Fresnel Code - Angular Spectrum Approach

```
N=512;
N2=N/2;
N21=N2+1;
a=zeros(N);
b=zeros(N);
c=zeros(N);
ph=zeros(N);
ph2=zeros(N);
R1sq=10^2;
R2sq=8^2;
z=400;
pi=3.14159;

for i1=1:N
   for i2=1:N
      if (i1-N21)^2+(i2-N21)^2<=R1sq
         a(i1,i2)=1;
      end;
   end;
end;
```

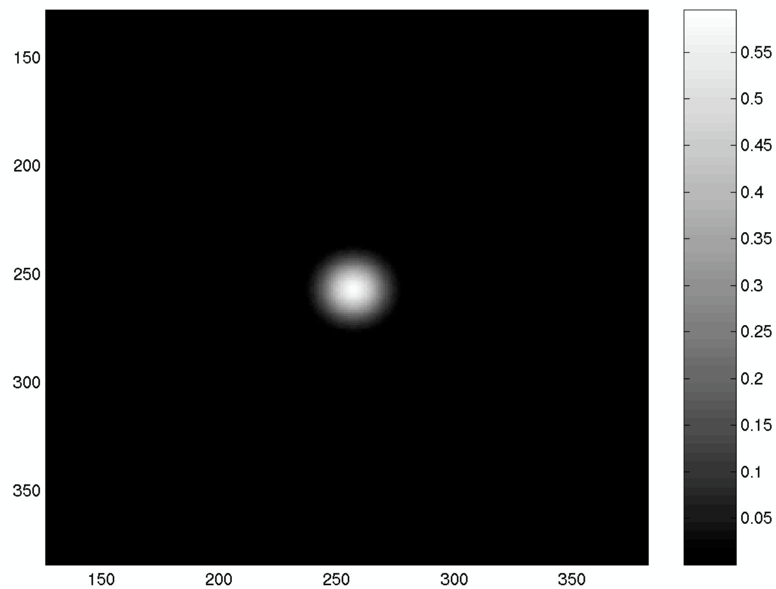
```
%for i1=1:N
%   for i2=1:N
%      if (i1-N21)^2+(i2-N21)^2<=R2sq
%         c(i1,i2)=1;
%      end;
%   end;
%end;

a=a-c;

figure(1);
imagesc(a);
colormap(gray);

a=fftshift(a);
```

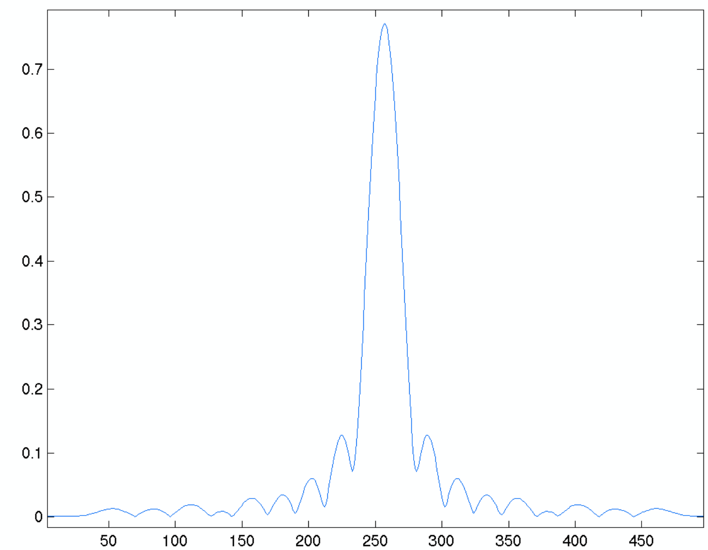
Fresnel Code - Angular Spectrum Approach

```
b=fft2(a);

b=fftshift(b);

figure(4);
imagesc(abs(b));

for i1=1:N
   for i2=1:N
      x=(i1-N21)/N;
      y=(i2-N21)/N;
      %ph(i1,i2)=exp(-
j*pi*z*(x^2+y^2));
      ph2(i1,i2)=exp(j*2*pi*z*sqrt(1-
x^2-y^2));
   end;
end;

b=b.*ph2;
```

```
figure(5);
imagesc(angle(ph2));

b=fftshift(b);
c=ifft2(b);
c=fftshift(c);

figure(2);
d=abs(c);
d=d.^2;
imagesc(d);
colormap(gray);
colorbar;

c1=c(N21,1:N);
figure(3);
plot(1:N,abs(c1));
```

