The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

1931-5a

Preparatory School to the Winter College on Micro and Nano Photonics for Life Sciences

4 - 8 February 2008

Mathematica file

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In[1]:=

Diffraction theory, coherence, geometrical optics, and optical imaging modalities

Miguel A. Alonso G.

University of Rochester

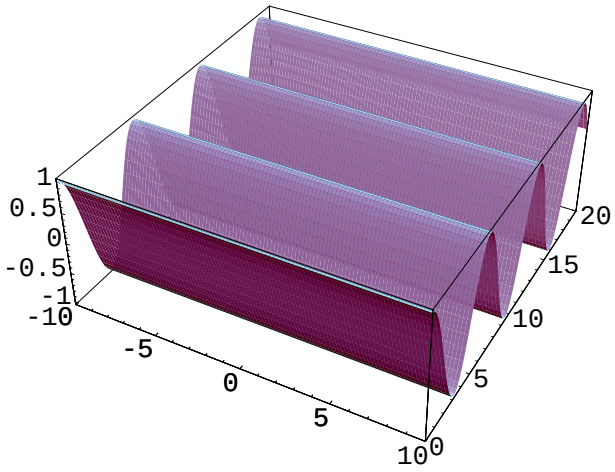
Fourier Transforms

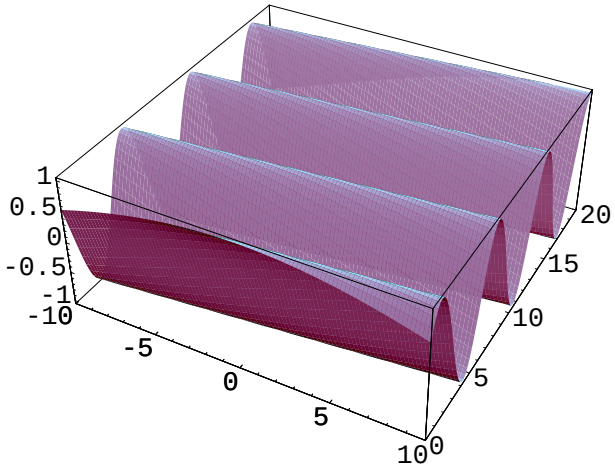
Diffraction Theory

■ Homogeneous and evanescent waves

```
In[11]:= kz[kx_] = If[kx^2 < 1, Sqrt[1 - kx^2], I Sqrt[kx^2 - 1]];
         wave[kx_] := Plot3D[Re[Exp[I (-x kx + z kz[kx])]],
           {x, -10, 10}, {z, 0, 20}, PlotPoints → 100, Mesh → False, PlotRange → All]

In[13]:= Table[wave[kx], {kx, 0, 2., .1}]
```

