Bessel applications (Fraunhofer diffraction)

BesselJ [n, z] gives the Bessel function of the first kind $J_n(z)$.

BesselY [n, z] gives the Bessel function of the second kind $Y_n(z)$ ... The Neumann function

It satisfies the differential equation $z^2 y'' + z y' + \left(z^2 - n^2\right) y = 0$ that we obtained for example in the solution of the Laplace equation in cilindrical coordenates.

Remenber that :

n = ν is a number (It could be complex number)
y = y (x) where x is the independent variable

Traditional form

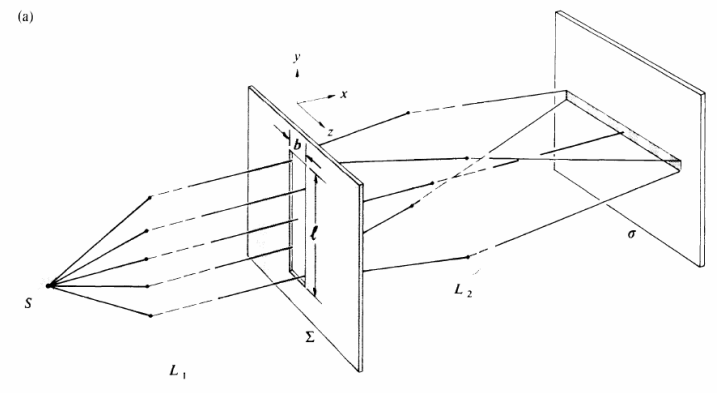
```
BesselJ[n, r] // TraditionalForm
BesselY[n, r] // TraditionalForm
```

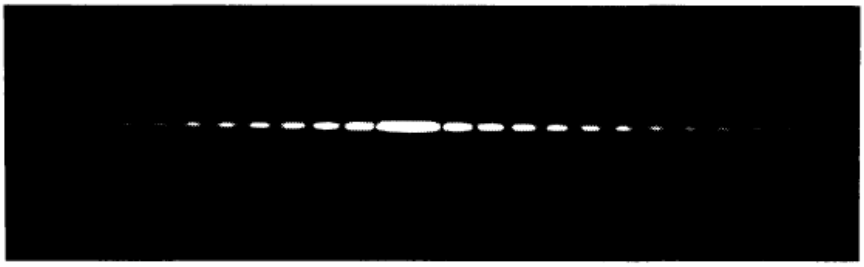
$J_n(r)$

$Y_n(r)$

The single slip (Optics, Eugene Hecht book)

```
Import["Bessel-fig1.png"]
Import["Bessel-fig2.png"]
```





(b)

Intensity of the Fraunhofer diffraction pattern of a circular aperture versus diffraction angle :

```
Import["Bessel-fig3.png"]
```

