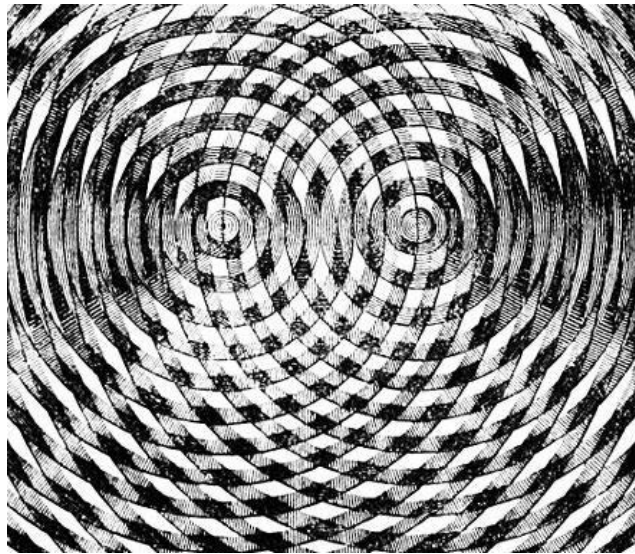
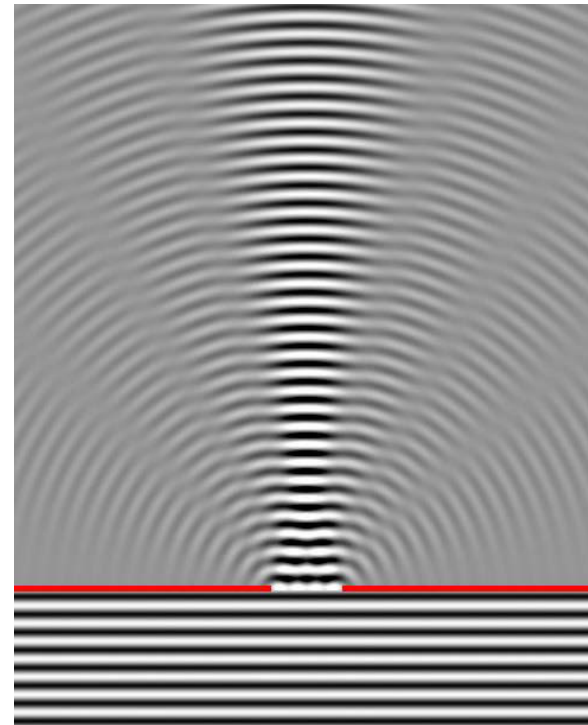


Nanomaker

Lab #2: Holography



Both images are in the public domain.

