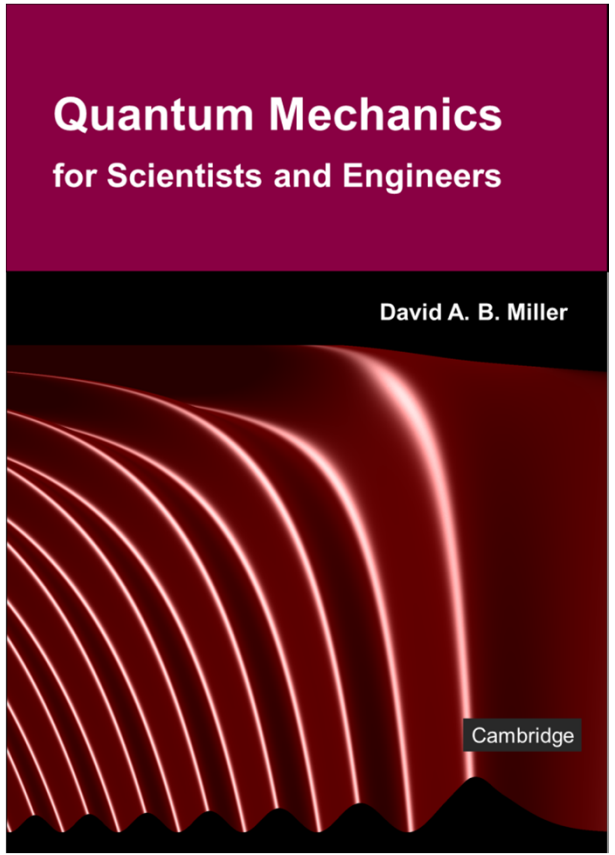
2.1 Wave propagation

Slides: Video 2.1.3 Diffraction

Text reference: Quantum Mechanics for Scientists and Engineers

Section B.4



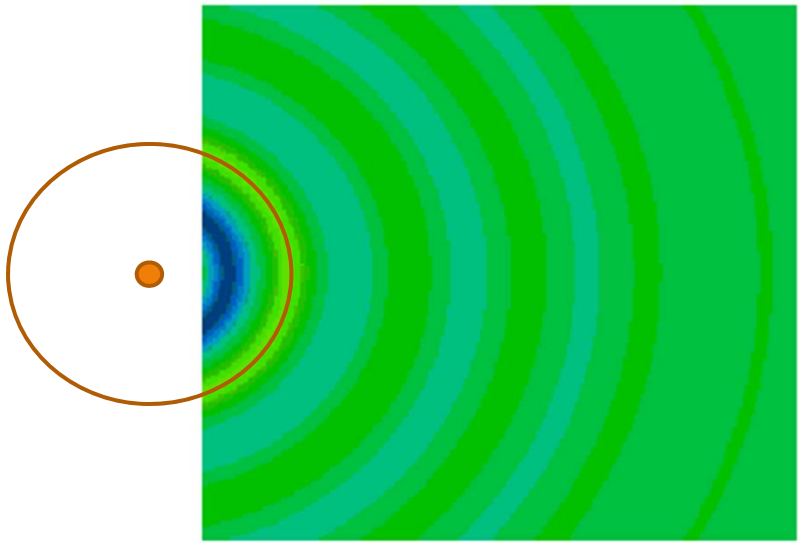
Wave propagation

Diffraction

Quantum mechanics for scientists and engineers

David Miller

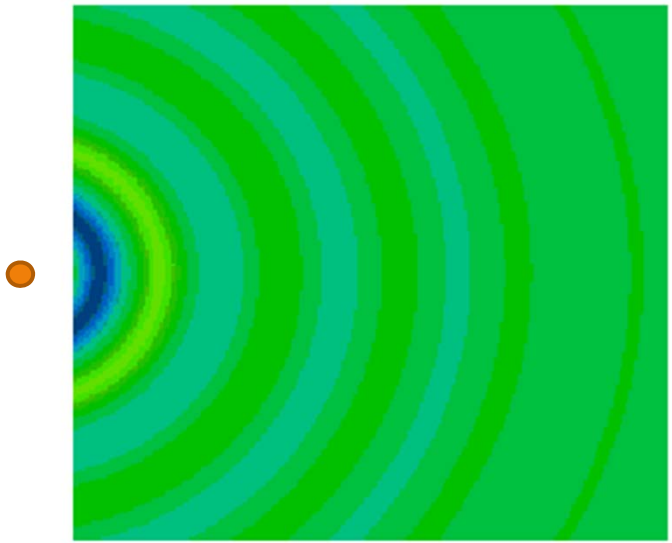
Waves from a point source



Here is a “snapshot” of a wave from a point source

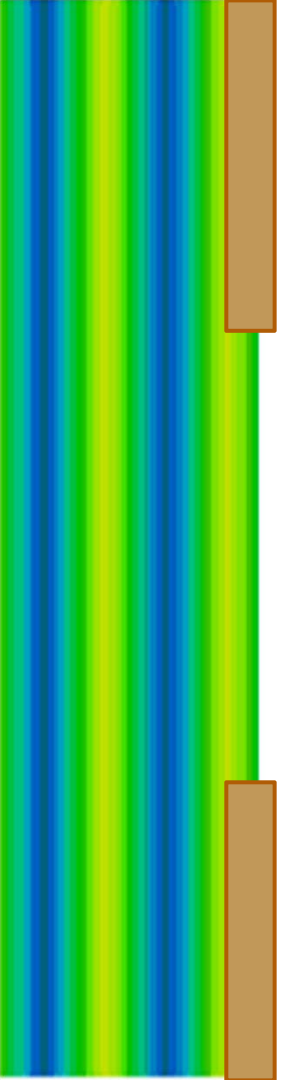
showing the waves are circular

Waves from a point source



We can watch the wave from this point source as it propagates

giving a circularly expanding wave



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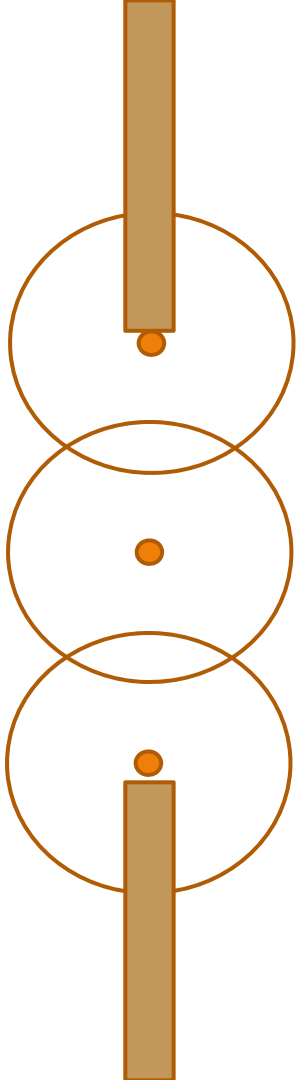
Waves from an aperture