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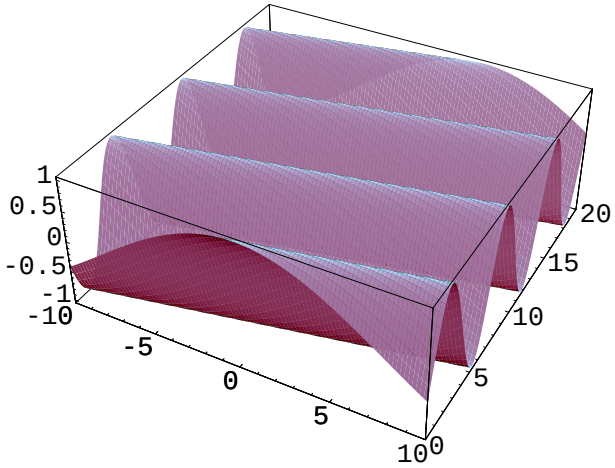
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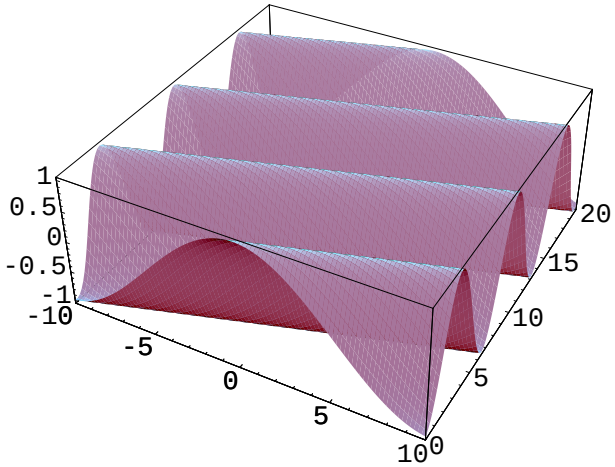
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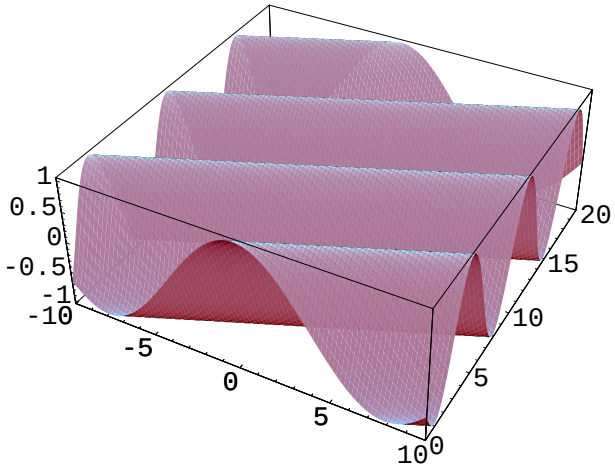
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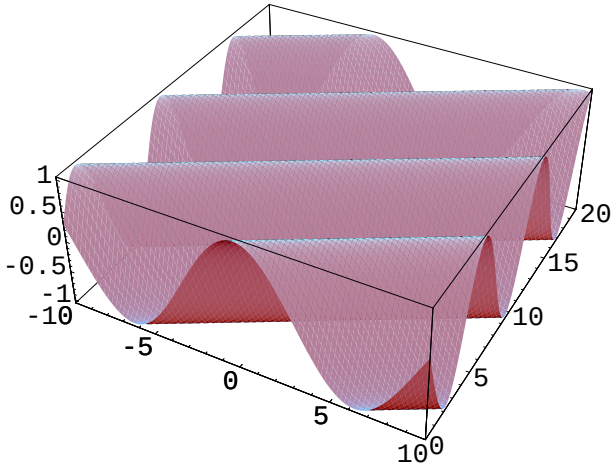
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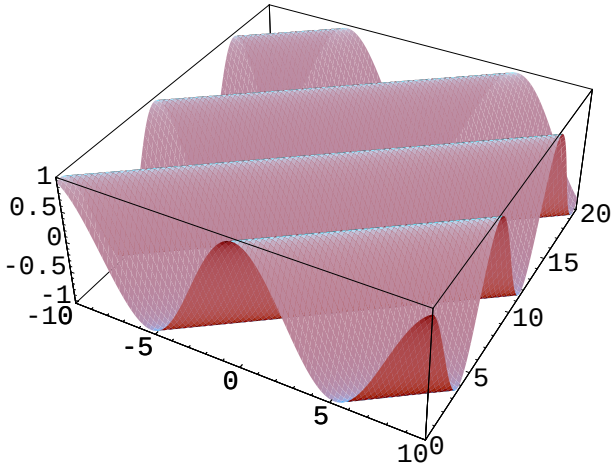
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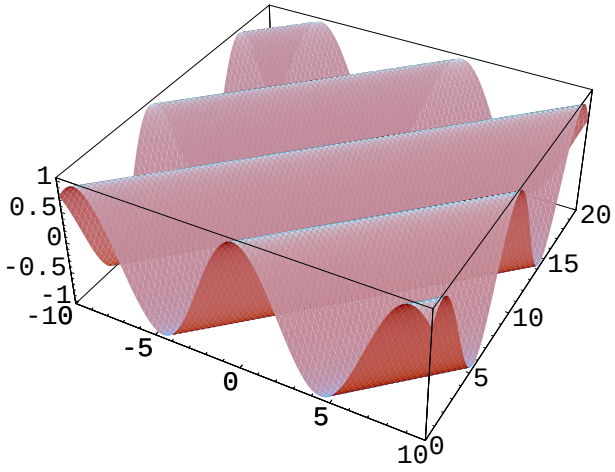