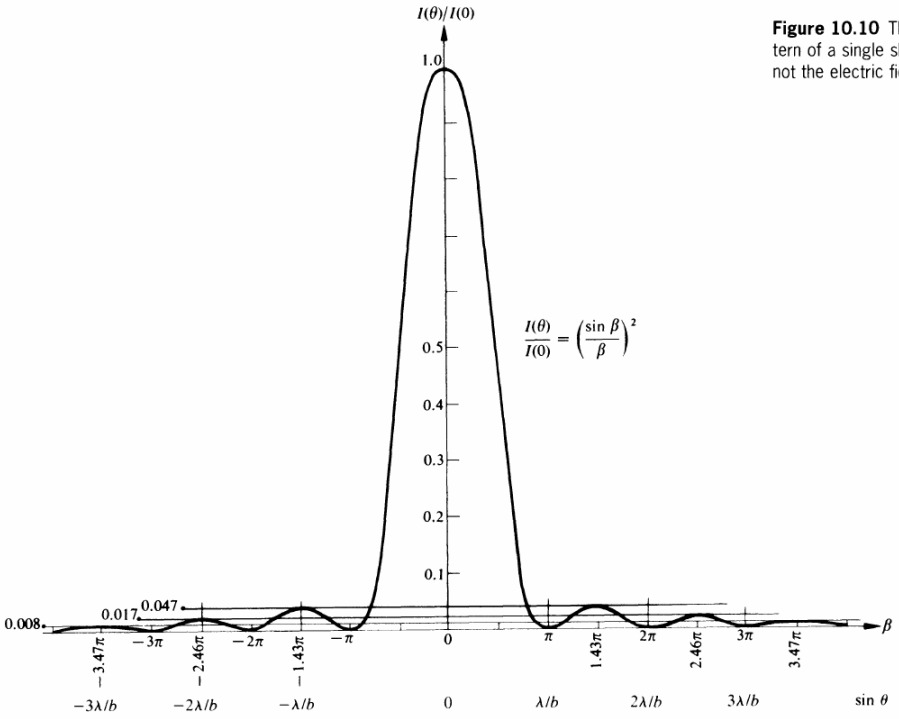


Figure 10.10 The Fraunhofer diffraction pattern of a single slit. This is the irradiance (and not the electric field) distribution

Multiple slips

Two slips

```
Import["Bessel-fig4.png"]
```

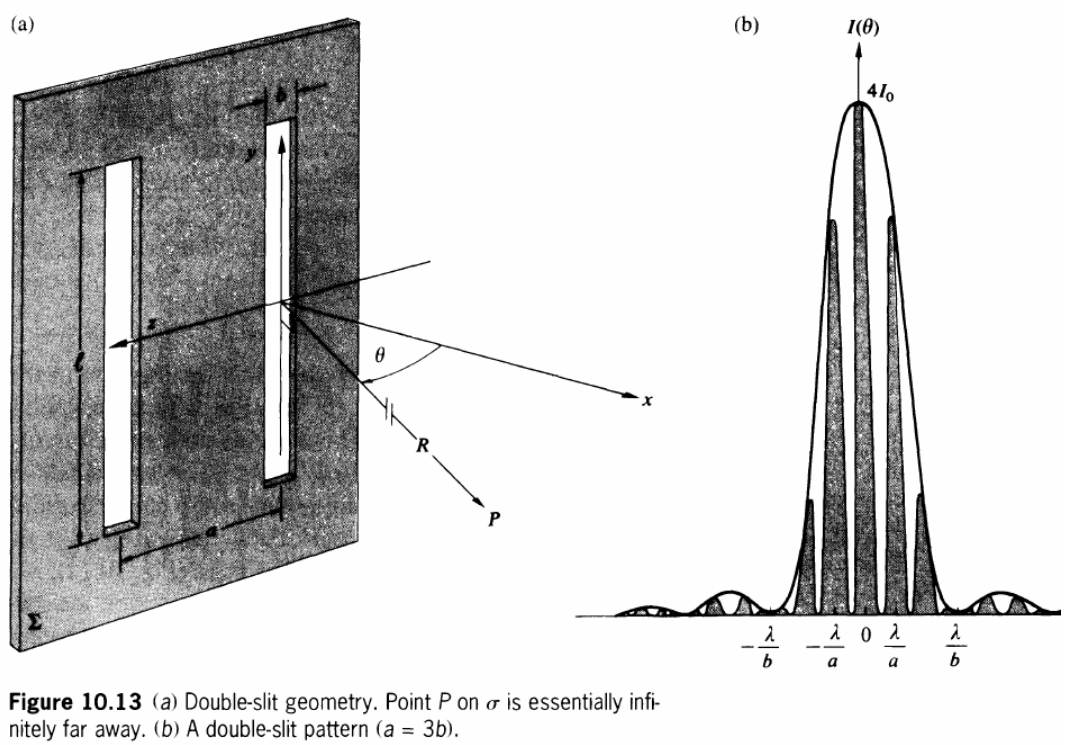


Figure 10.13 (*a*) Double-slit geometry. Point *P* on σ is essentially infinitely far away. (*b*) A double-slit pattern ($a = 3b$).

```
Import["Bessel-fig5.png"]
```