Suppose we want to know the wave from an aperture

a “gap” in a wall

that is illuminated with a plane wave from the left



Waves from an aperture

Suppose we want to know the wave from an aperture

a “gap” in a wall

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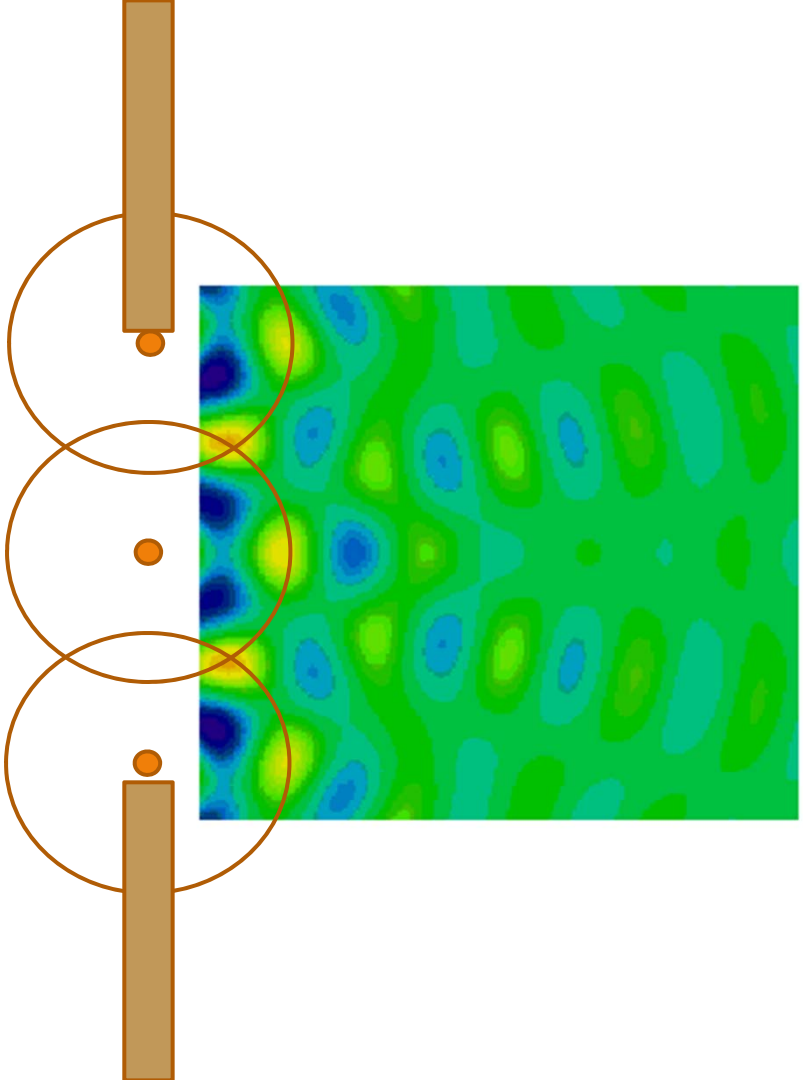