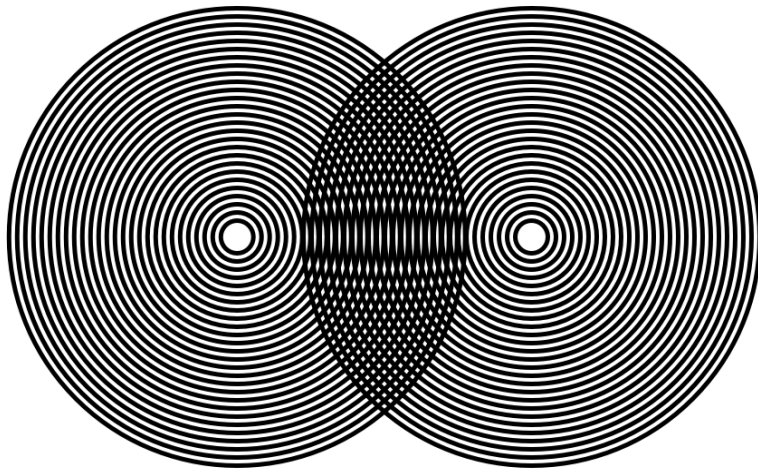


Interference

Diffraction

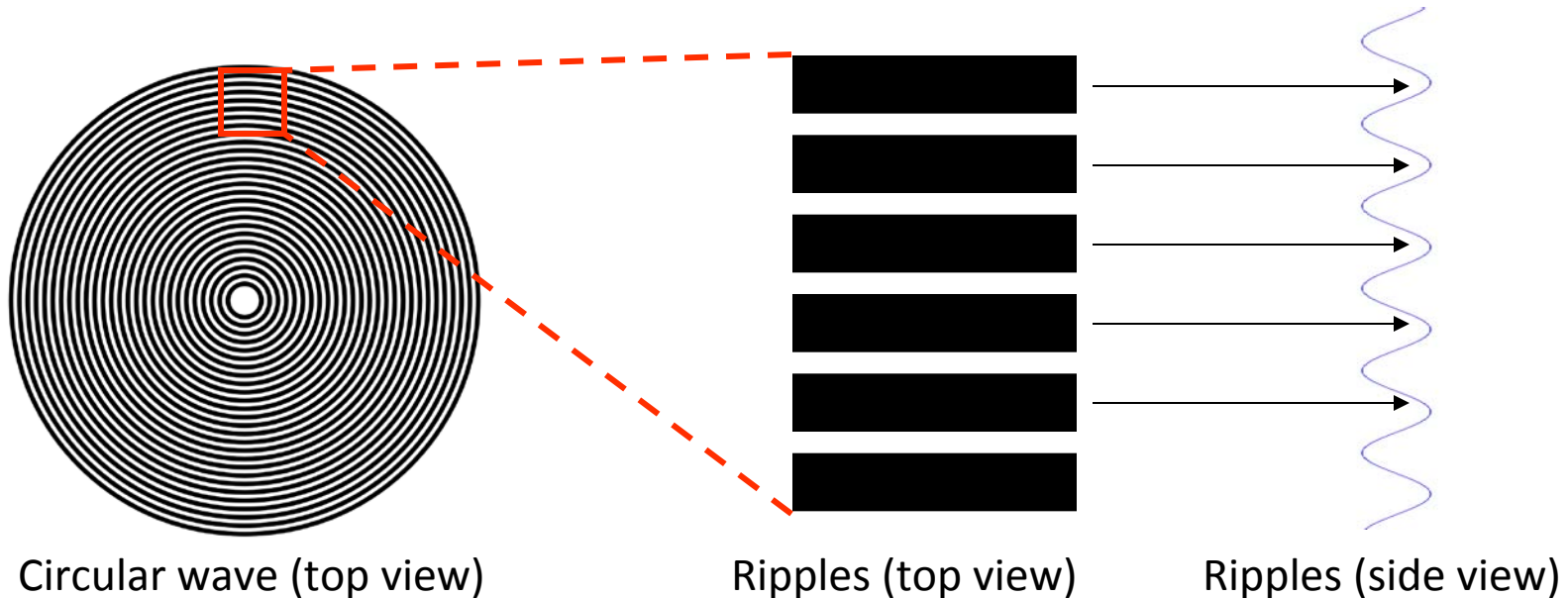
3D Images

Light Behaves Like a Wave



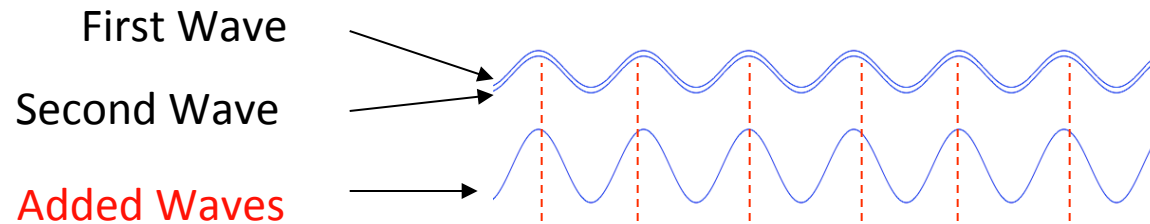
Interference is what happens when two or more waves collide.

To understand interference, let's zoom in...

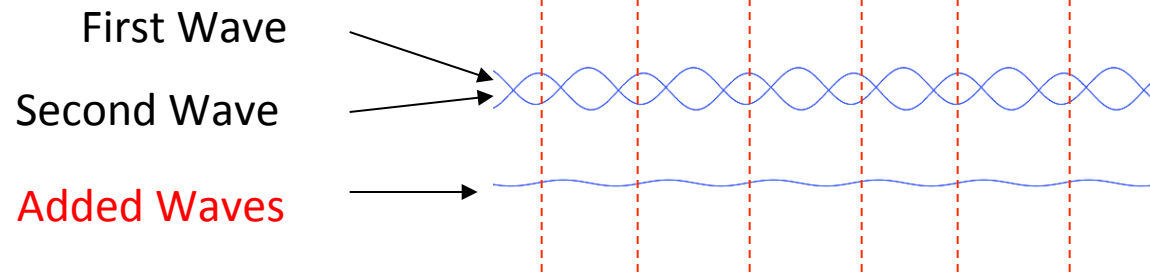


Interference

When waves **interfere**, you add them together

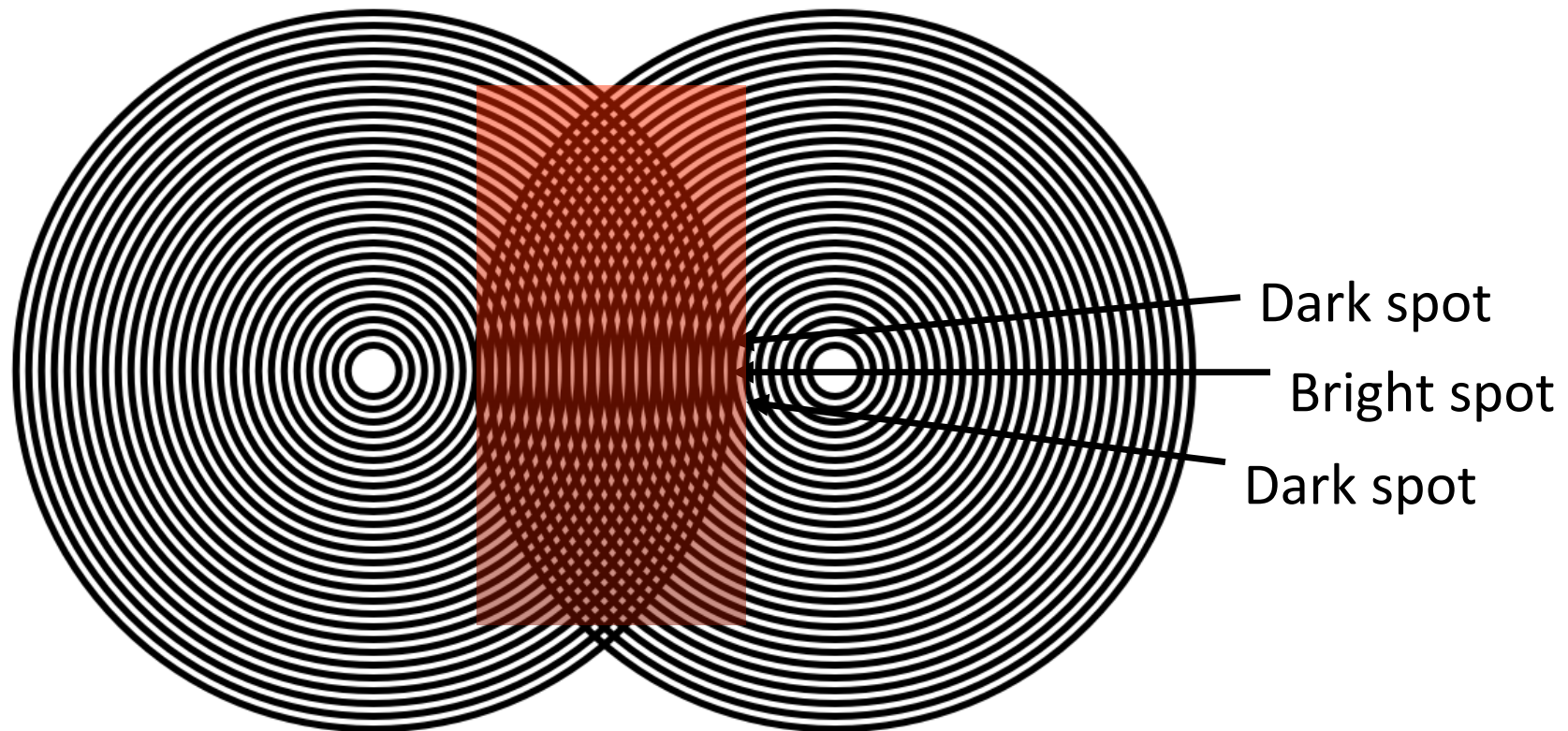


When the waves are aligned, the **added wave is bright**.
This is called “**constructive interference**”