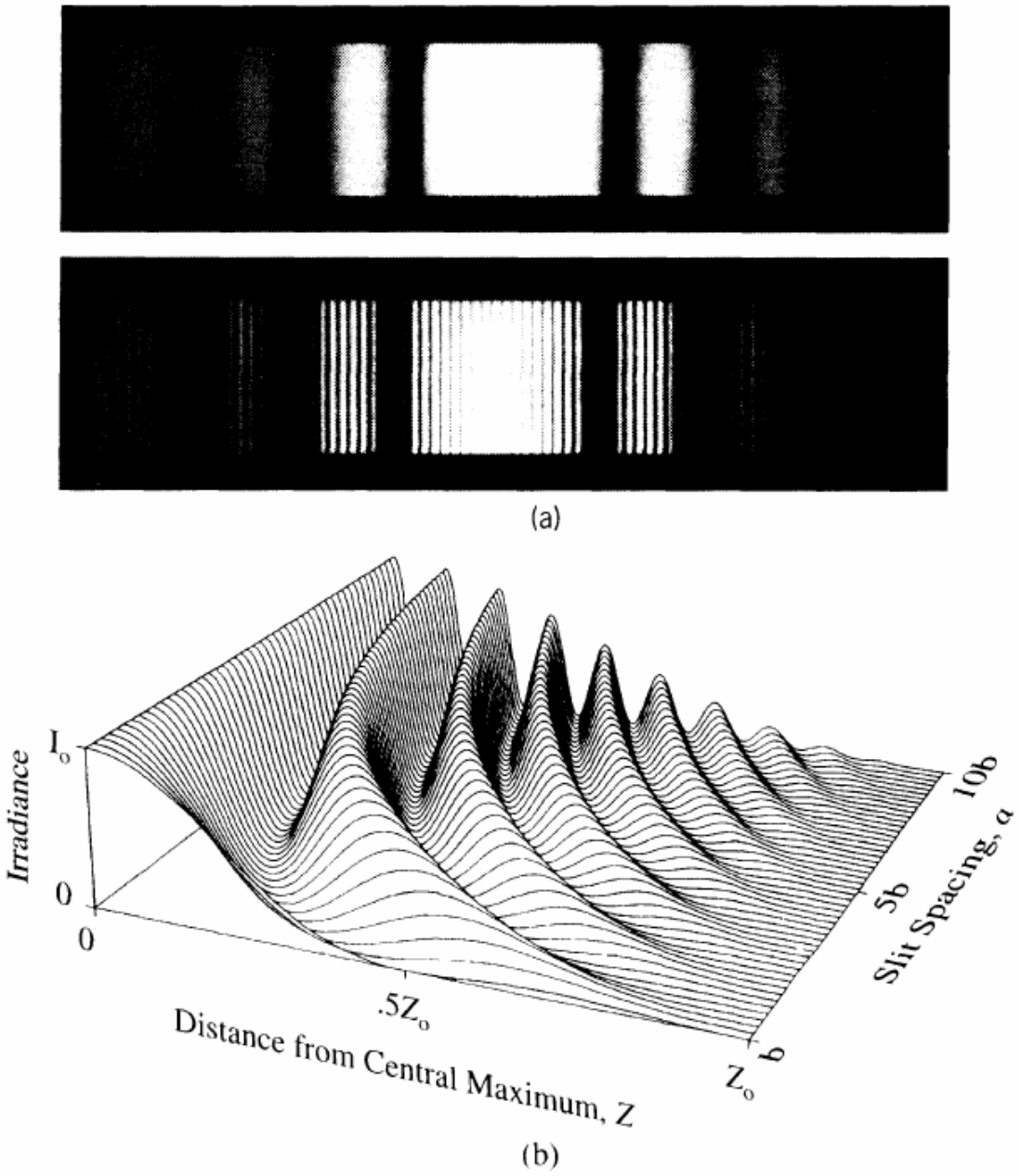


Figure 10.14 Single- and double-slit Fraunhofer patterns. (*a*) Photographs taken with monochromatic light. The faint cross-hatching