We could start by using just 3 point sources on this plane wave front

to try to describe the transmitted wave



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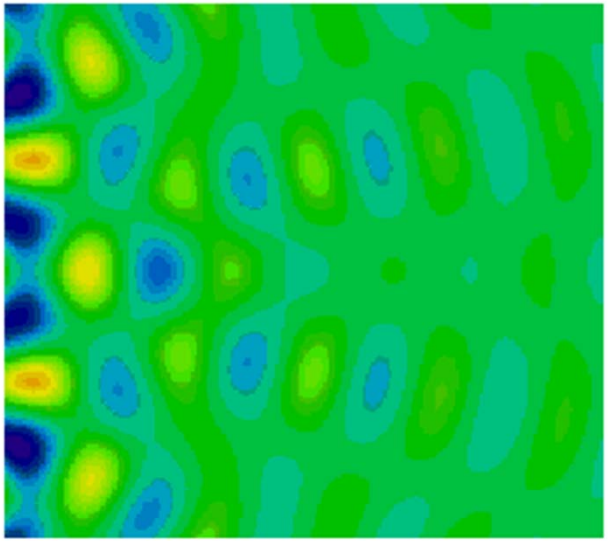
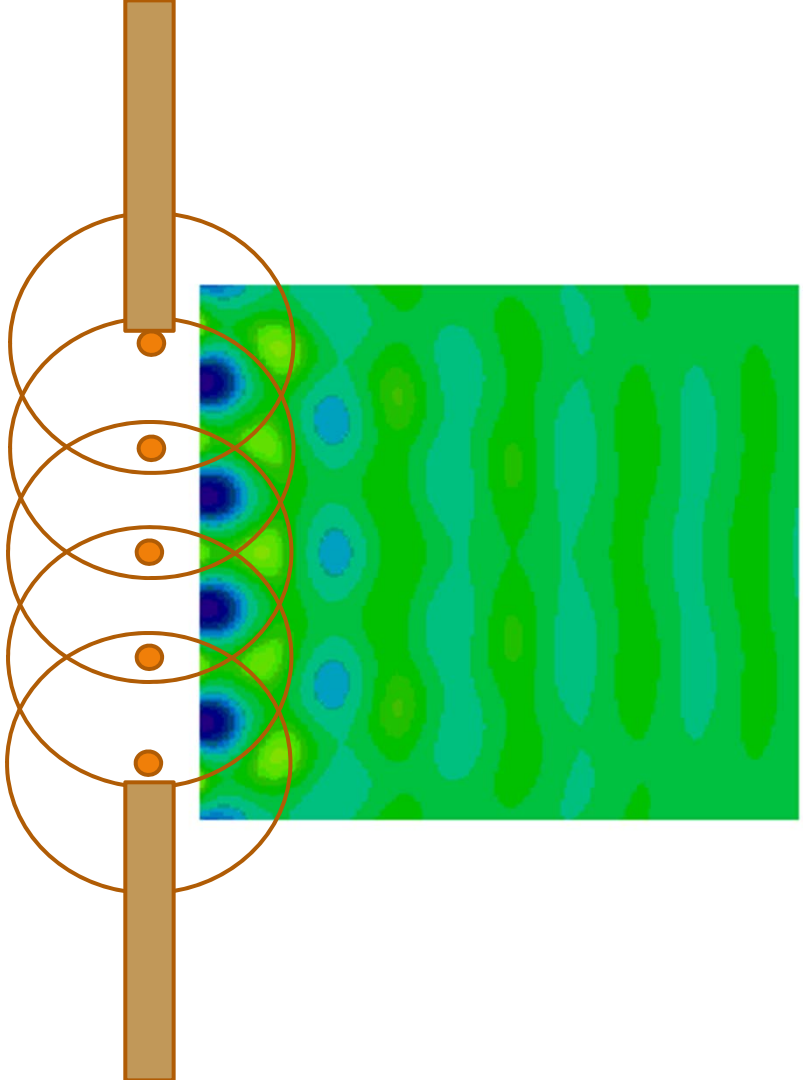