When the waves are *misaligned*, the **added wave is dark**.
This is called “**destructive interference**”

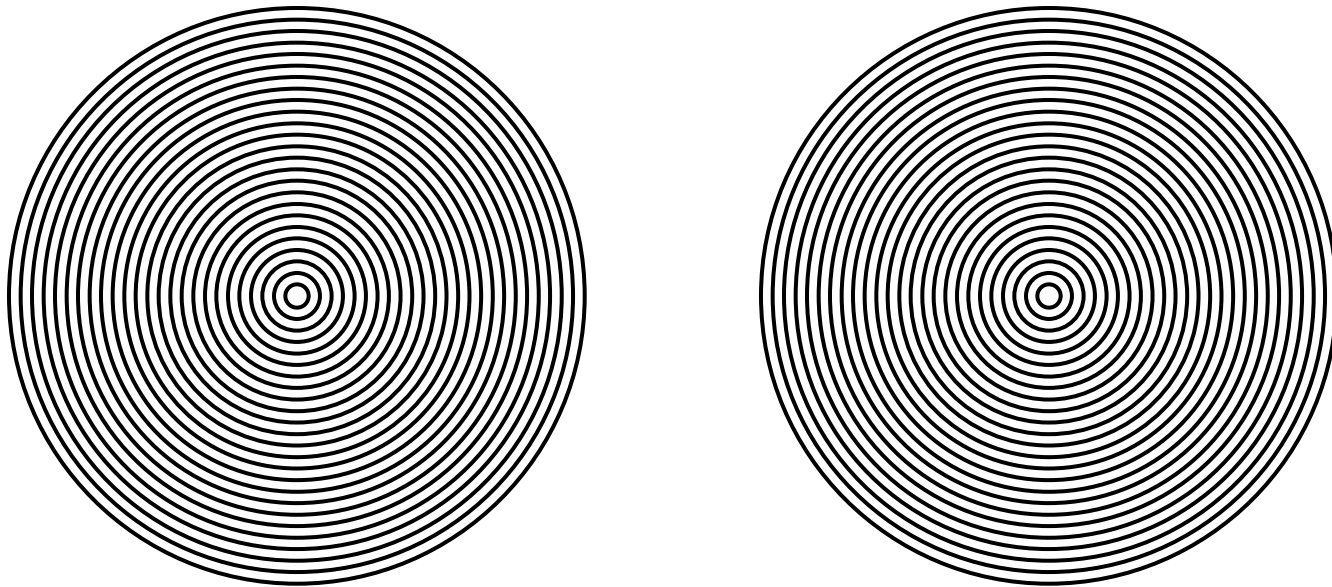
Interference Fringes



Constructive and destructive interference happens when two waves collide. This produces bright and dark spots.

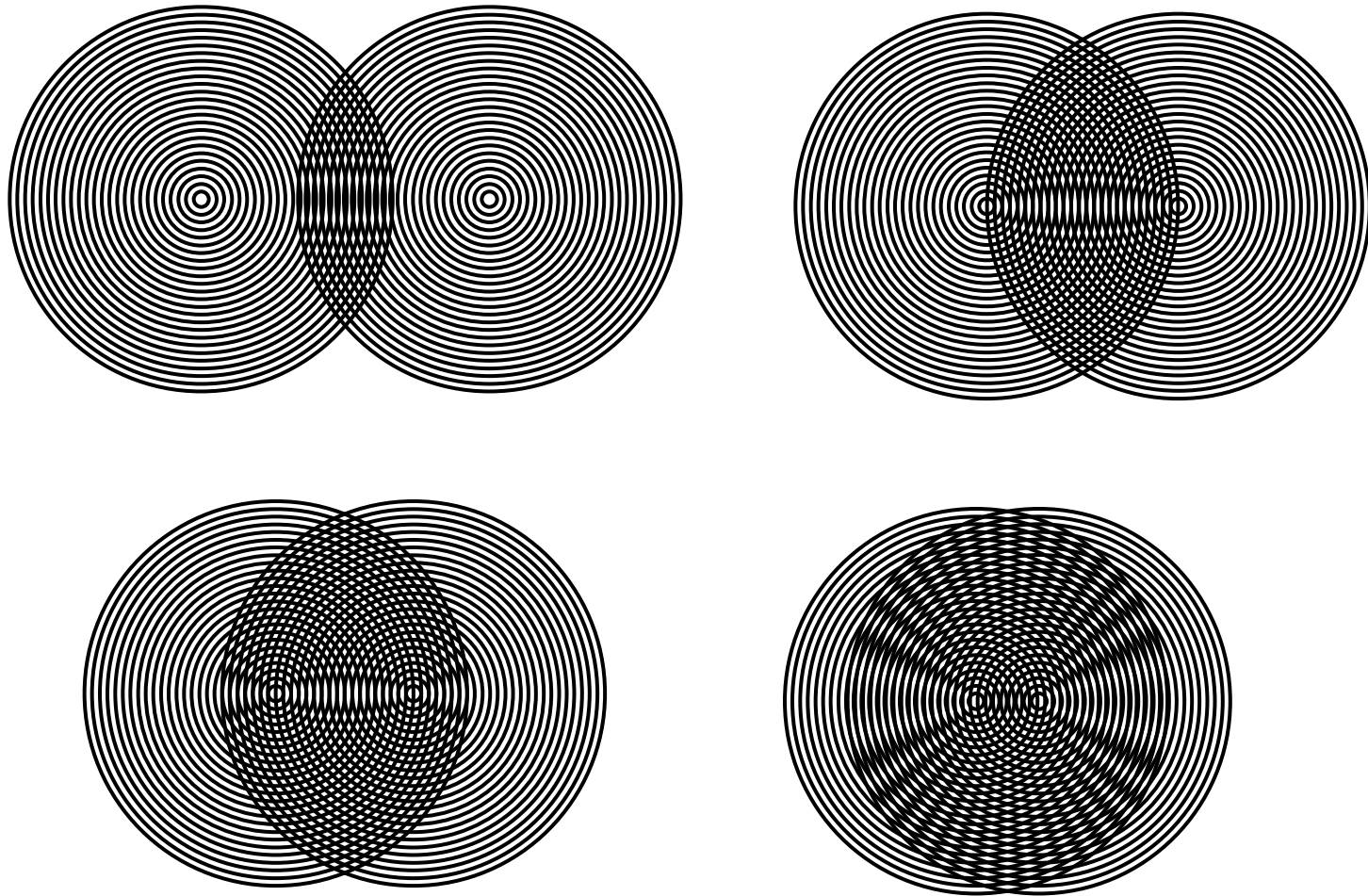
Alternating bright and dark spots are called **fringes**.

