

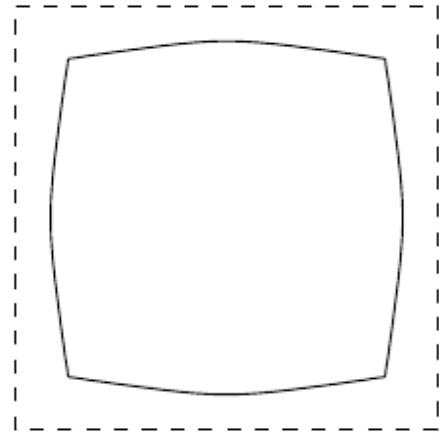
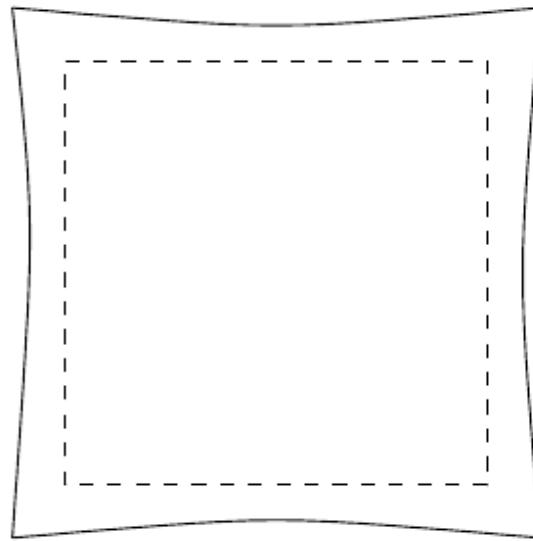
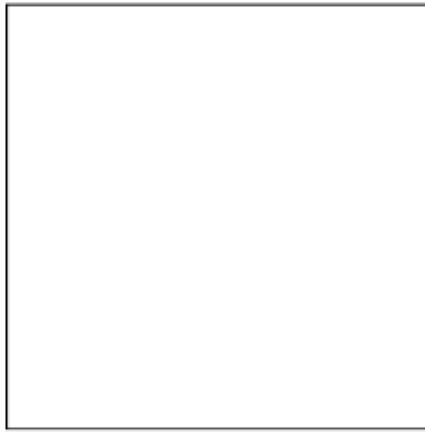
球面像差