If we use 3 point sources on this plane wave front

the result is not very accurate



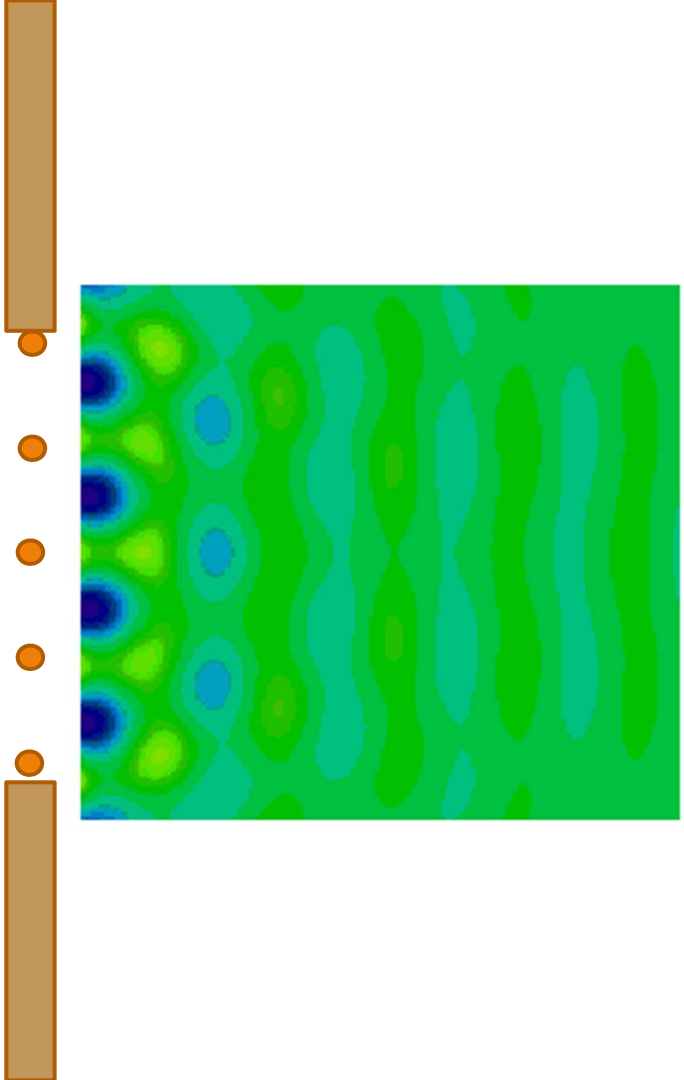
Waves from an aperture

If we use 5 point sources

the result may not be accurate near the aperture

but we see locally plane waves at larger distances

Waves from an aperture



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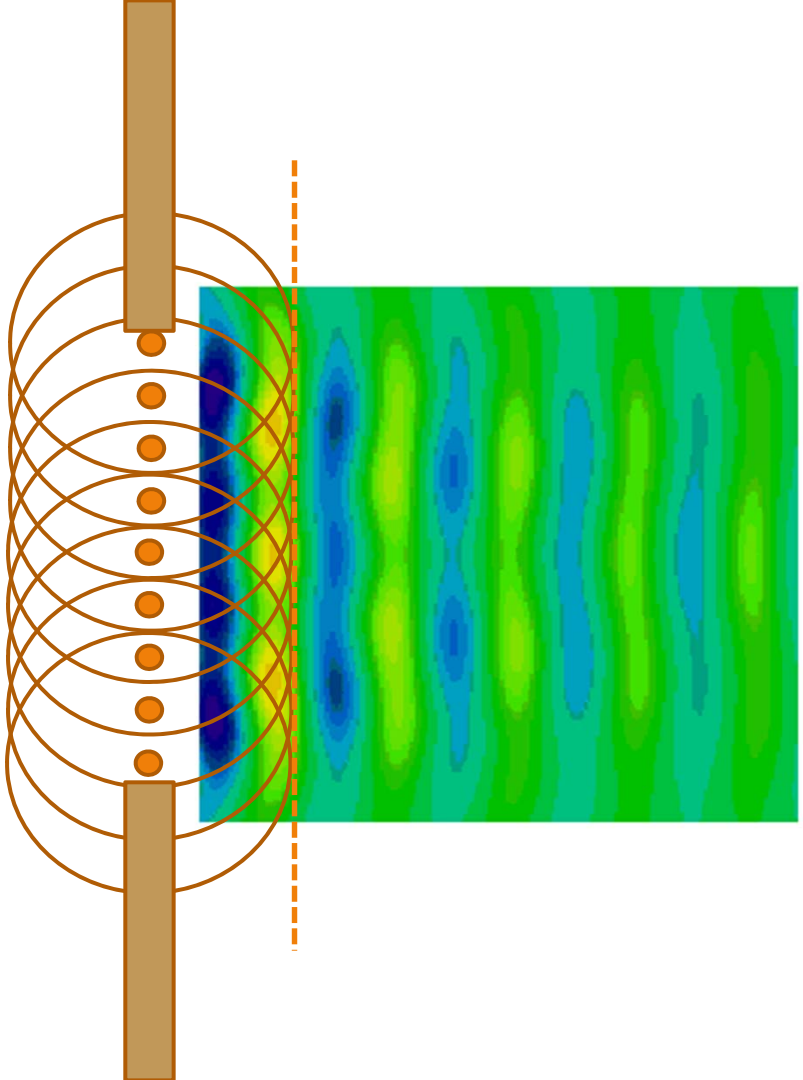
Waves from an aperture



With 9 point sources

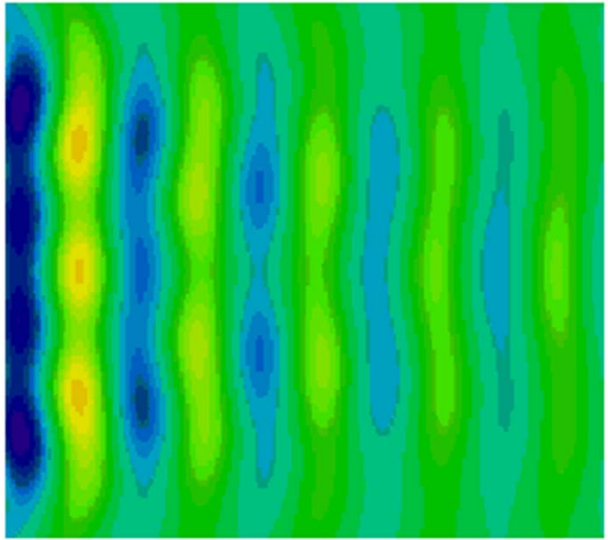
we see the circles are beginning to describe a straight line

