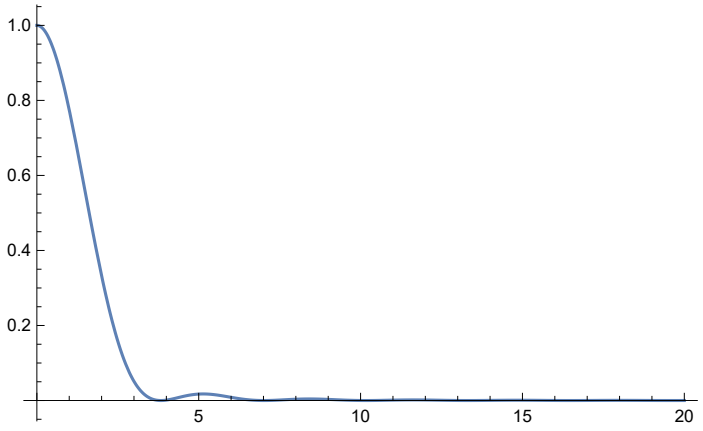
Diffraction from Circle and Circle-Square Combo

by Dr. Colton, Physics 471 (last updated: Winter 2024)

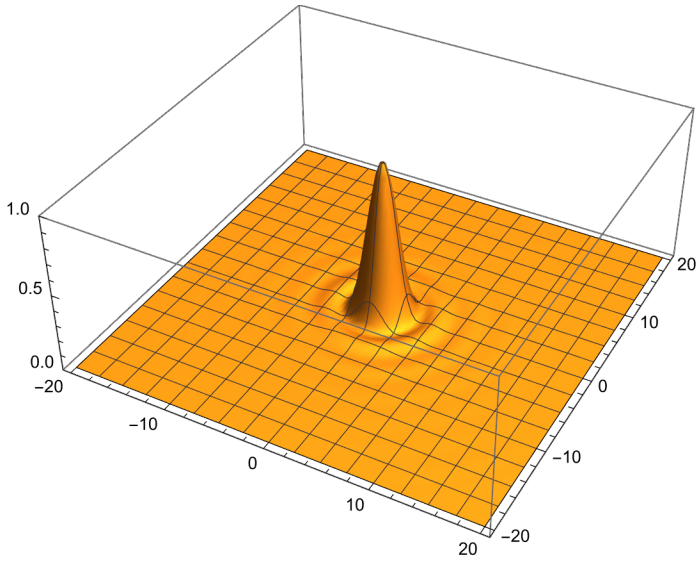
In[1]:=
```
jinc[x_] := 2 BesselJ[1, x] / x

(* Diffraction through a circular aperture, radius a *)
(* This is the "Airy pattern",
which is the central "Airy disk" plus the "Airy rings" *)
(* With a, k, and z all set equal to 1 for simplicity *)
(* Plot of (FT of "top hat")^2 *)
Plot[jinc[kr]^2, {kr, 0, 20}, PlotRange → All]
Plot3D[jinc[Sqrt[x^2 + y^2]]^2, {x, -20, 20},
 {y, -20, 20}, PlotRange → {0, 1}, PlotPoints → 100]
DensityPlot[jinc[Sqrt[x^2 + y^2]]^2, {x, -20, 20},
 {y, -20, 20}, PlotRange → {0, 1}, PlotPoints → 100]
(* now zooming in a bit *)
Plot3D[jinc[Sqrt[x^2 + y^2]]^2, {x, -20, 20},
 {y, -20, 20}, PlotRange → {0, 0.02}, PlotPoints → 100]
DensityPlot[jinc[Sqrt[x^2 + y^2]]^2, {x, -20, 20},
 {y, -20, 20}, PlotRange → {0, 0.02}, PlotPoints → 100]
```