Many slips

```
Import["Bessel-fig6.png"]
```

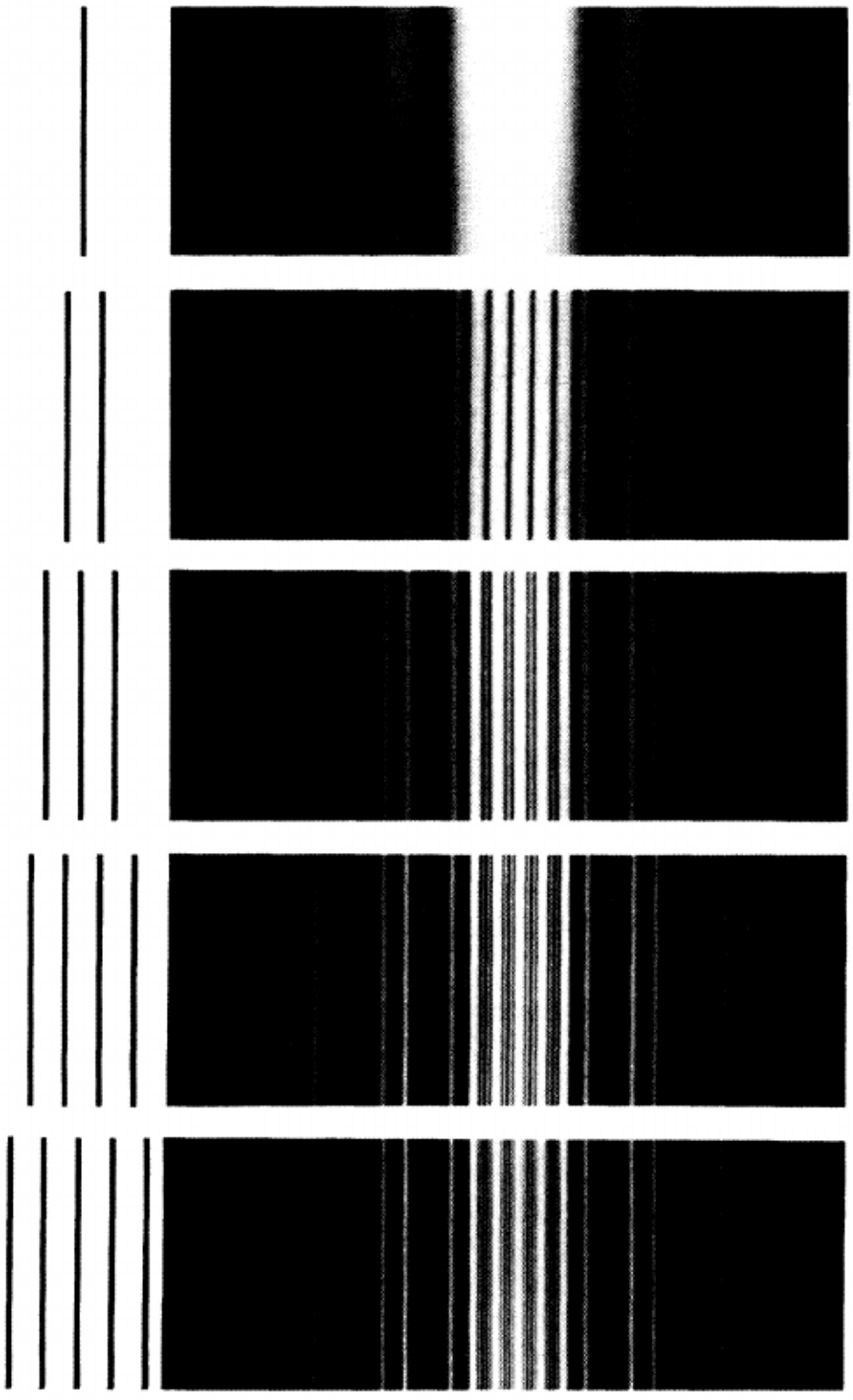
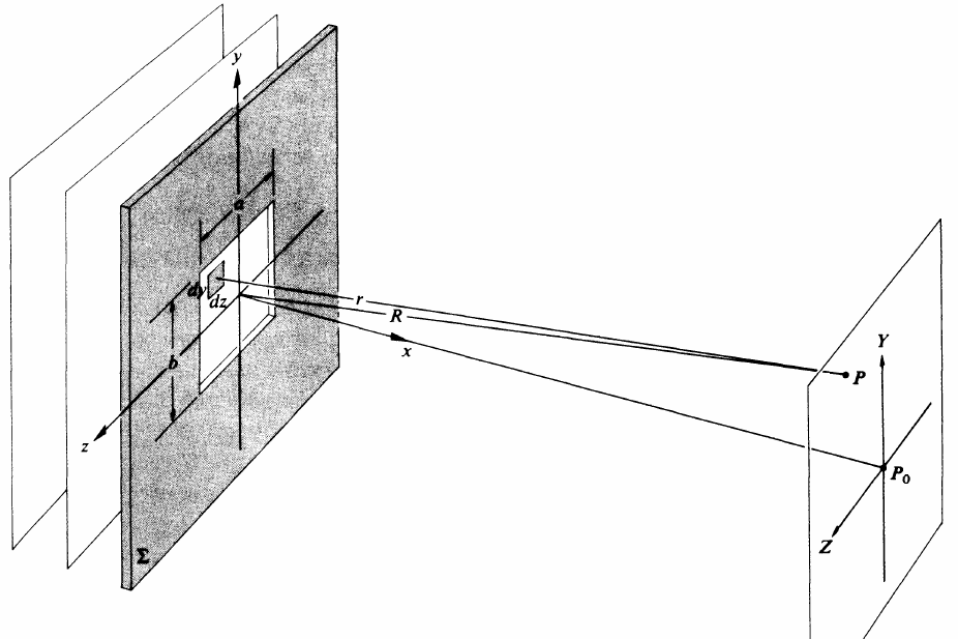