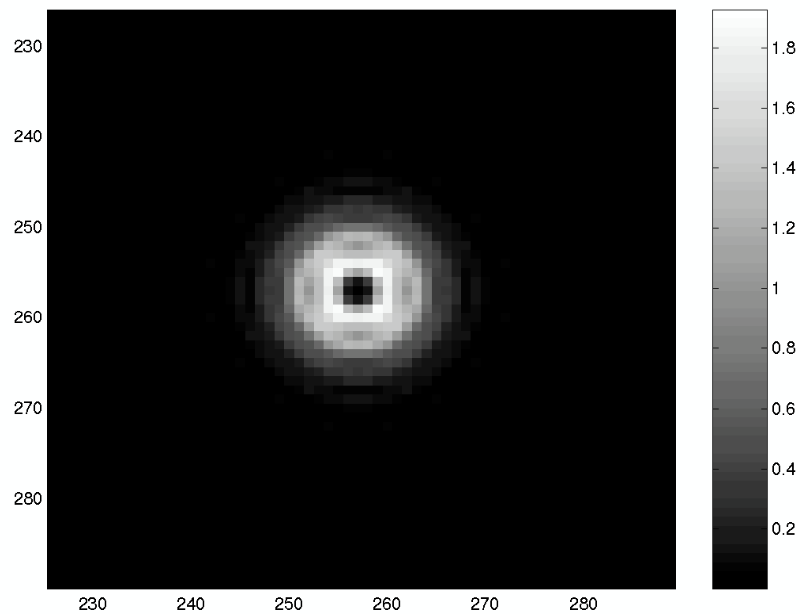
Fresnel Diffraction from a Disk

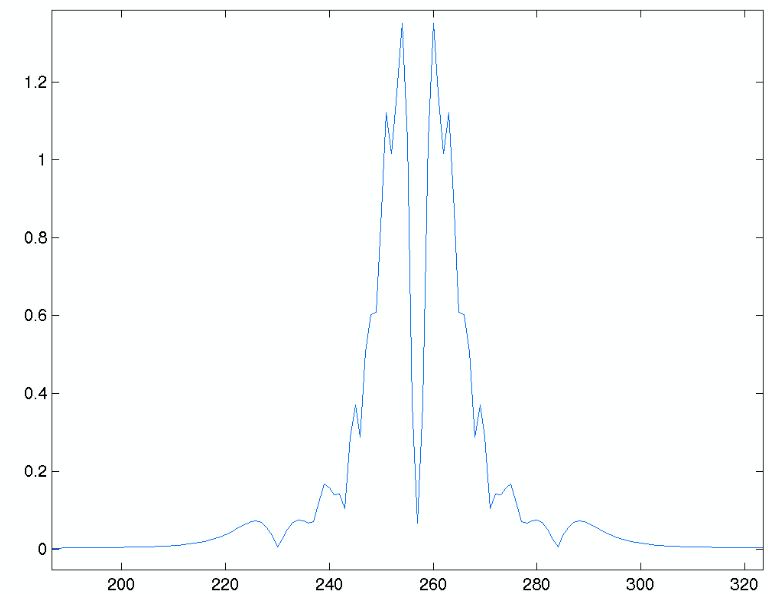




Towards the far-field. R = 10 lambda; z = 400 lambda

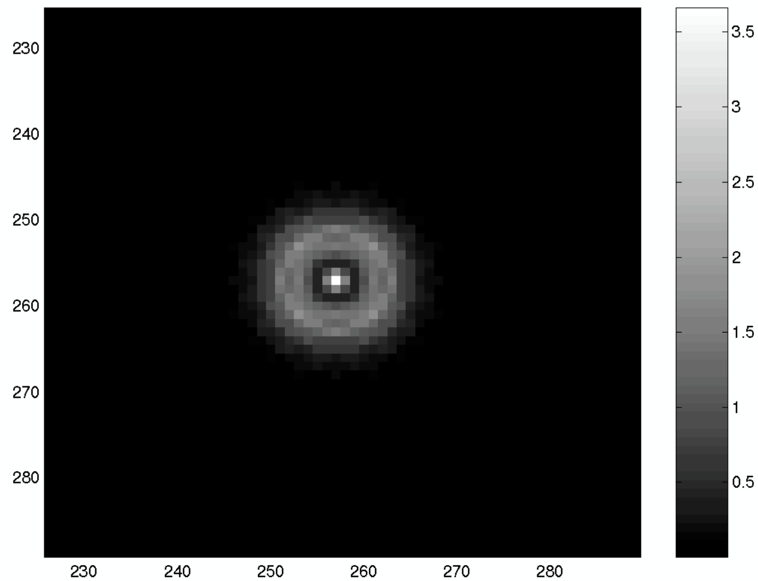
Fresnel Diffraction from a Disk

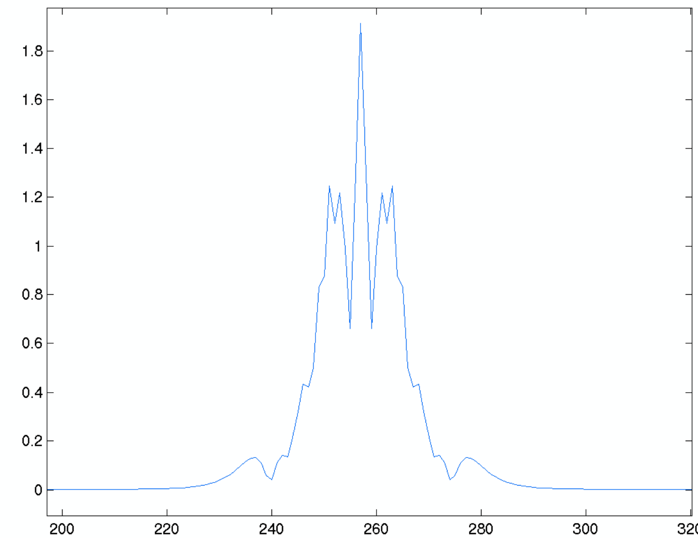




First minimum on axis. R = 10 lambda; z = 50 lambda

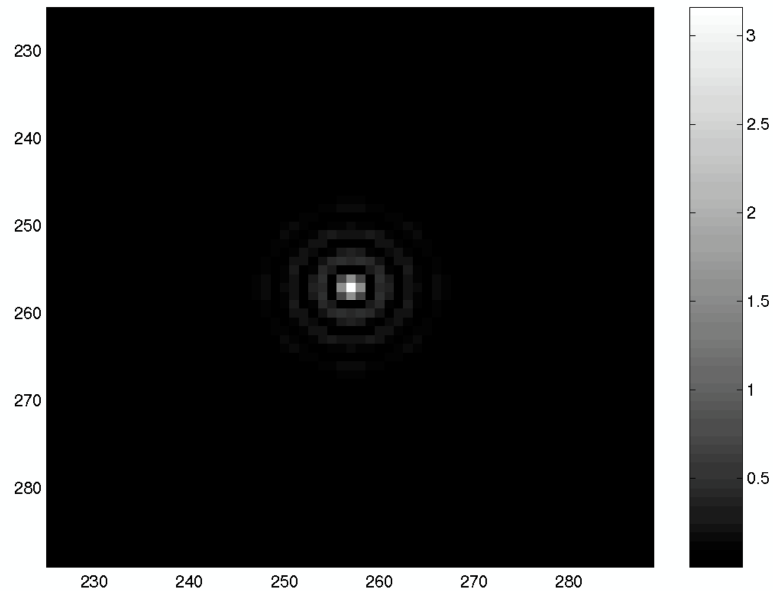
Fresnel Diffraction from a Disk

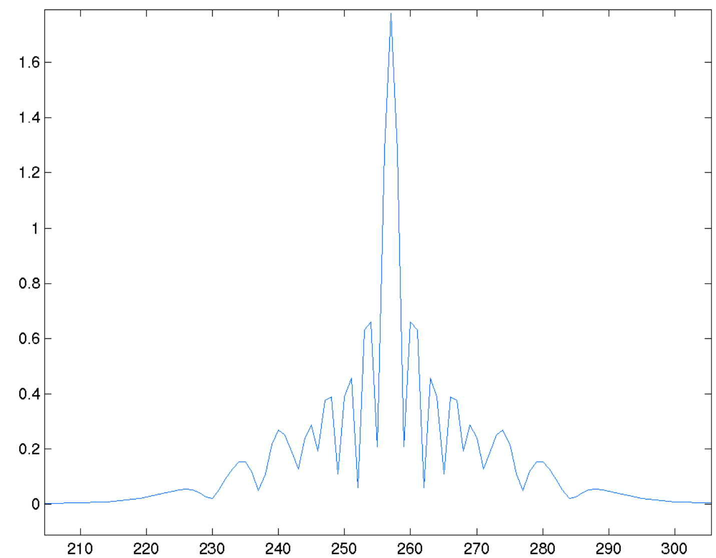