1/1



畸变

1/1



色像差

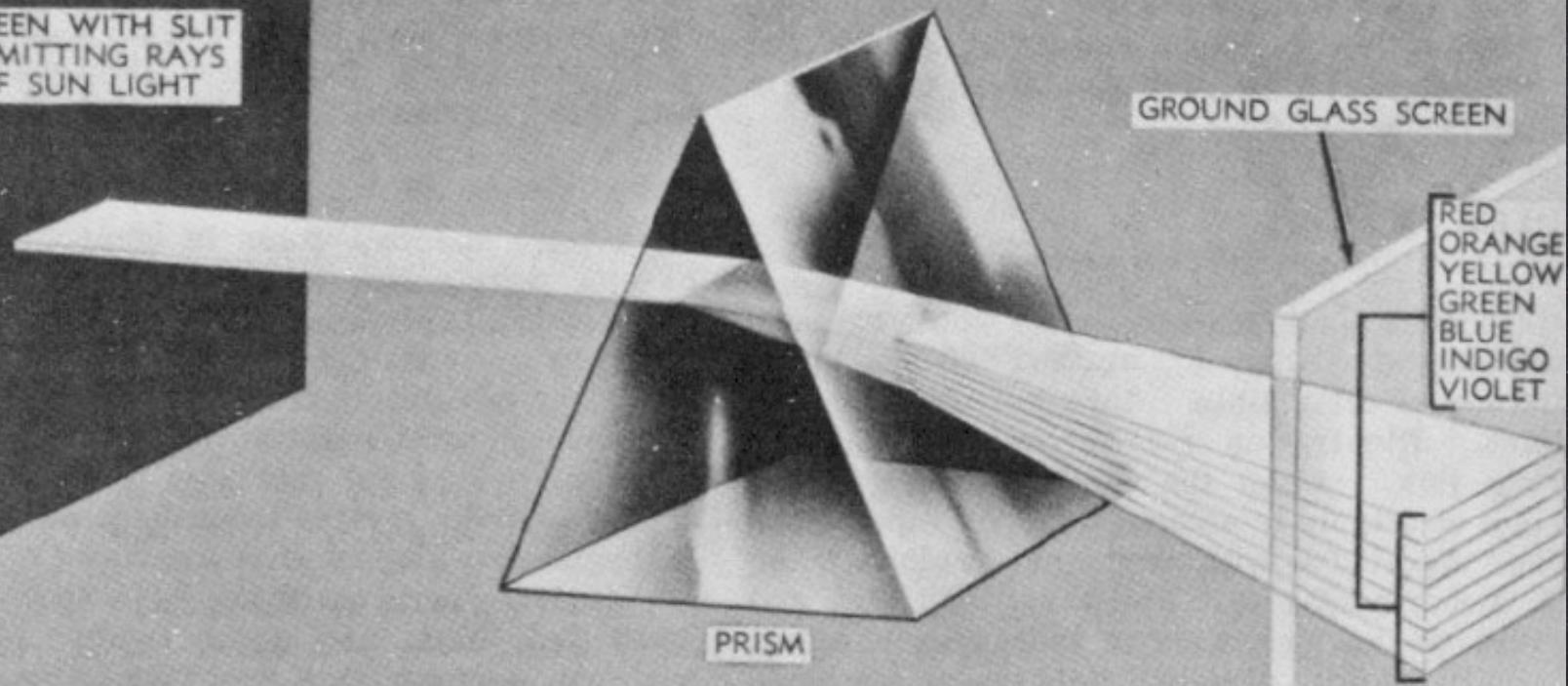
1/1

SCREEN WITH SLIT
ADMITTING RAYS
OF SUN LIGHT

GROUND GLASS SCREEN

RED
ORANGE
YELLOW
GREEN
BLUE
INDIGO
VIOLET

PRISM



透镜组

1/1

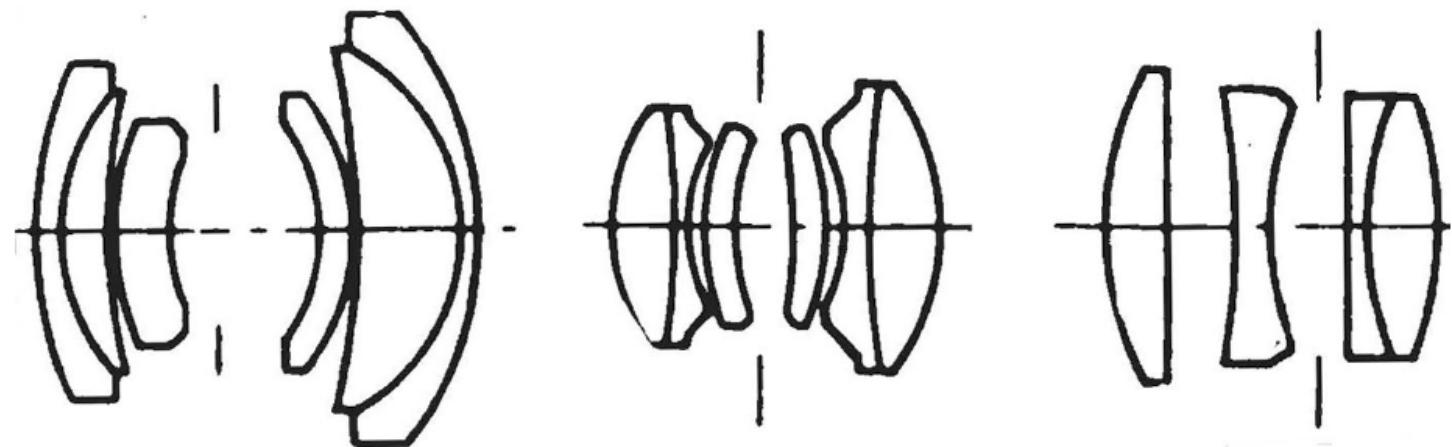


Figure 1.17. Photographics lenses. Reprinted from [Montel, 1972], p. 54.