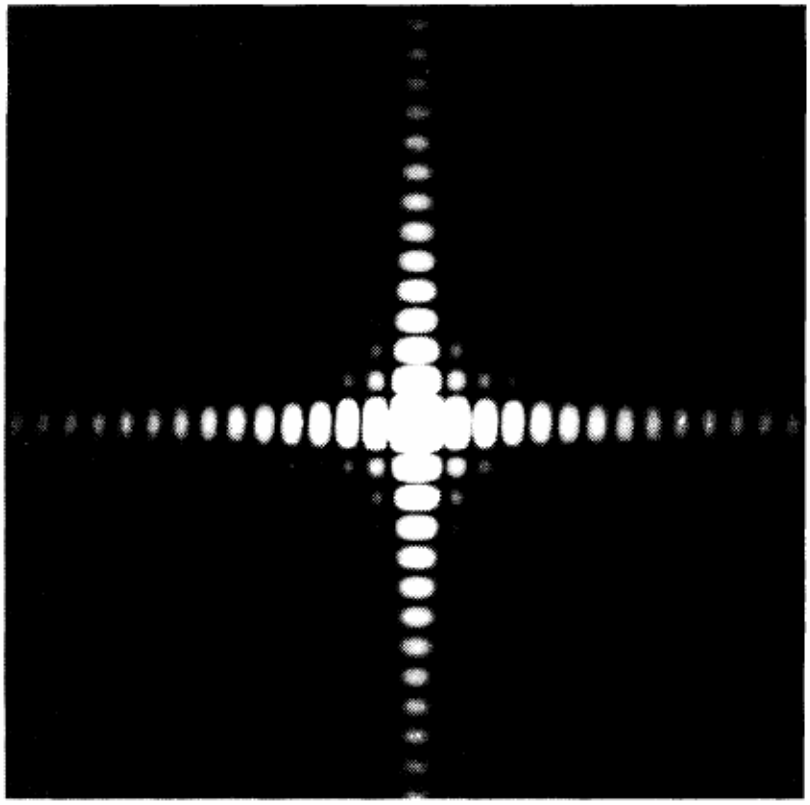
Figure 10.16 Diffraction patterns for slit systems shown at left. (Francis Weston Sears, *Optics*. Reprinted with permission of Addison Wesley Longman, Inc.)