Activity



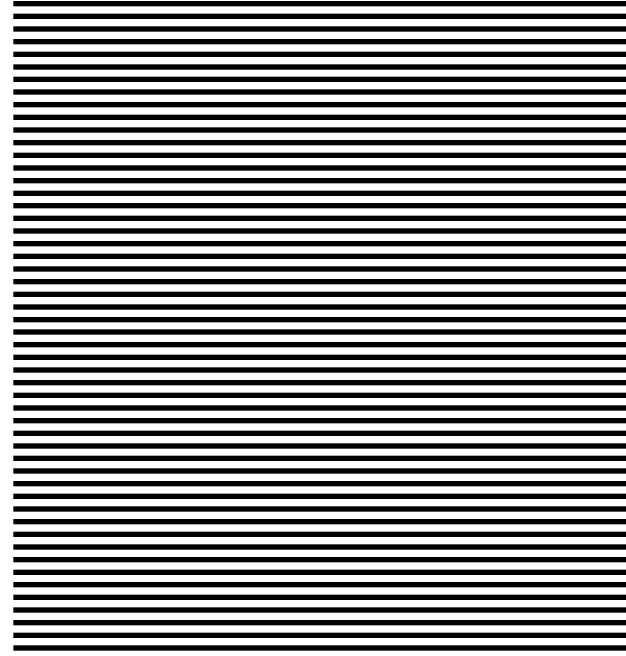
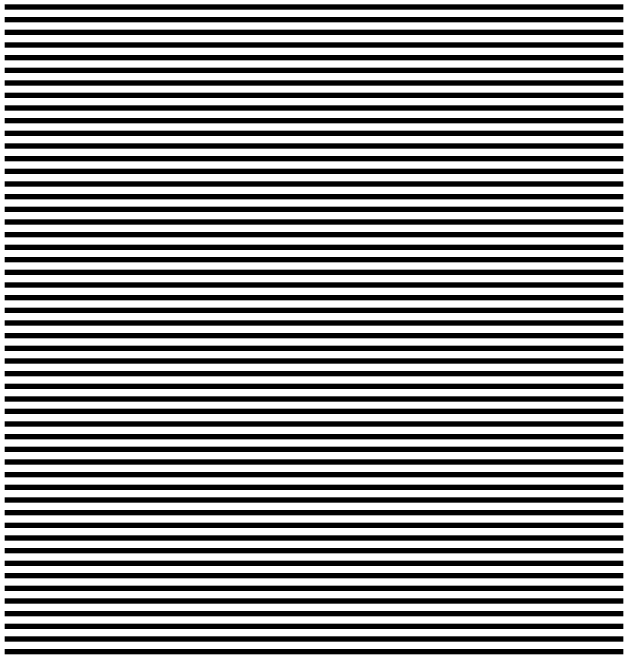
What happened when you add them together or move them around?

Moiré Pattern



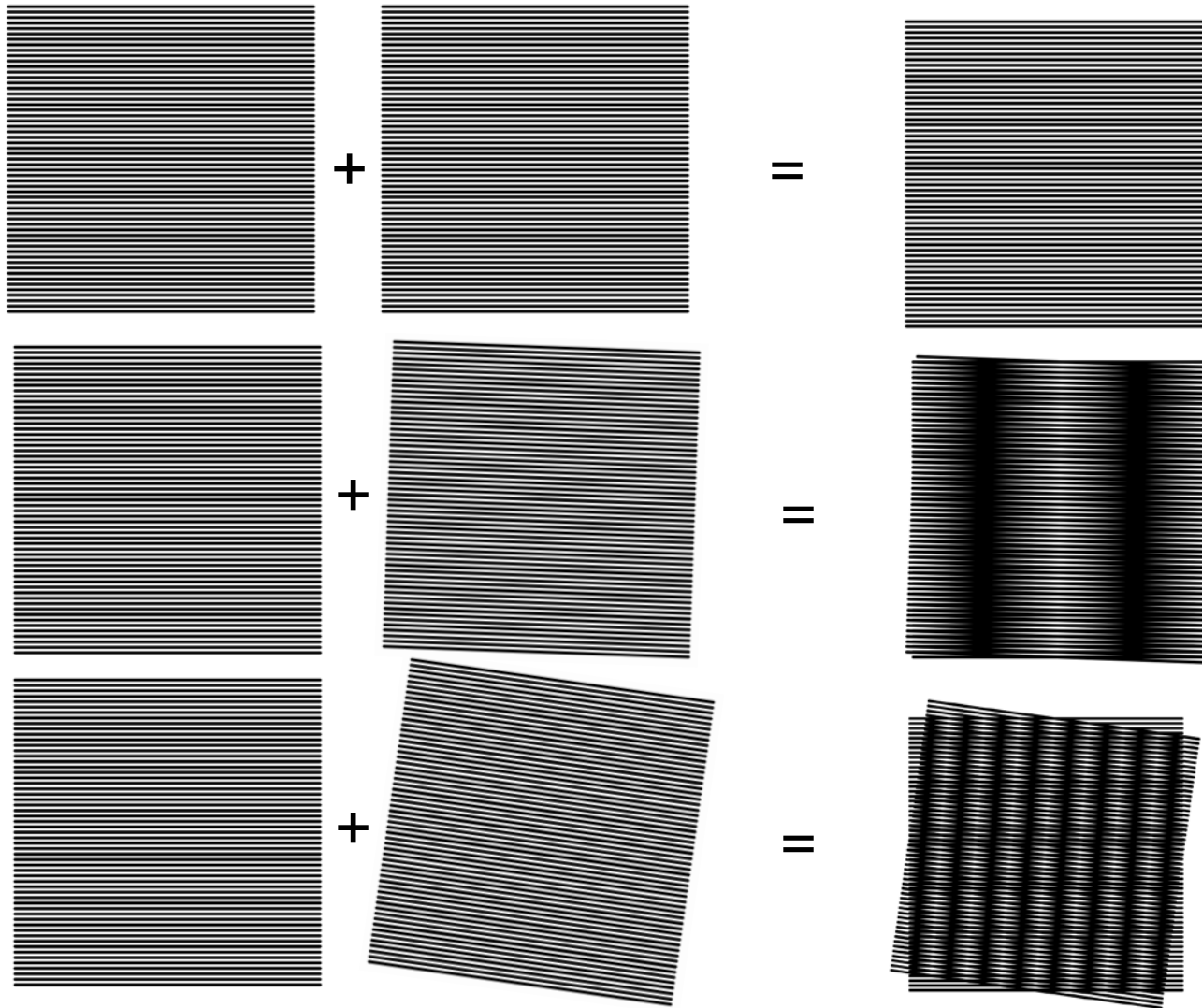
Research has shown that the retina needs about **80 ms** of seeing a new image before that image is registered in normal light conditions.