First peak on axis. R = 10 lambda; z = 33.3 lambda

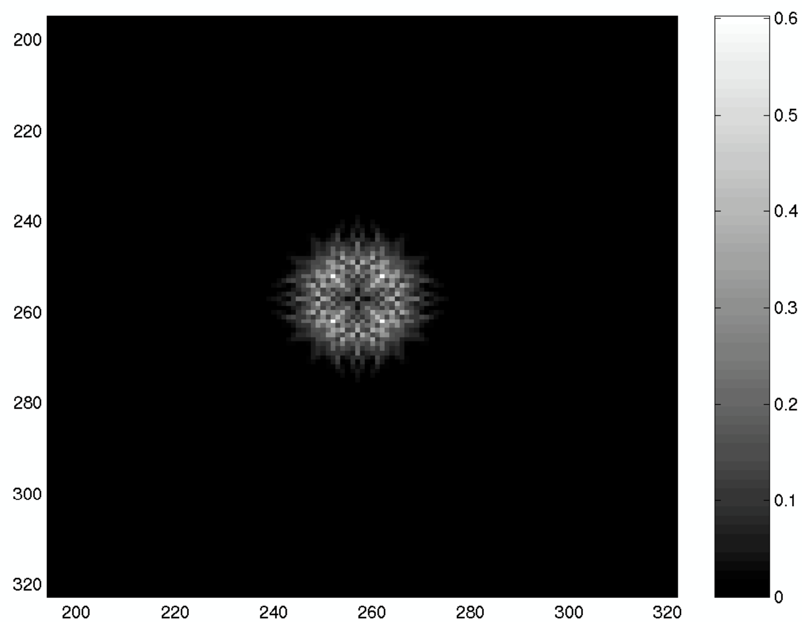
Fresnel Diffraction from a Ring

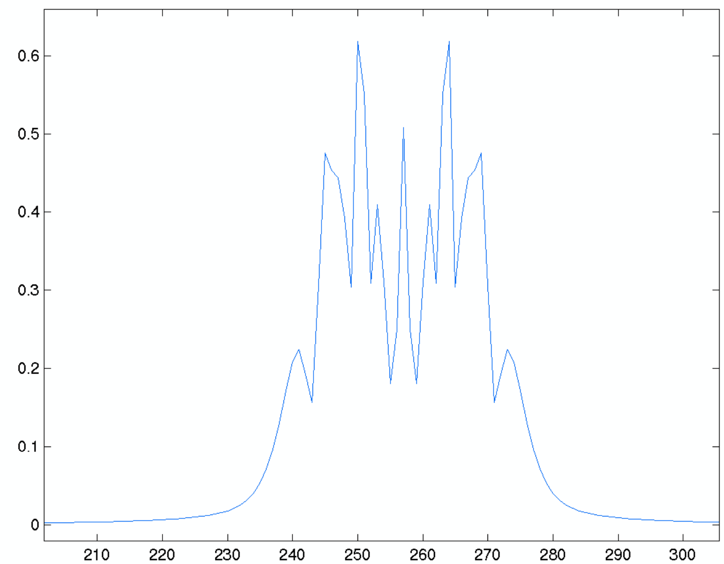




Where the disk was a minimum. R = 10 and 8 lambda; z = 50 lambda

Fresnel Diffraction from a Ring





Towards the shadow region. R = 10 and 8 lambda; z = 20 lambda

Exact Solution for On-Axis Field

Fresnel Diffraction from a Circular Aperture

On-Axis Field