Rectangular aperture

```
Import["Bessel-fig7.png"]
```




```
Import["Bessel-fig8.png"]
```



```
Import["Bessel-fig9.png"]
```

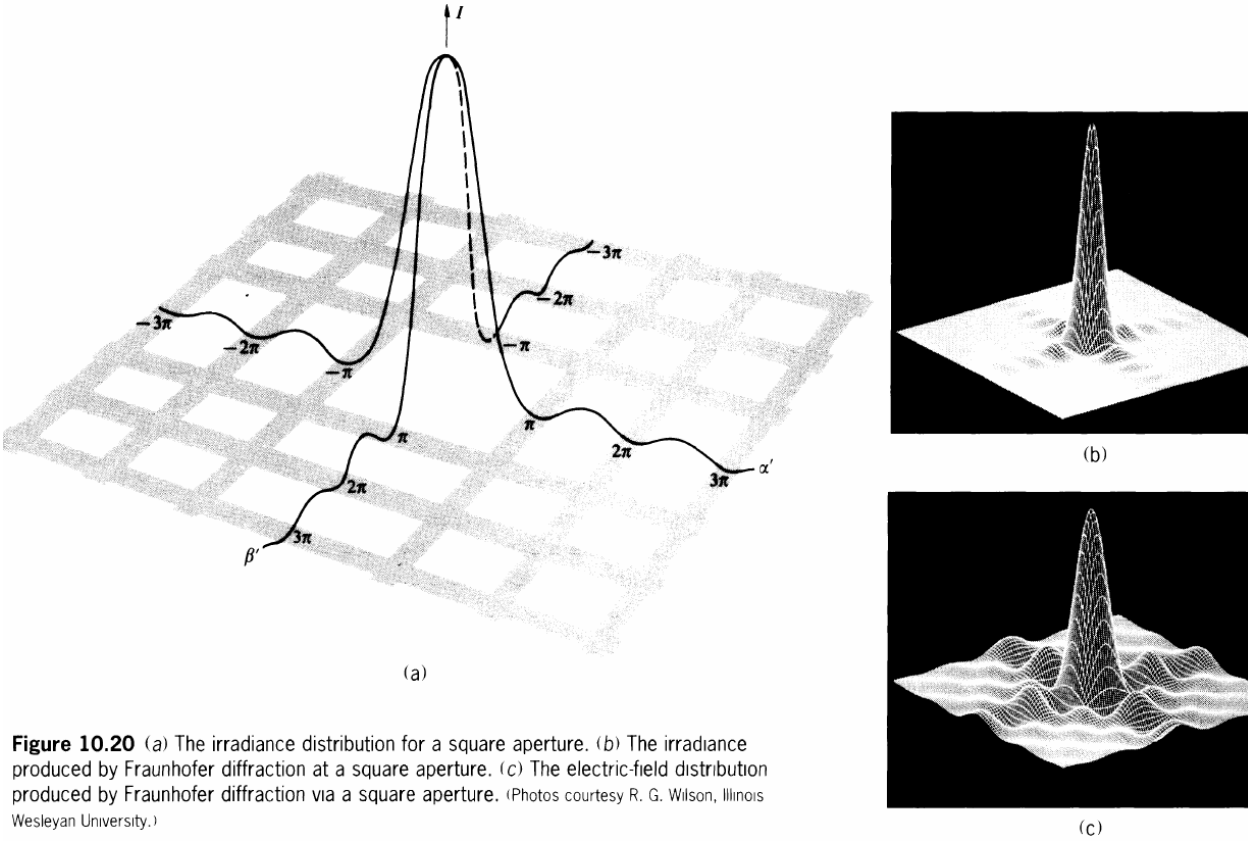
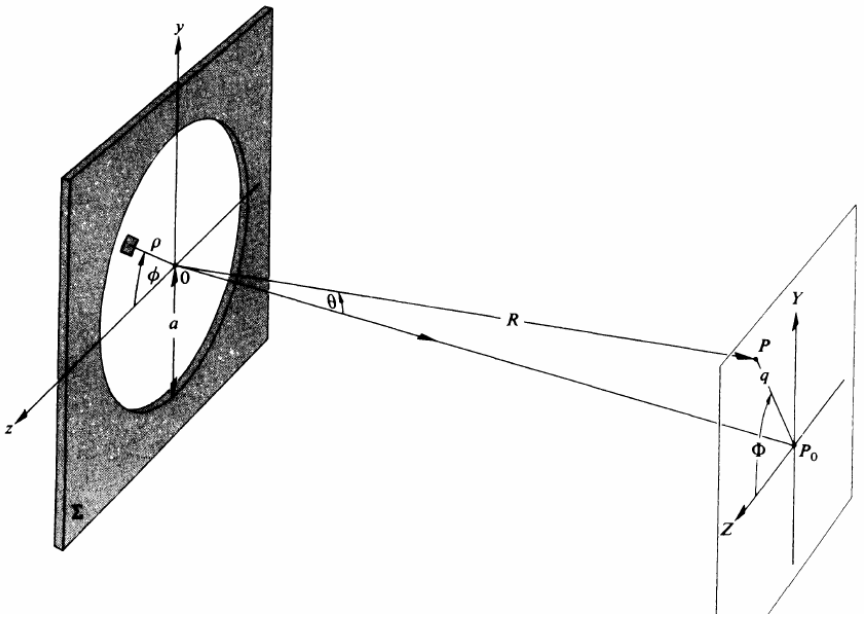
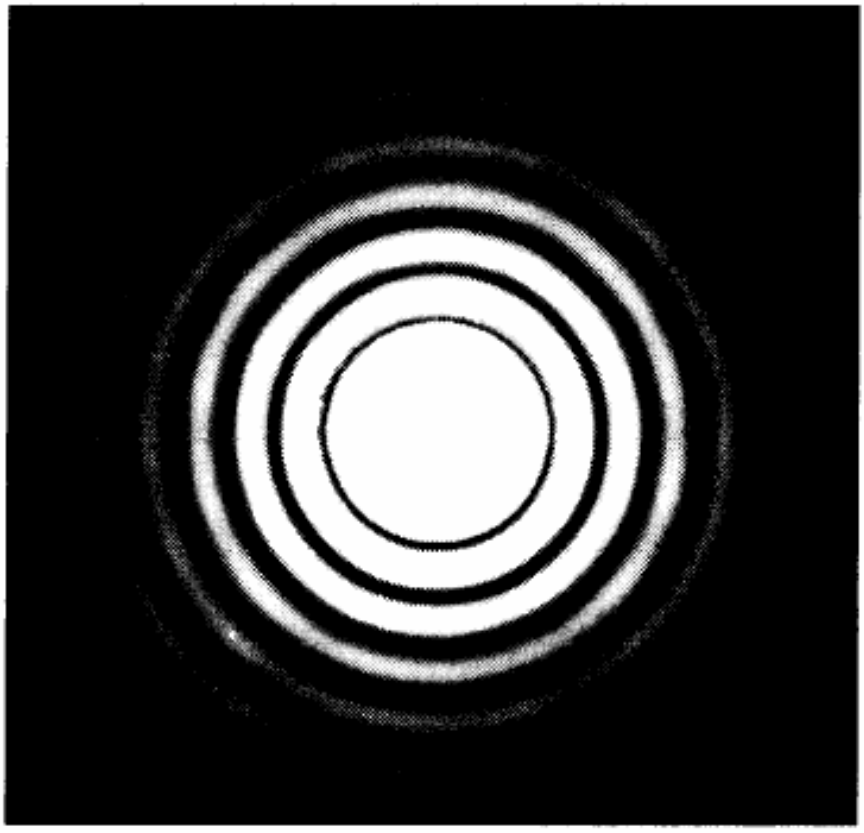


Figure 10.20 (*a*) The irradiance distribution for a square aperture. (*b*) The irradiance produced by Fraunhofer diffraction at a square aperture. (*c*) The electric-field distribution produced by Fraunhofer diffraction via a square aperture. (Photos courtesy R. G. Wilson, Illinois Wesleyan University.)