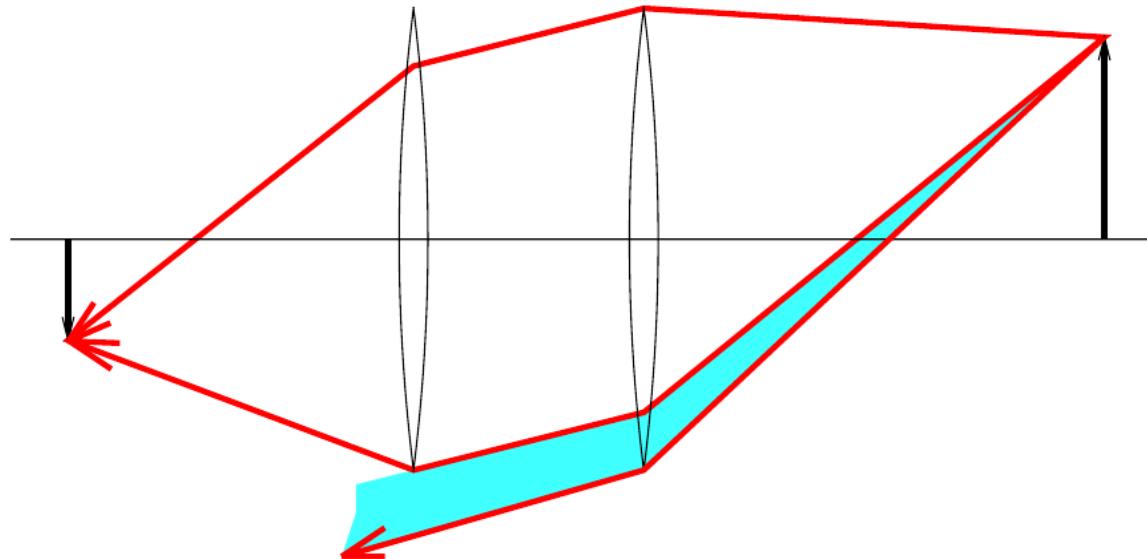
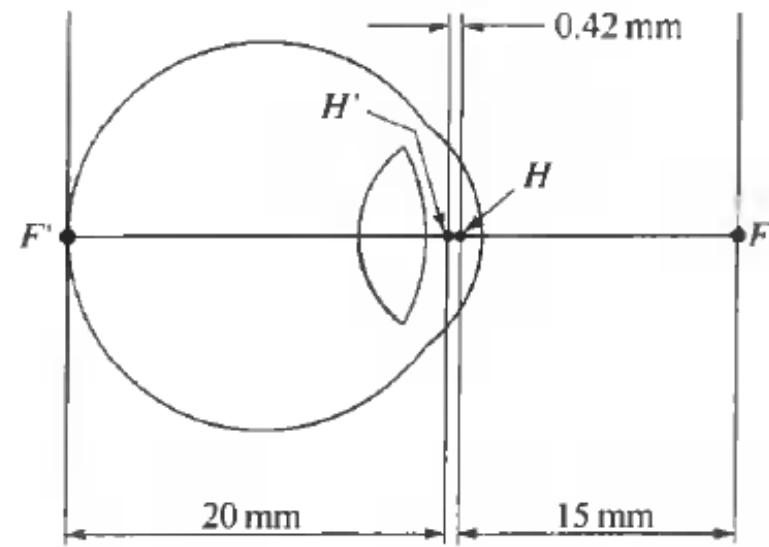
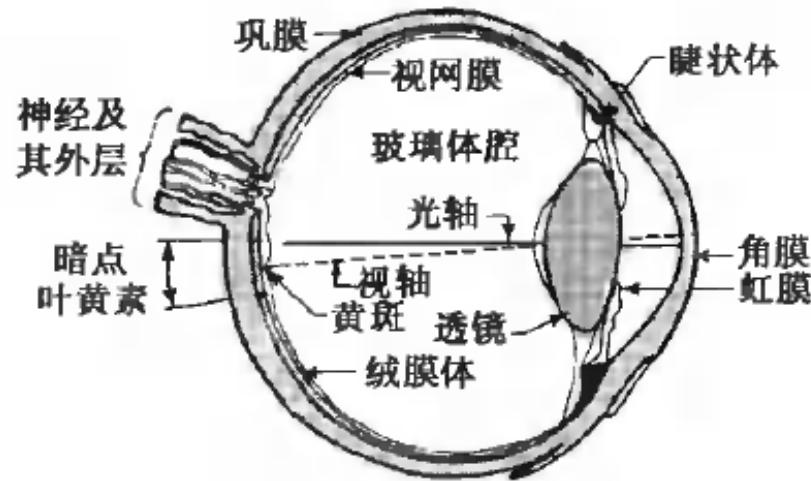