e.g., at their right edges

and they generate plane phase fronts on the right

as if the incident plane wave had propagated through the aperture

Waves from an aperture



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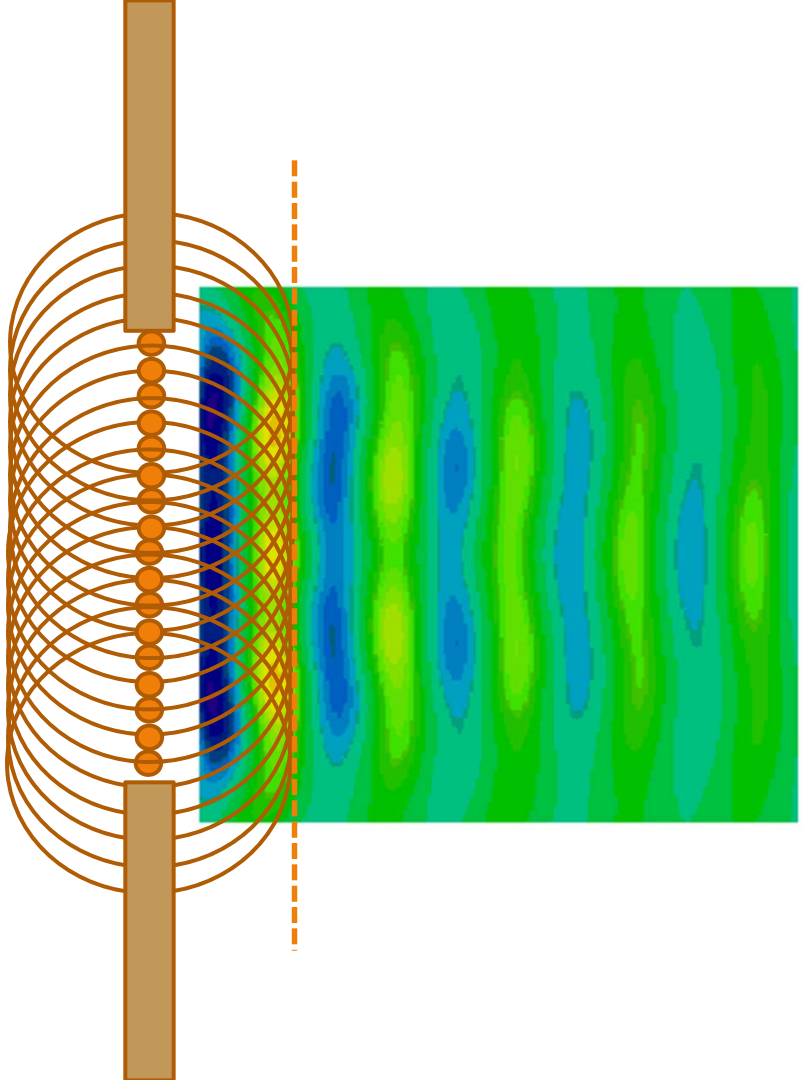