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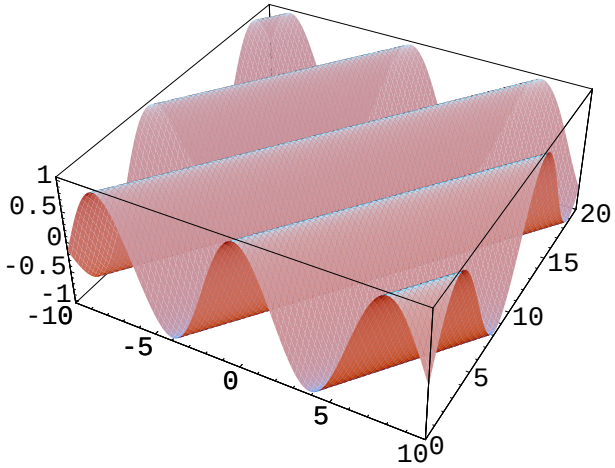
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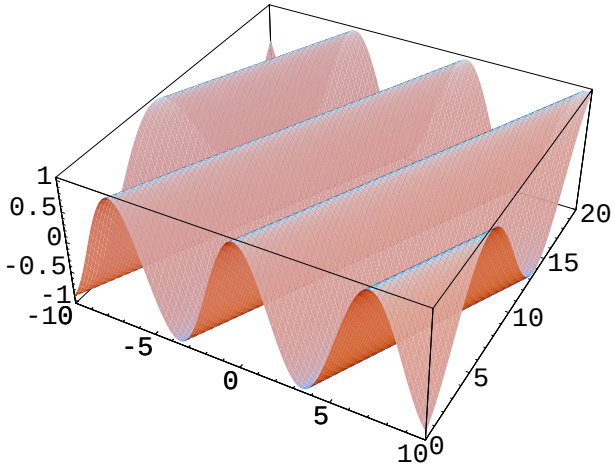
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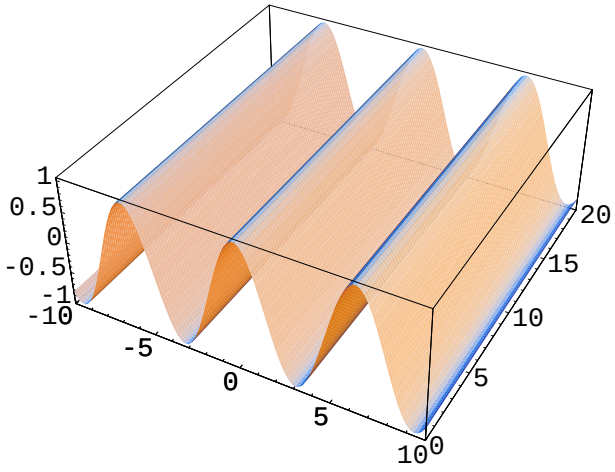
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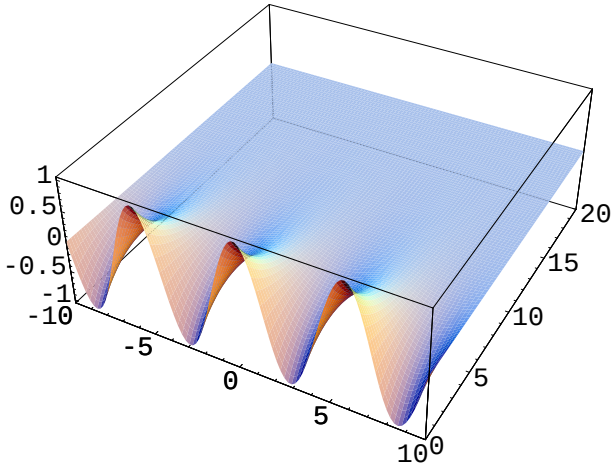
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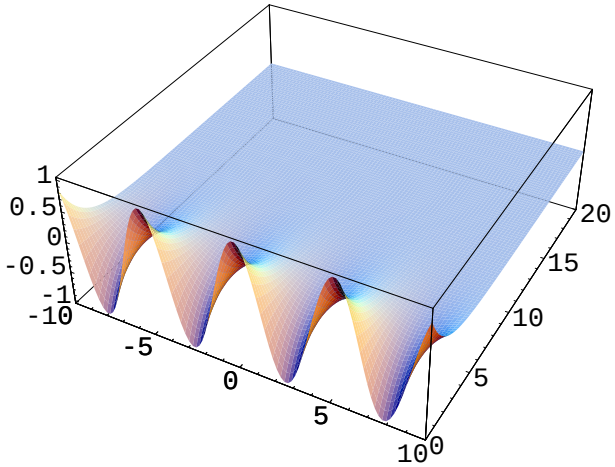
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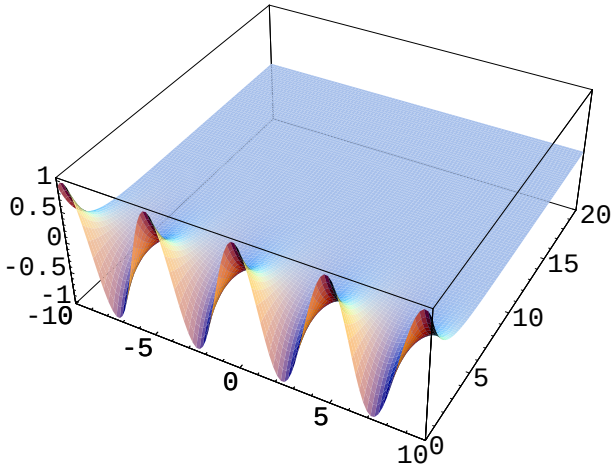