Figure 1.18. Vignetting effect in a two-lens system. The shaded part of the beam never reaches the second lens. Additional apertures and stops in a lens further contribute to vignetting.

人眼

1/1



视锥细胞响应曲线

1/1

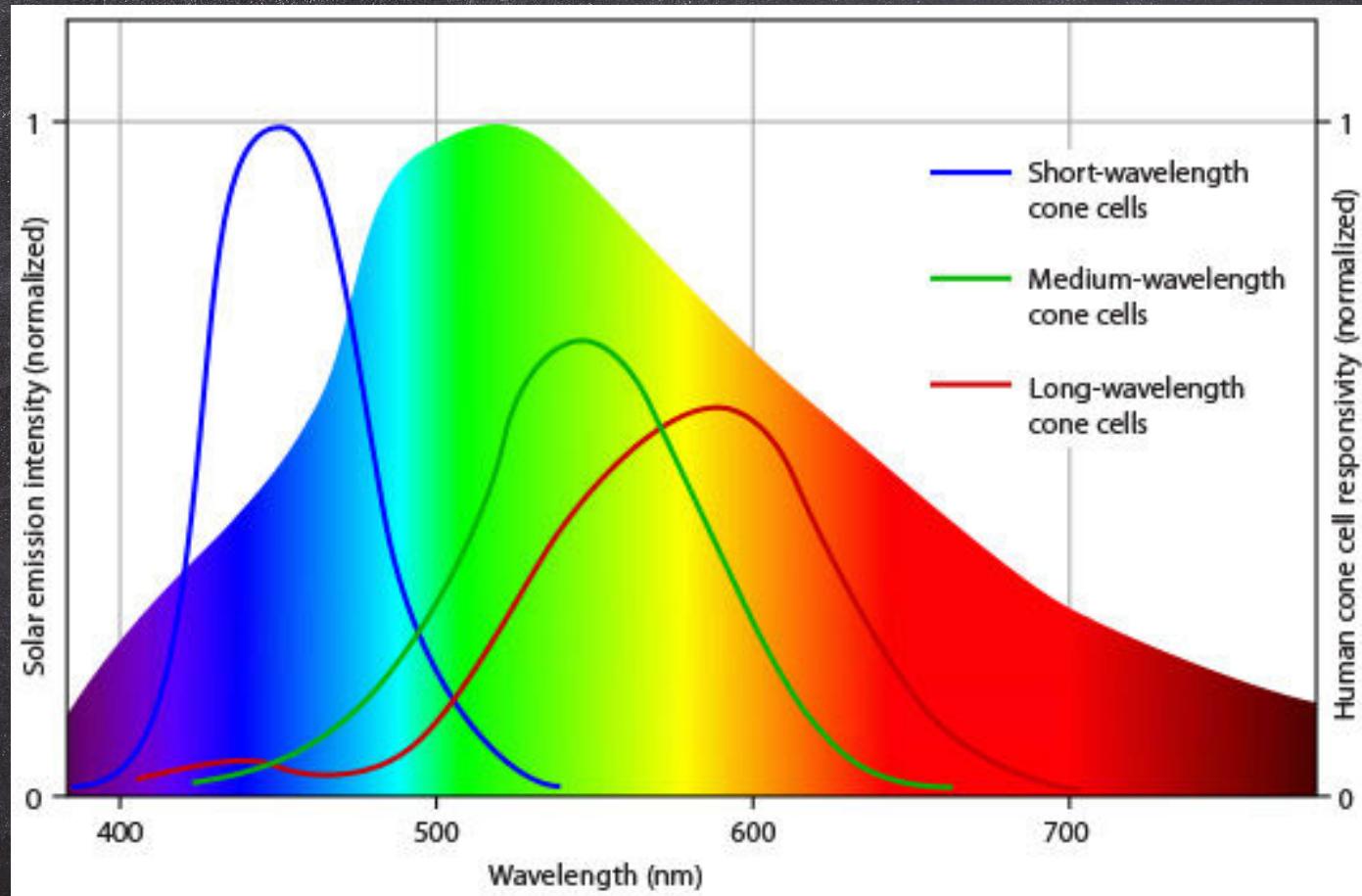




Figure 1.21. The first photograph on record, “la table servie”, obtained by Nicéphore Niépce in 1822. Reprinted from [Montel, 1972], p. 9.