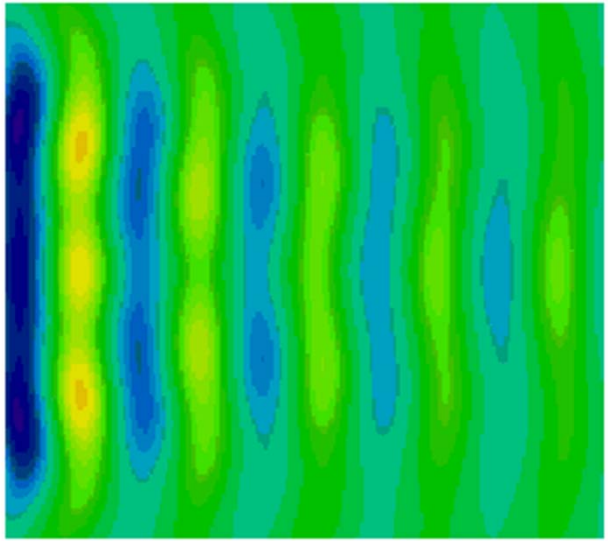
With 17 point sources

we have essentially converged on a good description in this model

obtaining initially plane wave fronts

from the original plane wave propagating “through” the aperture

Waves from an aperture



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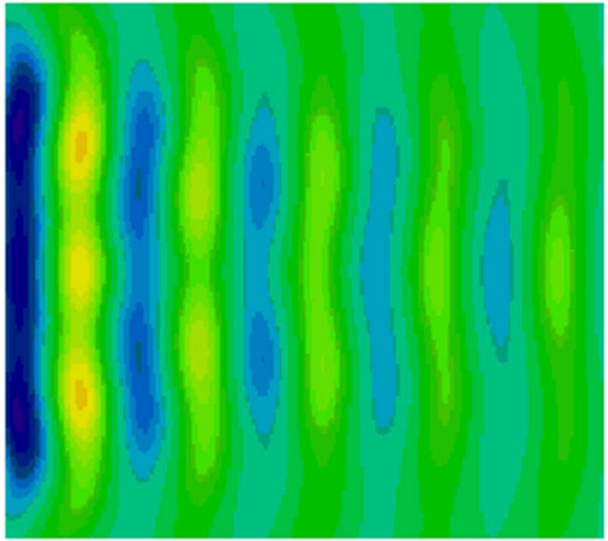