Activity



What happened when you add them together?

Moiré Pattern



The **bigger the angle**, the **smaller and closer** together their interference fringes

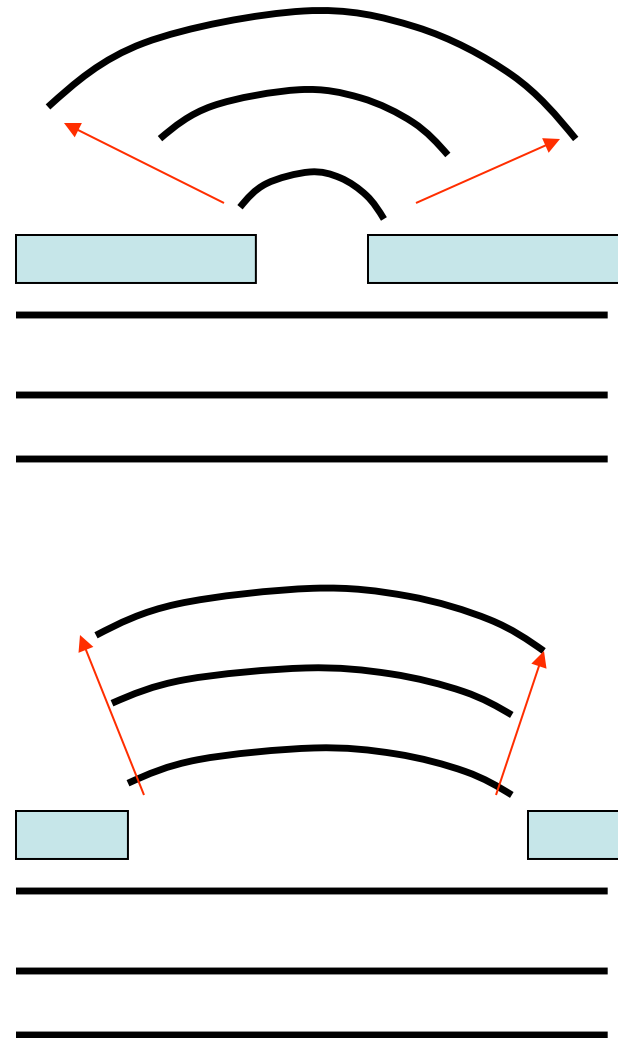
Interference
Diffraction
3D Images

Diffraction

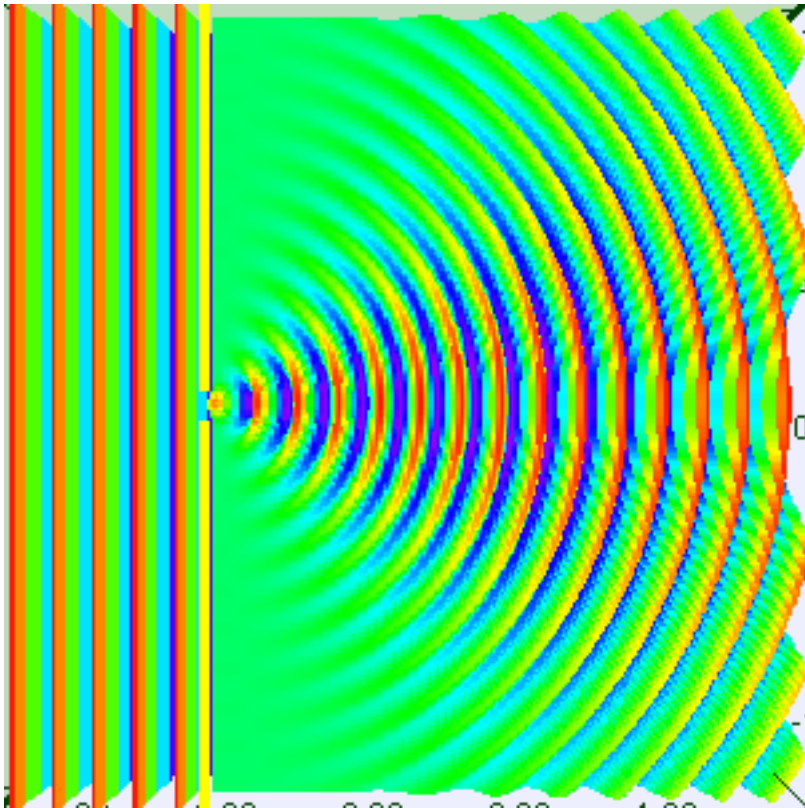
Waves spread out, or **diffract** when they pass through an opening or gap.