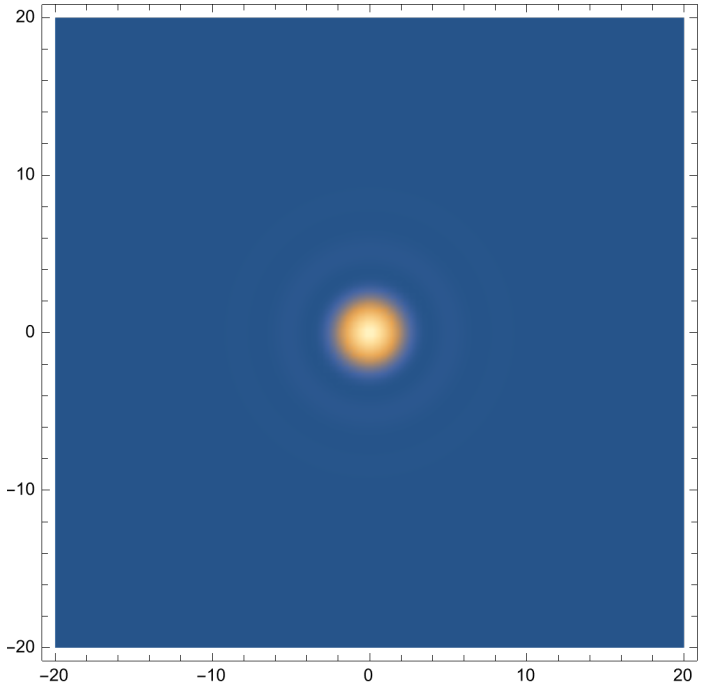
Out[2]=



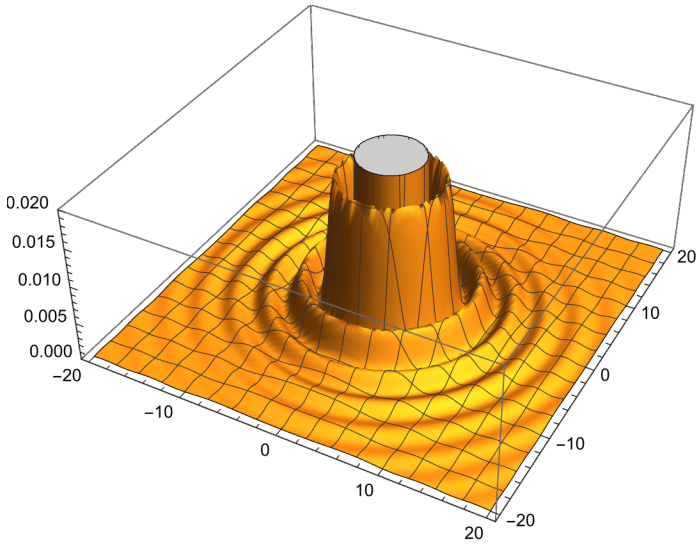
Out[3]=



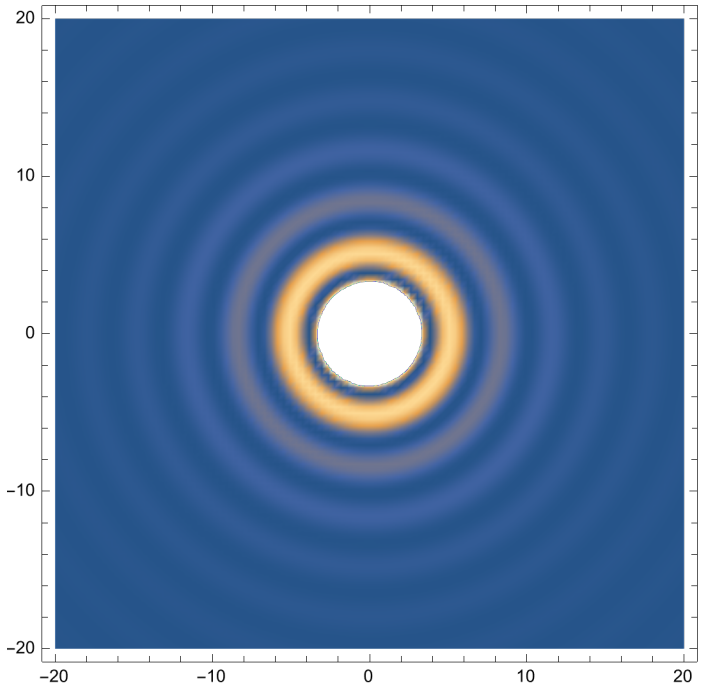
Out[4]=



Out[5]=

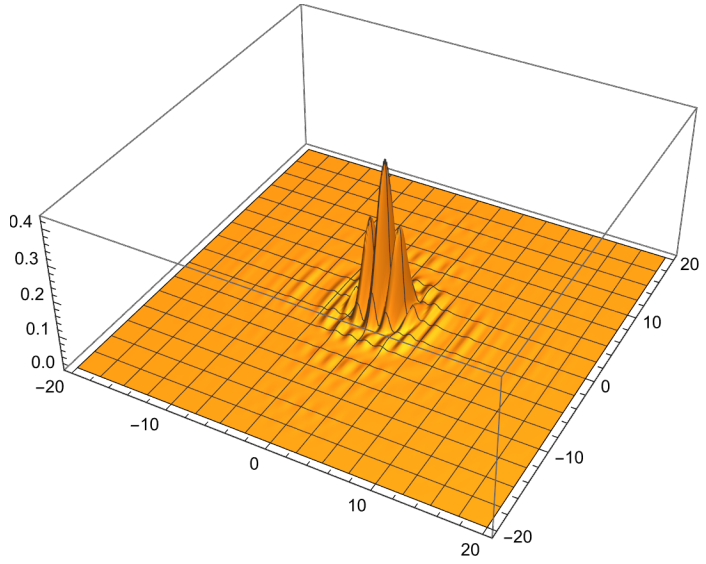

0.020
0.015
0.010
0.005
0.000
−20
−10
0
10
20
20
10
0
−10
−20

Out[6]=

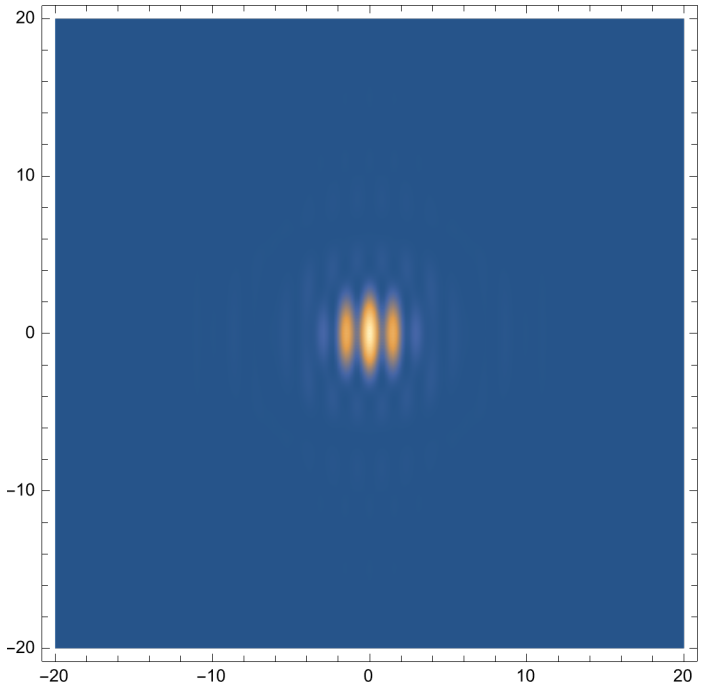

20
10
0
−10
−20
−20
−10
0
10
20

In[7]:=
```
(* A square side length a centered at (2a,0)
 combined with a circle radius a centered at at (-2a,0) *)
(* With a, k, and z all set equal to 1 for simplicity *)
(* Notice how the result incorporates features of a square,
a circle, and a double slit. *)