CCD

1/1

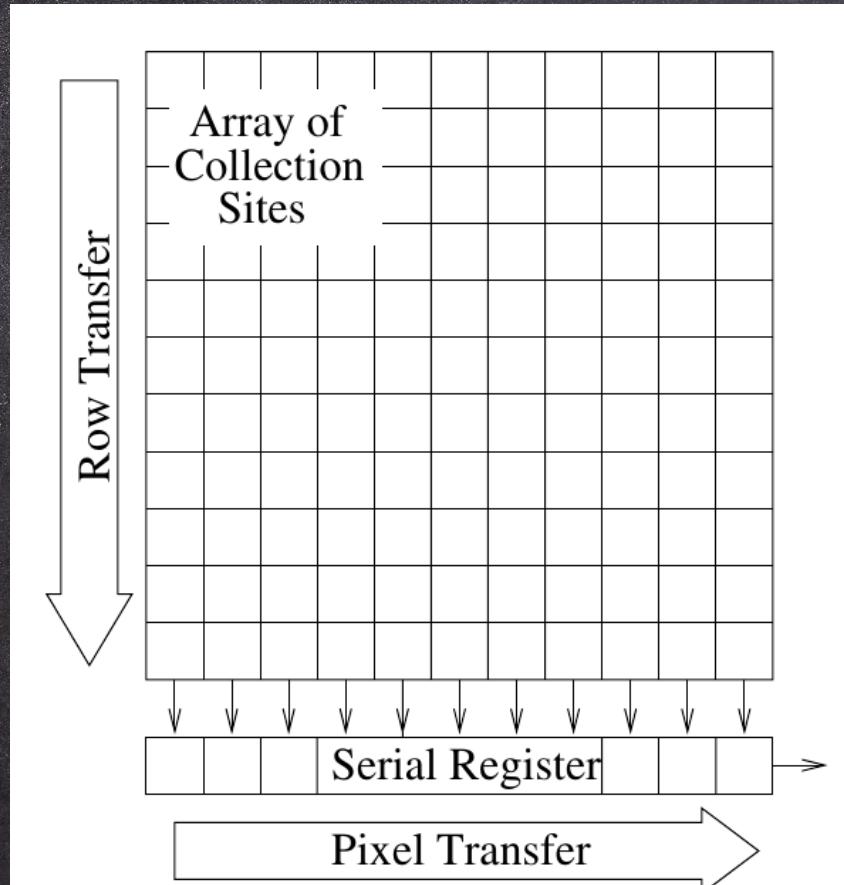


Figure 1.22. A CCD Device.

传感器模型

$$I(r, c) = T \int_{\lambda} \int_{\mathbf{p} \in S(r, c)} E(\mathbf{p}, \lambda) R(\mathbf{p}) q(\lambda) d\mathbf{p} d\lambda$$

$$D(r, c) = \gamma(N_I(r, c) + N_{DC}(r, c) + N_B(, rc) + R(r, c)) + Q(, r, c)$$