Small openings cause waves to diffract more, and the wave is more curved.

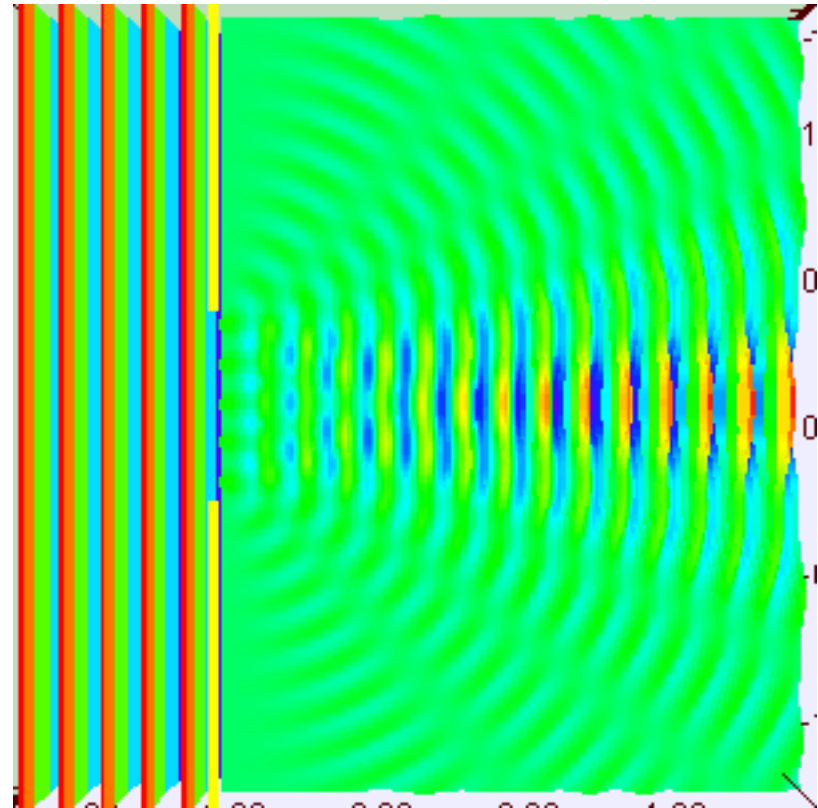
Waves don't diffract as much from big openings. The wave is less curved



Diffraction



Diffraction pattern from a slit of width equal to **one** wavelength of an incident plane wave.



Diffraction pattern from a slit of width equal to **five times** the wavelength of an incident plane wave.

Both images taken from [Open Source Single Slit Diffraction Model](#) by Fu-Kwun Hwan remixed by lookang.

Diffraction of Wave



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Photograph of diffracting water waves removed due to copyright restrictions.
Refer to diffraction.jpg in Media Gallery of [Rip Currents: Nearshore Fundamentals](#).

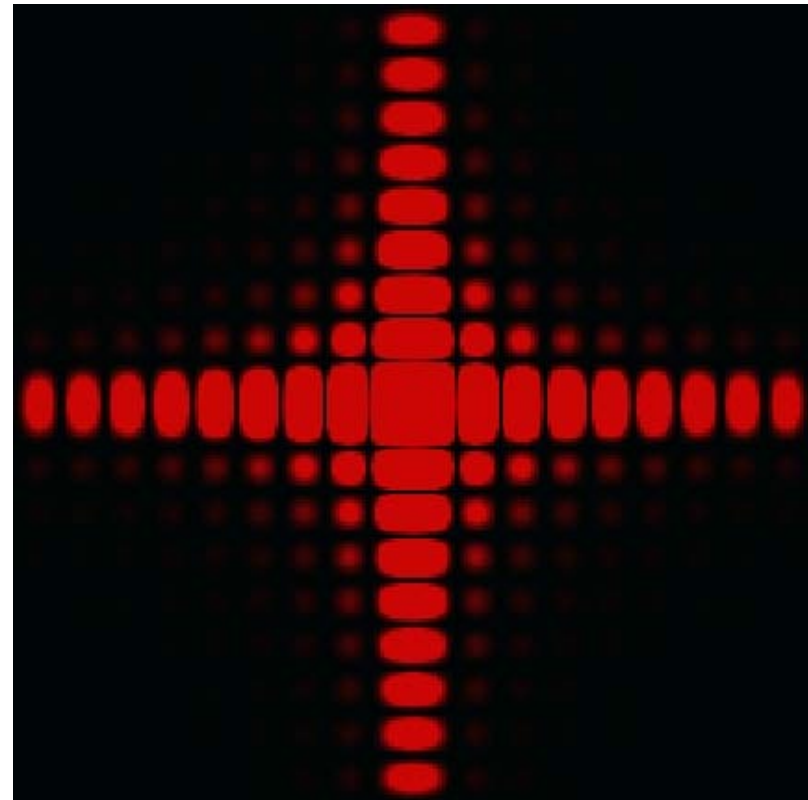
Diffraction of Light

A mercury streetlamp transmitted through a CD



Photo courtesy of [Pieter Kuiper](#) on Wikimedia Commons.

The intensity pattern formed on a screen by diffraction from a single slit from a single square aperture



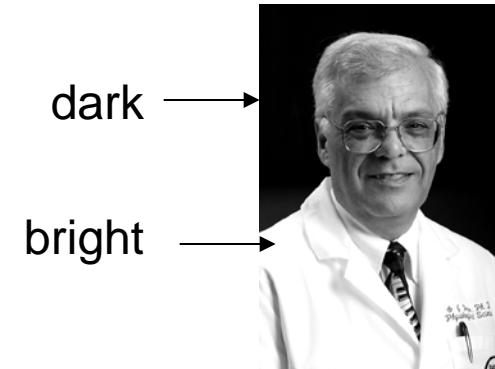
This image is in the public domain.