We can also see that something is happening on the right

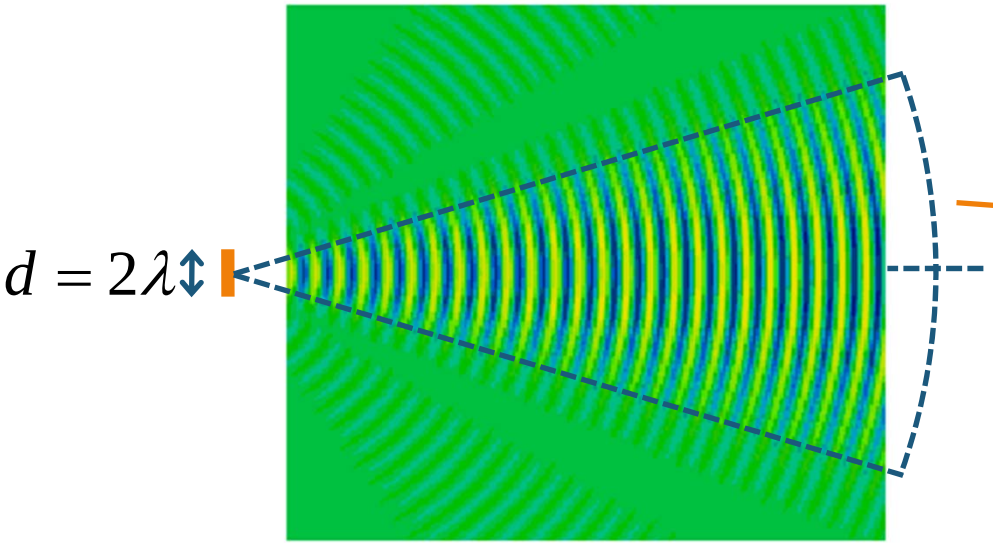
the waves seem to be getting weaker

in fact, they are actually spreading out

beyond our picture

Diffraction angle

For a source or aperture of width d

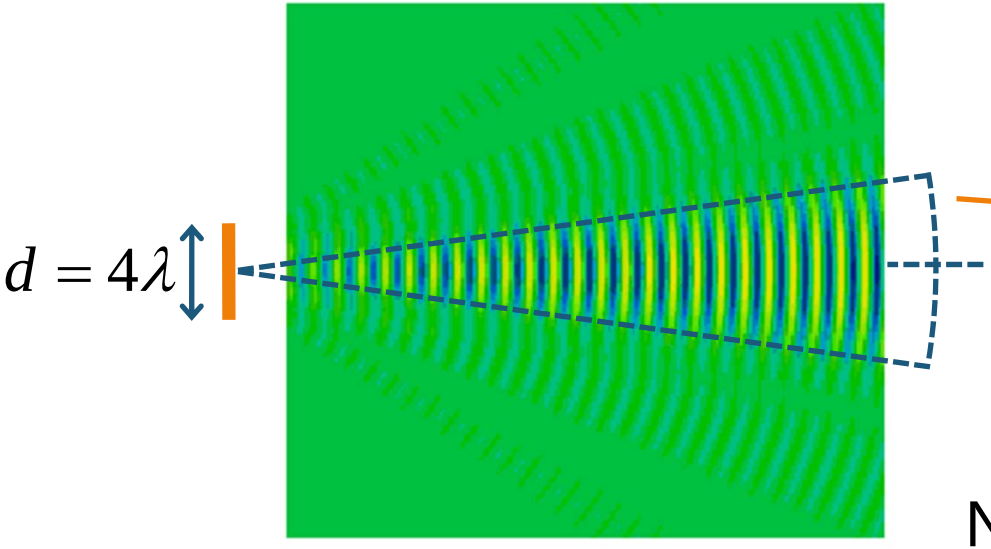


the diffraction angle

$$\theta \sim \frac{\lambda}{d}$$

where λ is the wavelength

Diffraction angle



For a source or aperture of width d