The circular aperture

```
Import["Bessel-fig10.png"]
Import["Bessel-fig11.png"]
Import["Bessel-fig12.png"]
Import["Bessel-fig13.png"]
```


y
ρ
ϕ
0
a
θ
R
Y
P
q
Φ
P0
z
Z
Σ



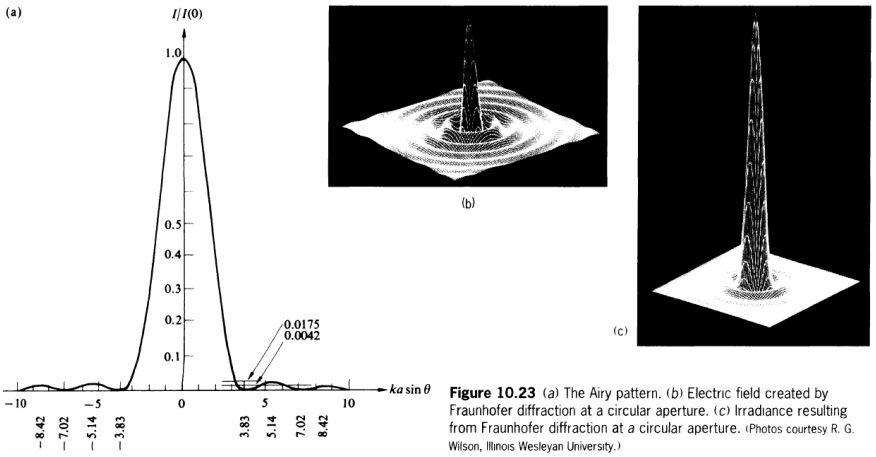
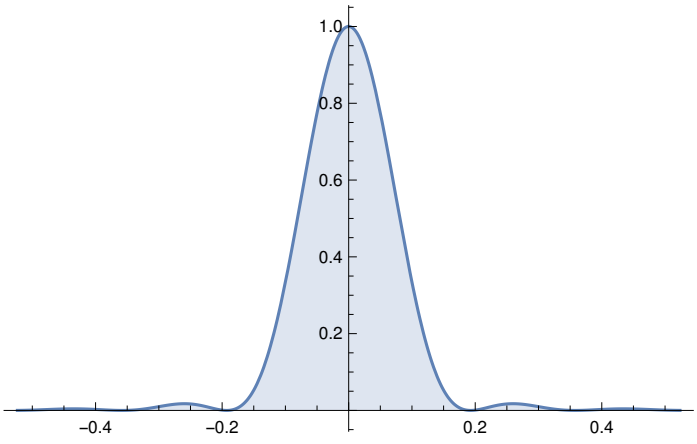


Figure 10.23 (a) The Airy pattern. (b) Electric field created by Fraunhofer diffraction at a circular aperture. (c) Irradiance resulting from Fraunhofer diffraction at a circular aperture. (Photos courtesy R. G. Wilson, Illinois Wesleyan University.)

$$I(\theta) = I(0)\left[\frac{2J_1(ka\ sin\ \theta)}{ka\ \sin\ \theta}\right]^2$$

Plot the function

```
Plot[(2 * BesselJ[1, 20 Sin[θ]] / (20 Sin[θ]))^2, {θ, -π/6, π/6}, Filling → Axis]
```



```
Plot[(2 * BesselJ[1, 20 Sin[θ]] / (20 Sin[θ]))^2, {θ, -π/3, π/3}, Filling → Axis]
```