$rad := 10$

$j := 250 .. 5000 \qquad z_j := \frac{j}{25}$

$$Uax_j := \left| 2 \cdot \sin\left(\pi \cdot \frac{rad^2}{2 \cdot z_j}\right) \cdot \exp\left(j \cdot \pi \cdot \frac{rad^2}{2 \cdot z_j}\right) \right|$$

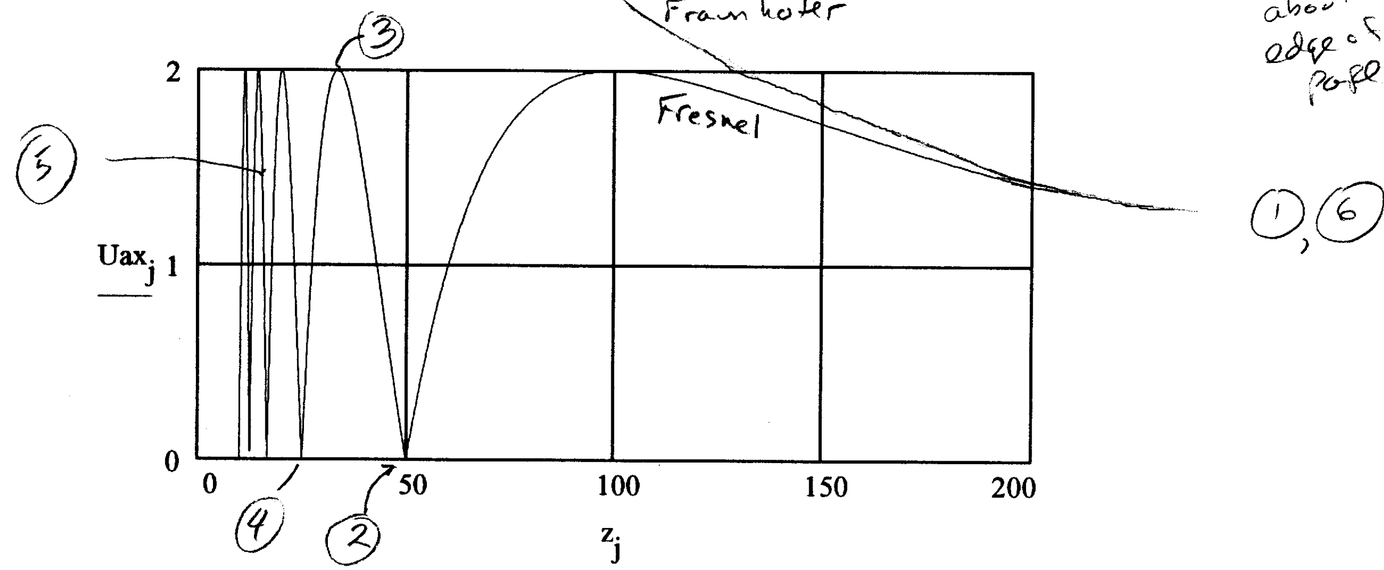
UNITS (of radius + Z) are λ's

Fraunhofer when

$$Z \gg \pi \frac{r_{MAX}^2}{\lambda} = \pi \frac{(10)^2}{1} = 100\pi \ (\times \lambda)$$

$Z \gg 314.159$

about edge of paper.