the diffraction angle

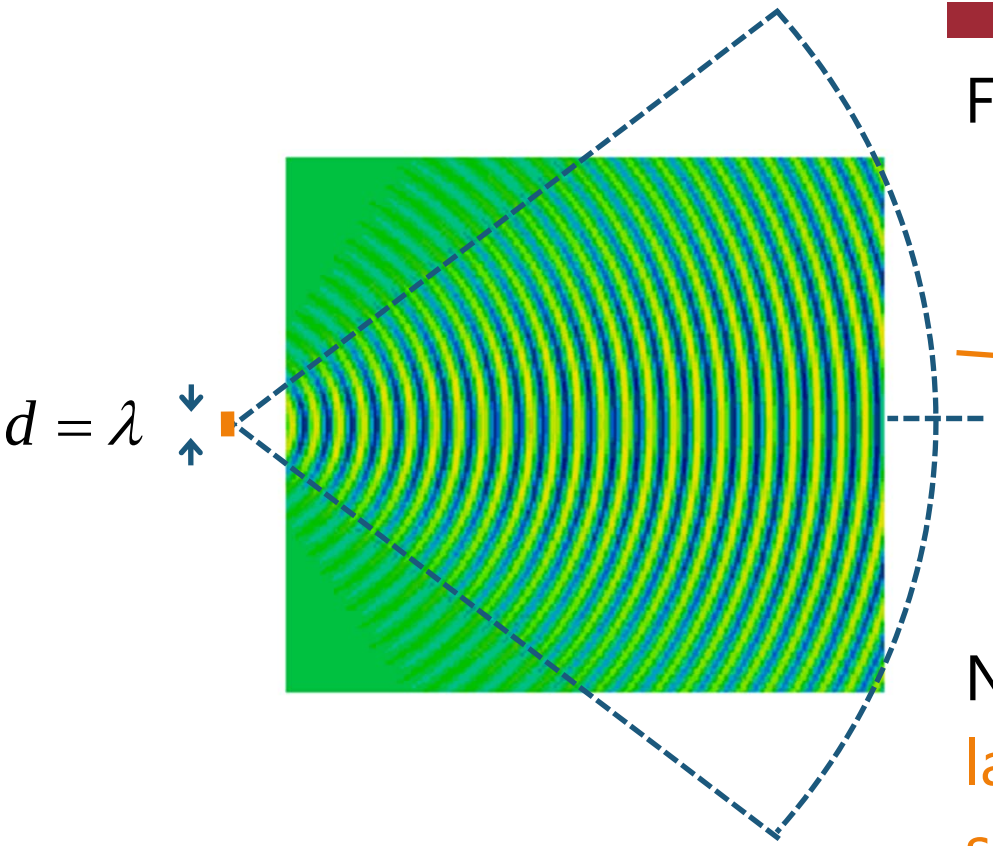
$$\theta \sim \frac{\lambda}{d}$$

where λ is the wavelength

Note the inverse relation

larger aperture, smaller angle

Diffraction angle



For a source or aperture of width d

the diffraction angle

$$\theta \sim \frac{\lambda}{d}$$

where λ is the wavelength

Note the inverse relation

larger aperture, smaller angle

smaller aperture, larger angle