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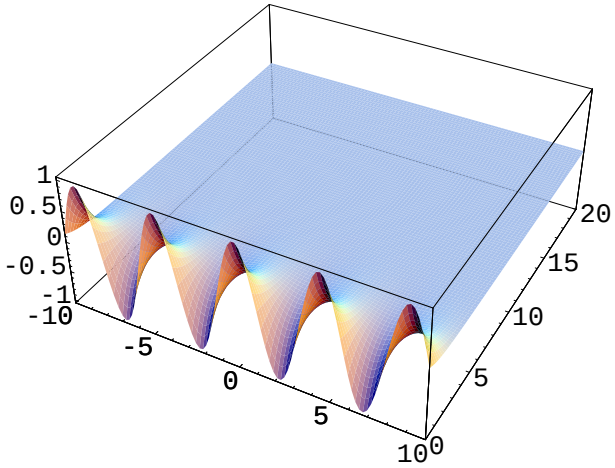
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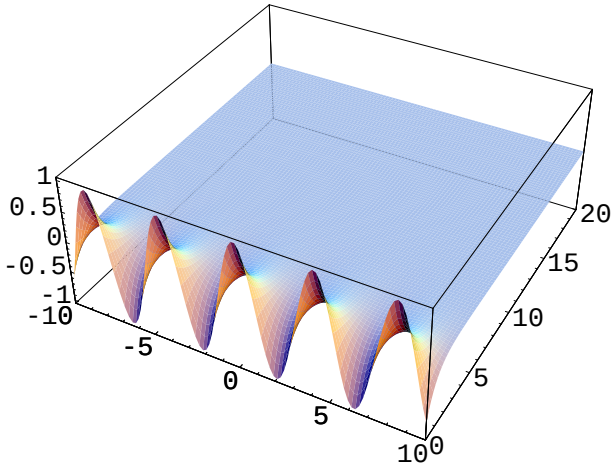
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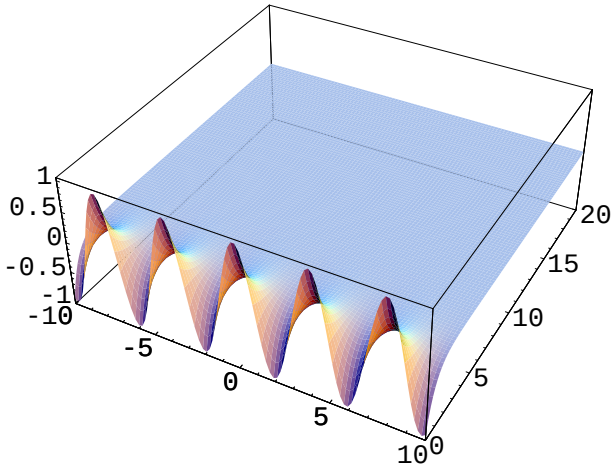
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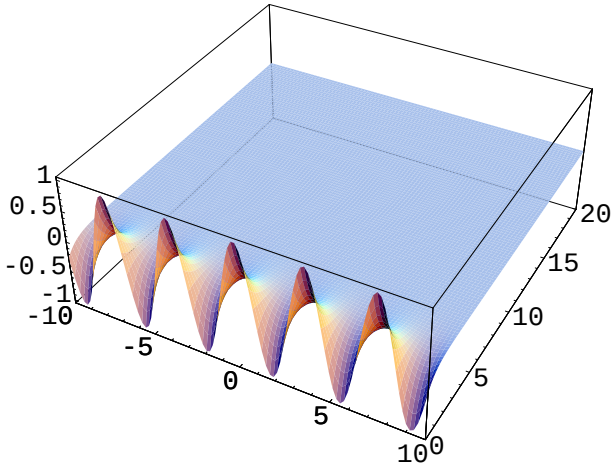
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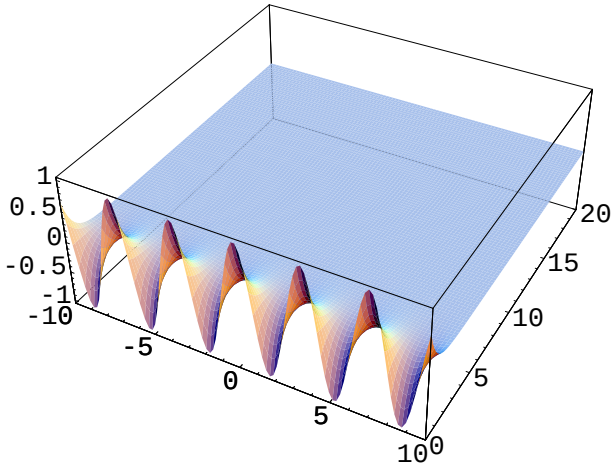
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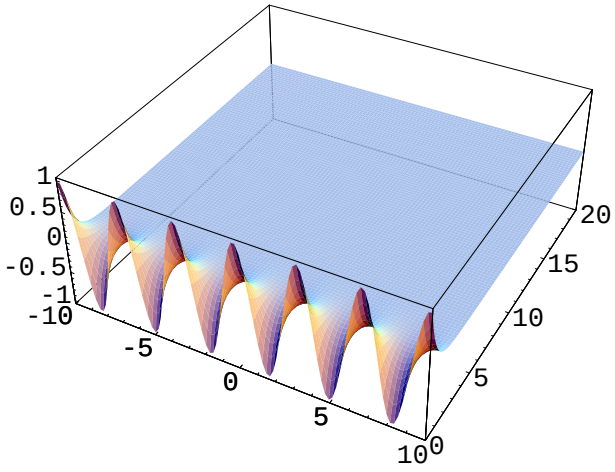