On-axis diffracted field behind a disc as a function of z.

Radial Dependence in the Far Field

Off Axis and with the Fourier-Bessel transform.

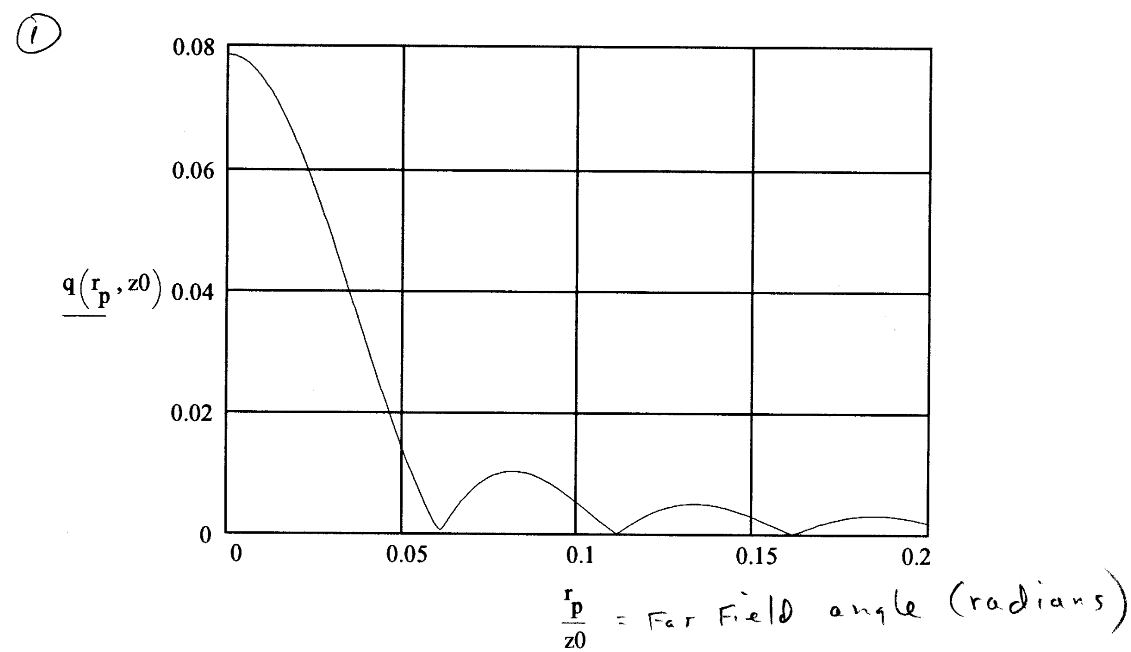
$z0 := 4000$

$p := 1..400 \qquad r_p := \frac{p}{0.5}$

$$q(r,z) := 2\cdot\frac{\pi}{z}\cdot\left|\int_0^{rad} J0\left(2\cdot\pi\cdot\frac{r}{z}\cdot r1\right)\cdot\exp\left(j\cdot\pi\cdot\frac{r1^2}{z}\right)\cdot r1\, dr1\right|$$