Interference
Diffraction
3D Images

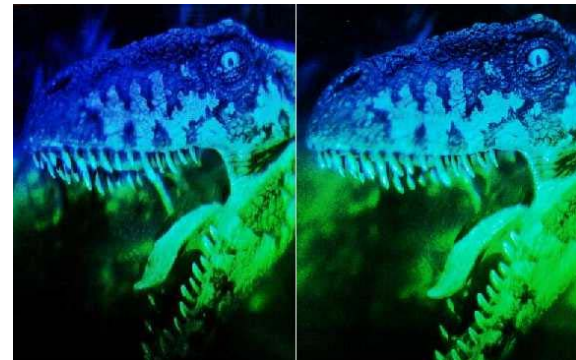
What Is a Hologram?

The word “hologram” means “whole message”.
(from the Greek words “holos” and “gramma”)

A regular photograph only captures the brightness, or intensity of light at different places.



A hologram captures not only the brightness, but also the **direction** and **shape** of the light waves that hit it.



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Conventional Photography

- Records only intensity
- 2-d version of a 3-d scene
- Photograph lacks depth perception or parallax
- Phase relation (i.e. interference) are lost

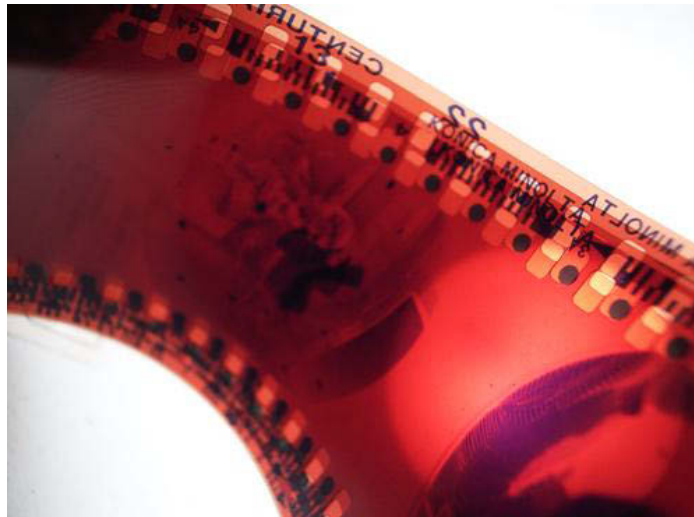
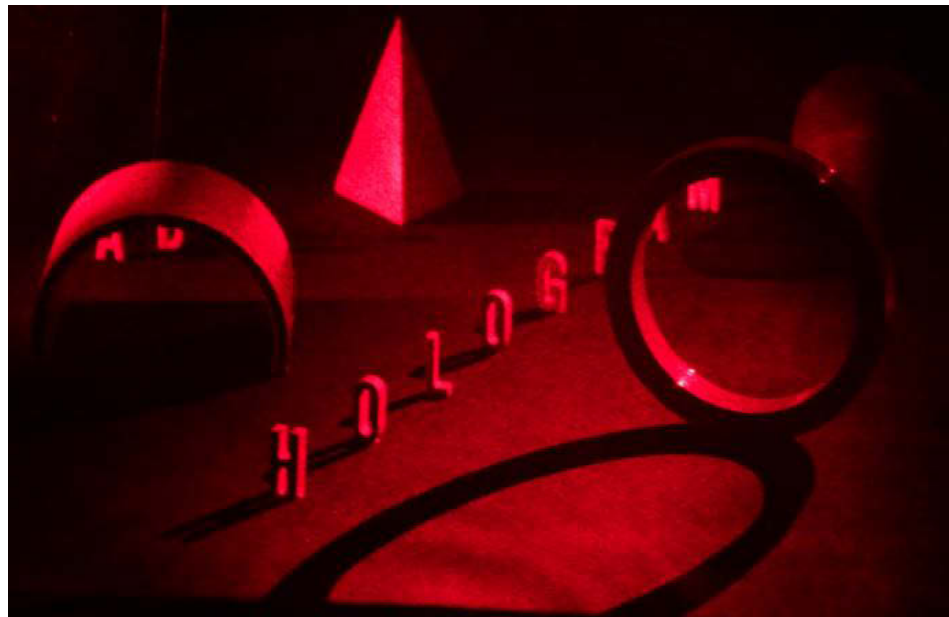


Photo courtesy of [14zawa](#) on Flickr.

Holographic Photography

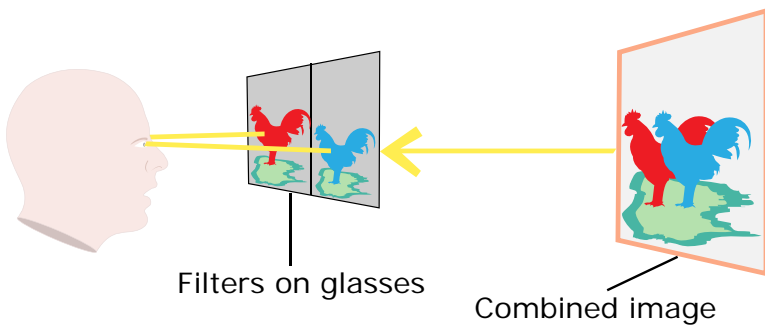
- Freezes the intricate wavefront of light that carries all the visual information of the scene including amplitude and phase
- The view a hologram, the wavefront is reconstructed
- View what we would have seen if present at the original scene through the window defined by the hologram
- Provides depth perception and parallax



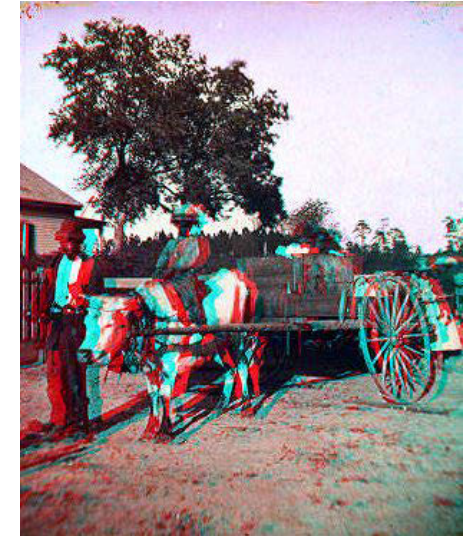
Adopted from [6.007](#), Lecture 28

3D Images

Red/Blue Glasses



Both images (above, right) are in the public domain.