sum[x_, y_] :=
 Exp[I 2 x ] (1 / (2 Pi) ) Sinc[x / 2] Sinc[y / 2] + Exp[-I 2 x] (1 / 2) jinc[Sqrt[x^2 + y^2]]
Plot3D[Abs[sum[x, y]]^2, {x, -20 , 20 },
 {y, -20 , 20}, PlotRange → {0, 0.4345}, PlotPoints → 200]
DensityPlot[Abs[sum[x, y]]^2, {x, -20, 20},
 {y, -20, 20}, PlotRange → {0, 0.4345}, PlotPoints → 200]
(* now zooming in a bit *)
Plot3D[Abs[sum[x, y]]^2, {x, -20 , 20 },
 {y, -20 , 20}, PlotRange → {0, 0.01}, PlotPoints → 200]
DensityPlot[Abs[sum[x, y]]^2, {x, -20, 20},
 {y, -20, 20}, PlotRange → {0, 0.01}, PlotPoints → 200]
```

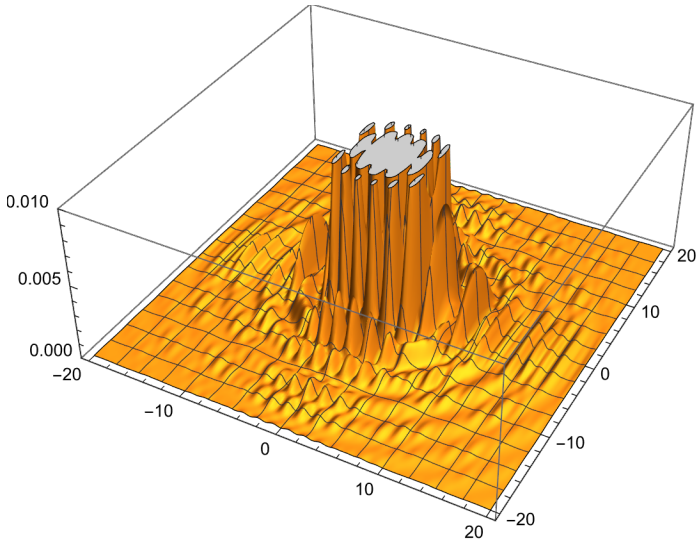
Out[8]=



Out[9]=



Out[10]=



Out[11]=