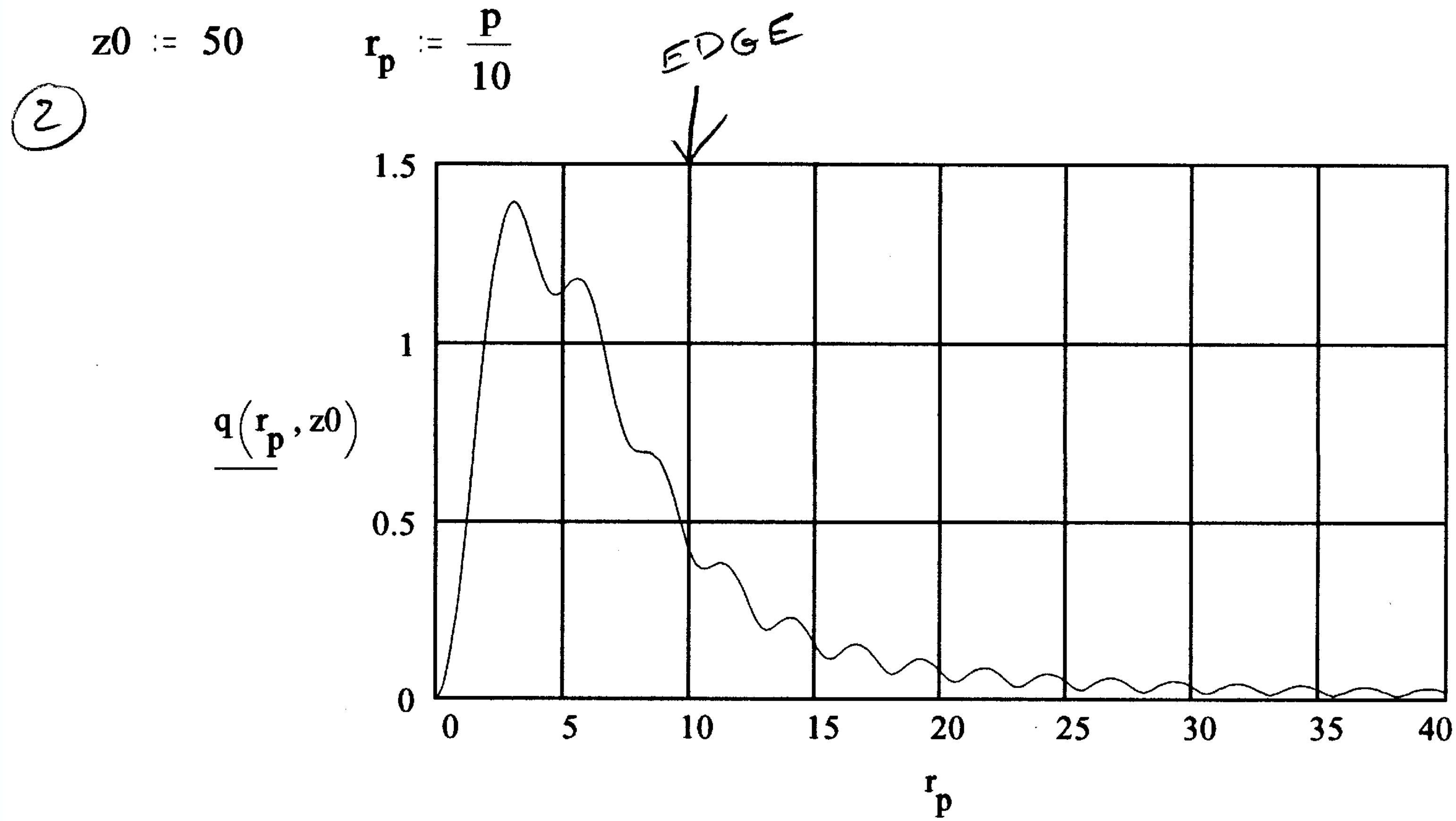
Radial dependence evaluated using the Fourier-Bessel transform.

In the far field at position (1), the field amplitude looks like a sinc function (magnitude). No change is observed at z0 = 8000 (except that the pattern is twice as wide.