With Polarized Light

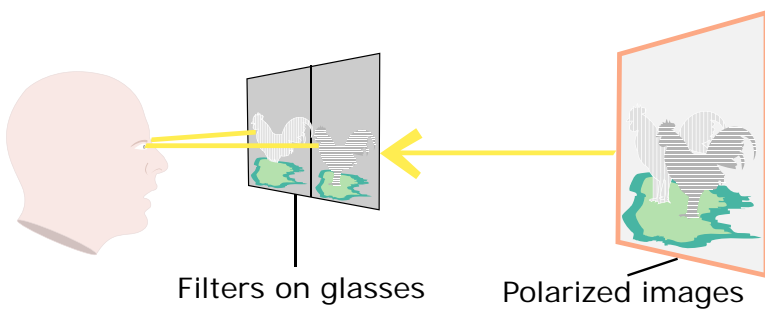


Image by MIT OpenCourseWare.

Photo courtesy of [kmakeice](#) on Flickr.



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5bU[`md\`' 8`]a U[Y`cZ`7fYUhi fY`Zfca `h\Y`6`UW`@U[ccb`"fYa cj YX`Xi Y`hc`Vtdmf][\hfYghf]W]cbg"

**Weekly Challenge:
Create your own 3D glasses**

How to Make a Hologram?

By using a beam splitter and mirrors, coherent laser light illuminates an object from different perspectives. Interference effects provide the depth that makes a three-dimensional image from two-dimensional views.

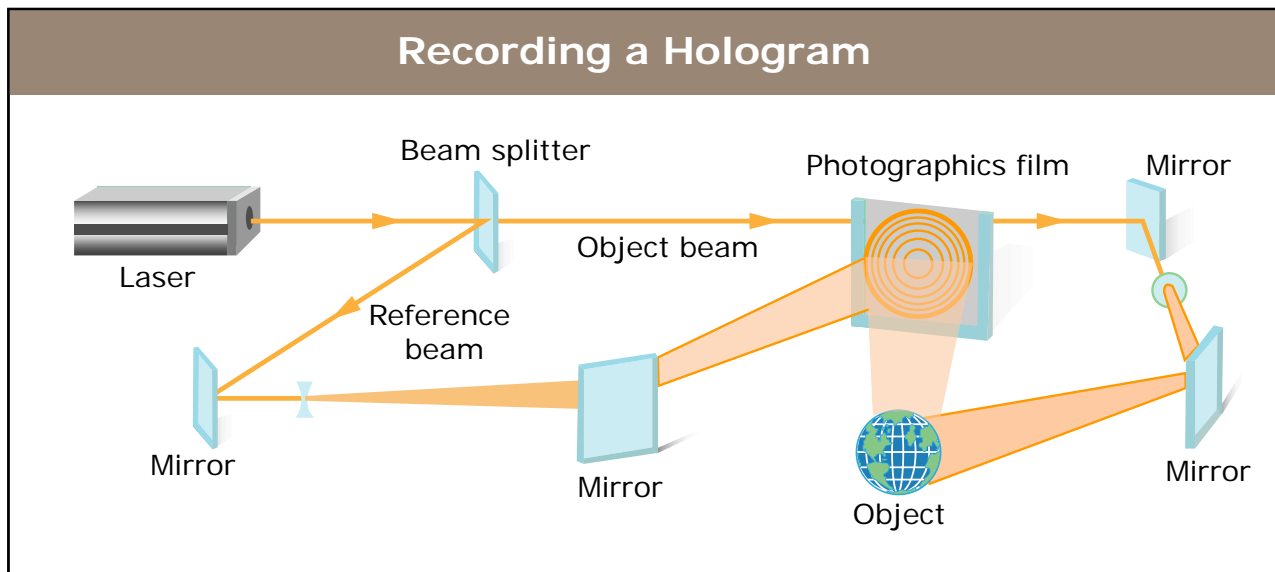


Image by MIT OpenCourseWare.

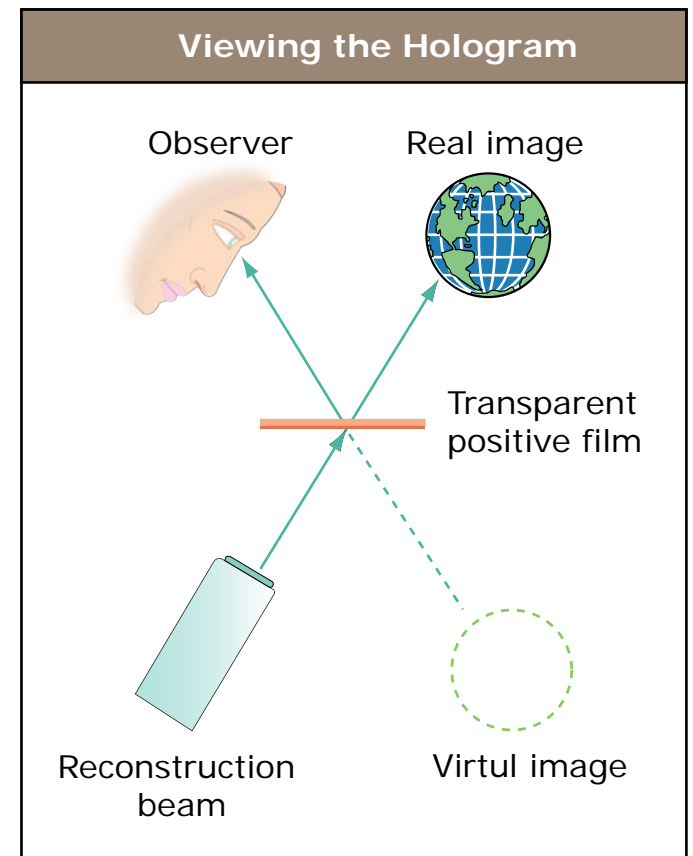


Image by MIT OpenCourseWare.

Conclusions

Holograms depend on the wave behavior of light.

You make them using **interference**.

You view them using **diffraction**.

Other 3D viewer technology:

Red/Blue glasses (Anaglyph)

Polarized 3D glasses

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6.S079 Nanomaker
Spring 2013

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