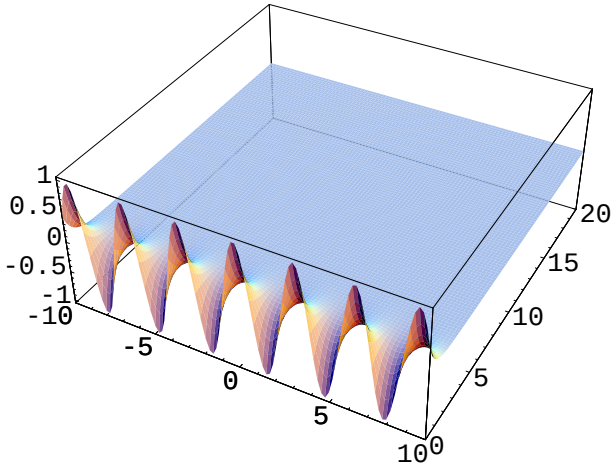


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■ Exercises: On−axis field for circular aperture of radius a

```
In[14]:= ko = 2 Pi;

In[15]:= UNonparaxial[a_, z_] = Simplify[z Integrate[
             (-I + 1 / u) Exp[I u] / u, {u, z, Sqrt[z^2 + a^2]}, Assumptions → {z > 0, a > 0}]]

         UParaxial[a_, z_] = Exp[I z] (Exp[-I a^2 / (2 z)] - 1)

         Plot[{Re[UNonparaxial[ko 4, ko z]], Re[UParaxial[ko 4, ko z]]}, {z, .1, 40}]
```

Focused beams

■ Gaussian Beam

```
w[wo_, z_] = Sqrt[wo^2 + I z / ko];
UGaussian[wo_, x_, z_] = Sqrt[wo / w[wo, z]] Exp[I ko z] Exp[-(x / w[wo, z])^2 / 2]

ContourPlot[Abs[UGaussian[.5, x, z]]^2,
 {z, -4, 4}, {x, -2, 2}, AspectRatio → Automatic]

Table[ContourPlot[Re[UGaussian[2, x, z] Exp[-I t]], {z, -4, 4},
  {x, -2, 2}, AspectRatio → Automatic], {t, 0, 2 Pi - Pi / 8, Pi / 8}]

Table[ContourPlot[Abs[UGaussian[wo, x, z]],
  {z, -4, 4}, {x, -2, 2}, AspectRatio → Automatic, PlotRange → All,
  ContourLines → False, Contours → 40], {wo, 1, 4, .1}]
```

■ Exercise : Norparaxial focused fields

■ Effects of polarization

Imaging