Radial Field at the First On-Axis Zero

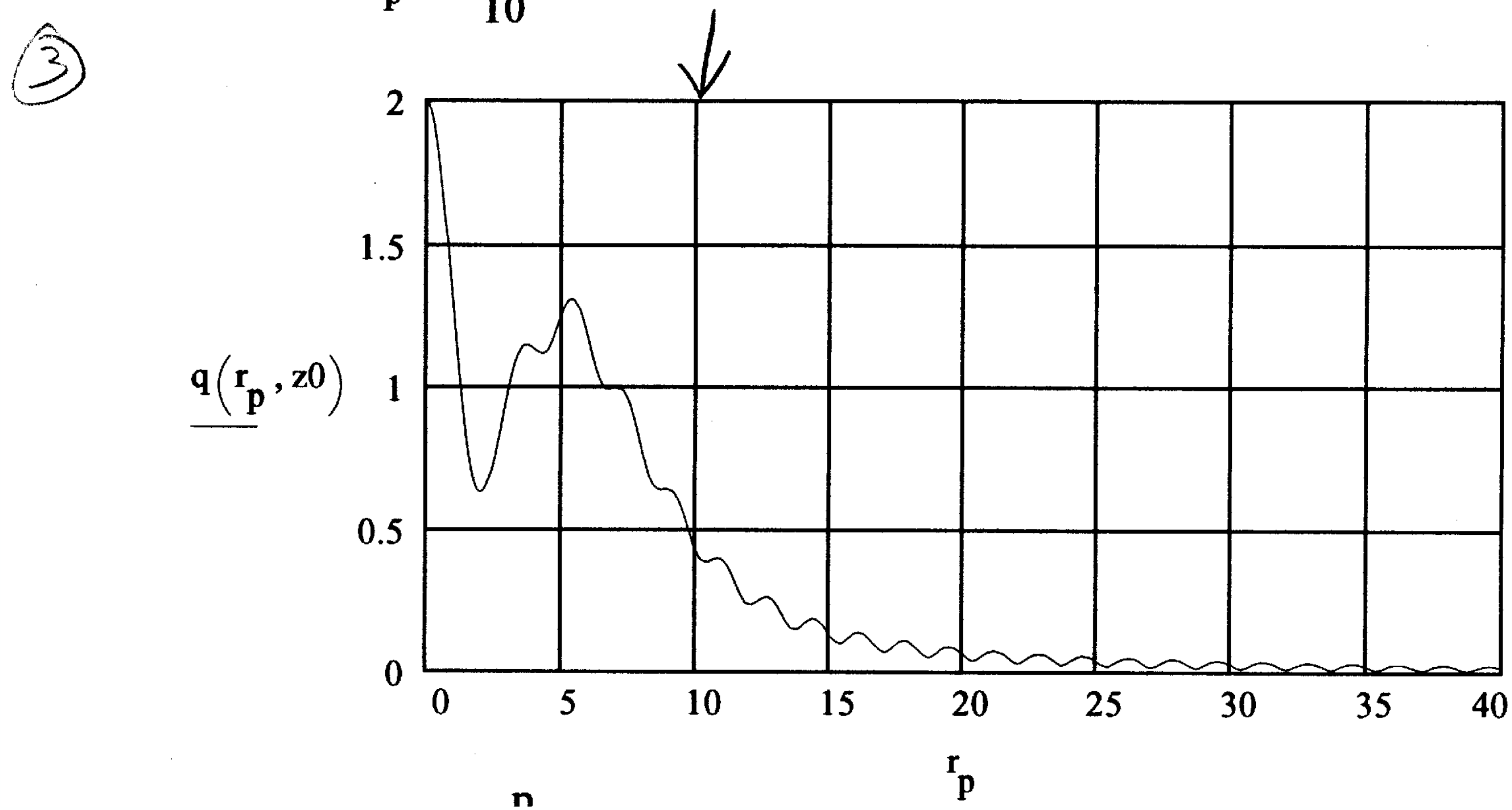
$z0 := 50$ $\quad r_p := \frac{p}{10}$



The edge of the disc is always shown as an arrow at the top. Radius is in units of wavelengths (not angle).

Radial Field at the Second On-Axis Maximum

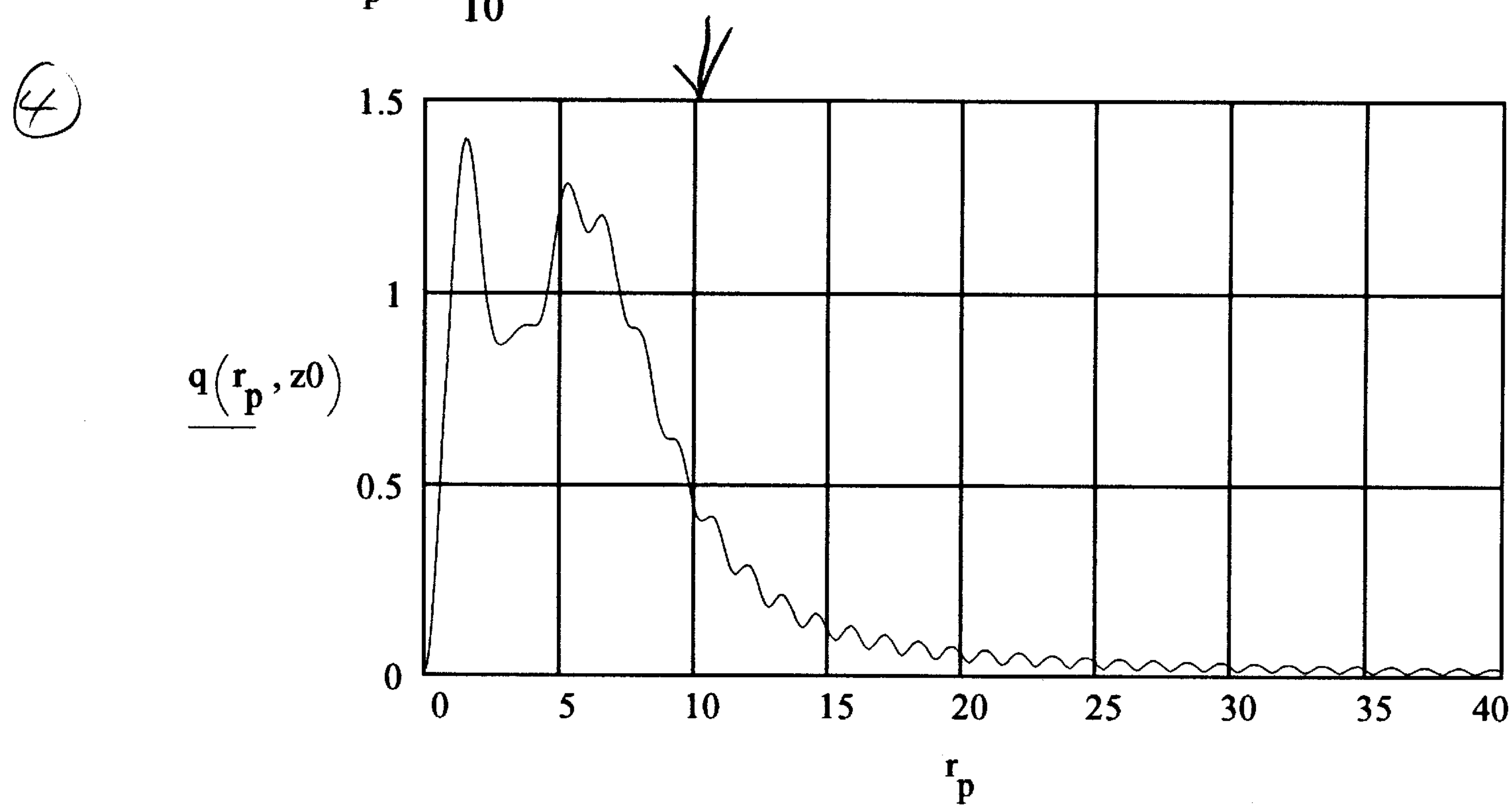
$z0 := 33.333 \quad r_p := \frac{p}{10}$



The edge of the disc is always shown as an arrow at the top.

Radial Field at the Second On-Axis Zero

$z0 := 25 \qquad r_p := \frac{p}{10}$

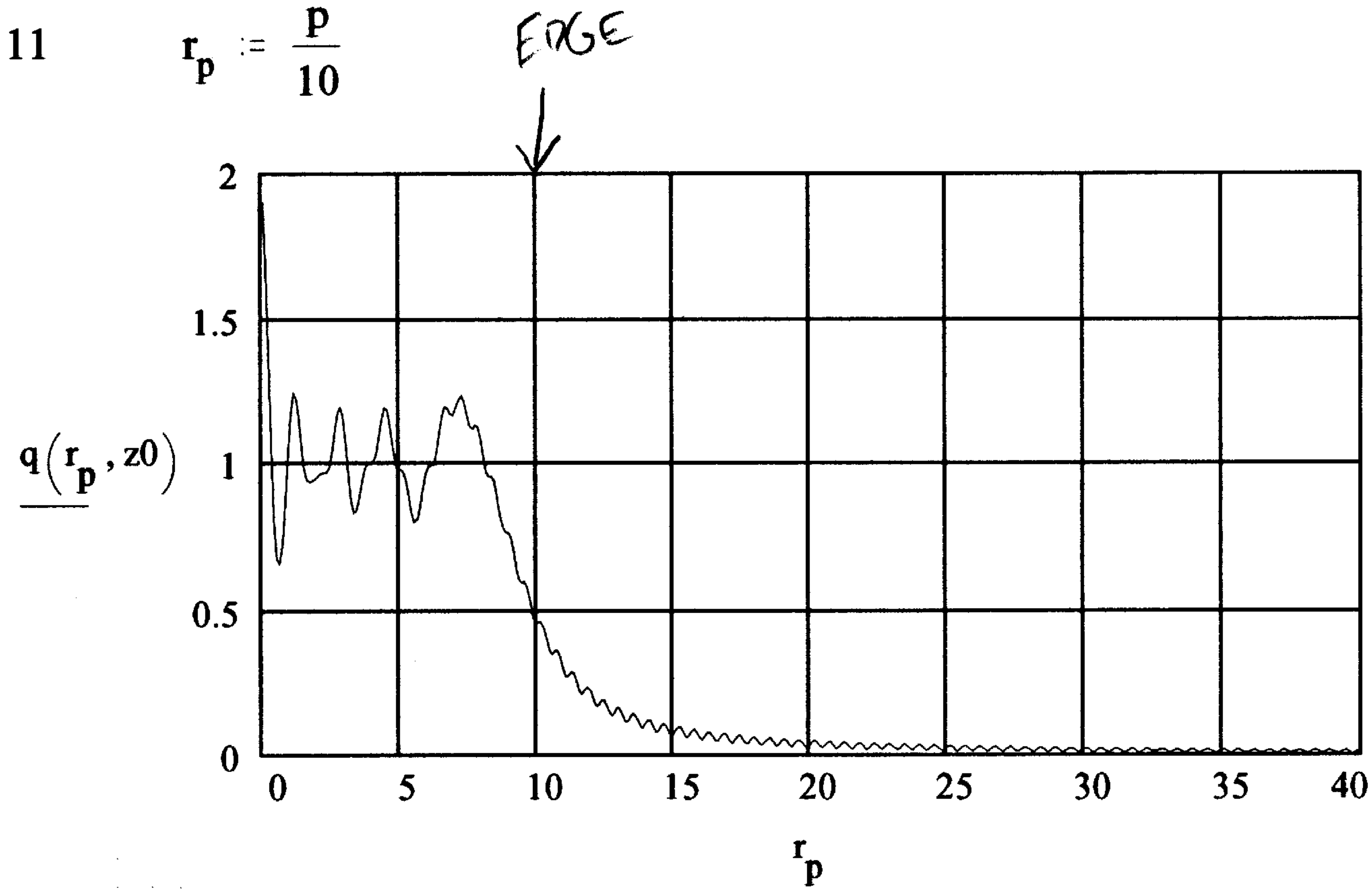


The edge of the disc is always shown as an arrow at the top.

Near the Third On-Axis Maximum

$z0 := 11 \qquad r_p := \frac{p}{10}$

(5)



The edge of the disc is always shown as an arrow at the top.