

# Physics behind holograms

# BASIC PRINCIPLES OF HOLOGRAPHY

Light waves

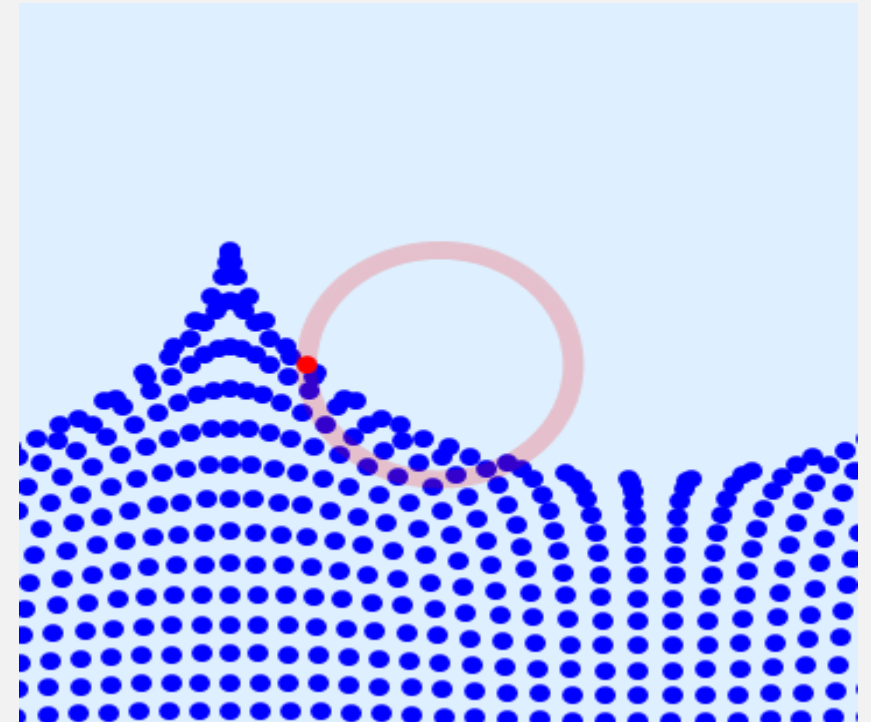
Interference  
Diffraction

\* We need to “take a picture” of the light waves in order to create a hologram

# WHAT IS A WAVE?

A disturbance that travels through a medium\* from one location to another.

\* Any substance or material that functions as the carrier of the wave

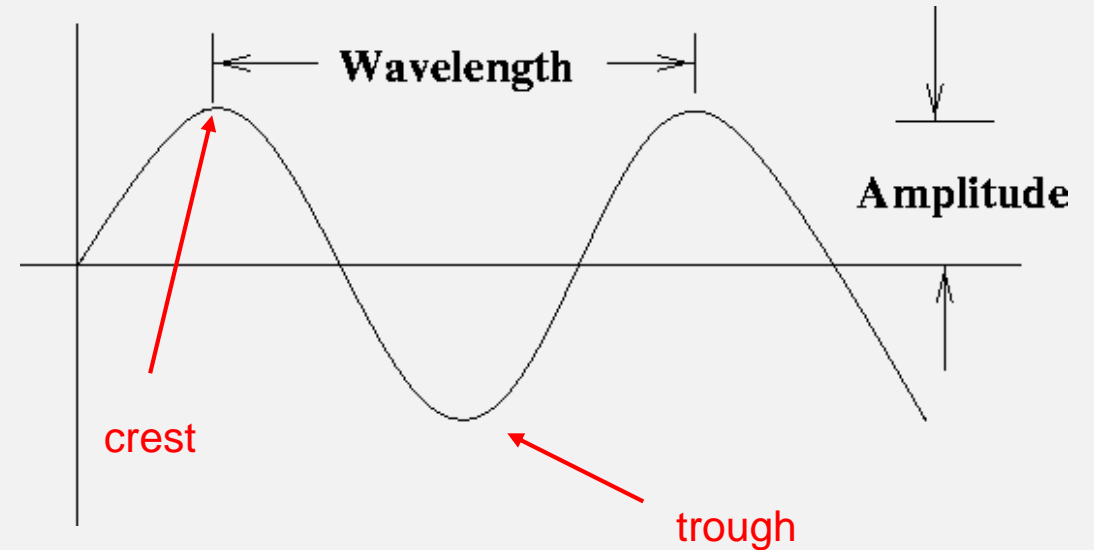


Schematic representation

[https://img.buzzfeed.com/buzzfeed-static/static/2015-10/9/14/enhanced/webdr08/anigif\\_enhanced-20366-1444416227-2.gif?downsize=715:\\*&output-format=auto&output-quality=auto](https://img.buzzfeed.com/buzzfeed-static/static/2015-10/9/14/enhanced/webdr08/anigif_enhanced-20366-1444416227-2.gif?downsize=715:*&output-format=auto&output-quality=auto)

# PROPERTIES OF WAVES

- Crest : wave's highest point
- Trough: wave's lowest point
- Wavelength: length between two crests
- Amplitude: height of a wave from rest line to crest
- Period: time of a complete wave passing from a point
- Frequency: number of waves passing from a point in a second
- Speed: velocity of a disturbance (m/s)

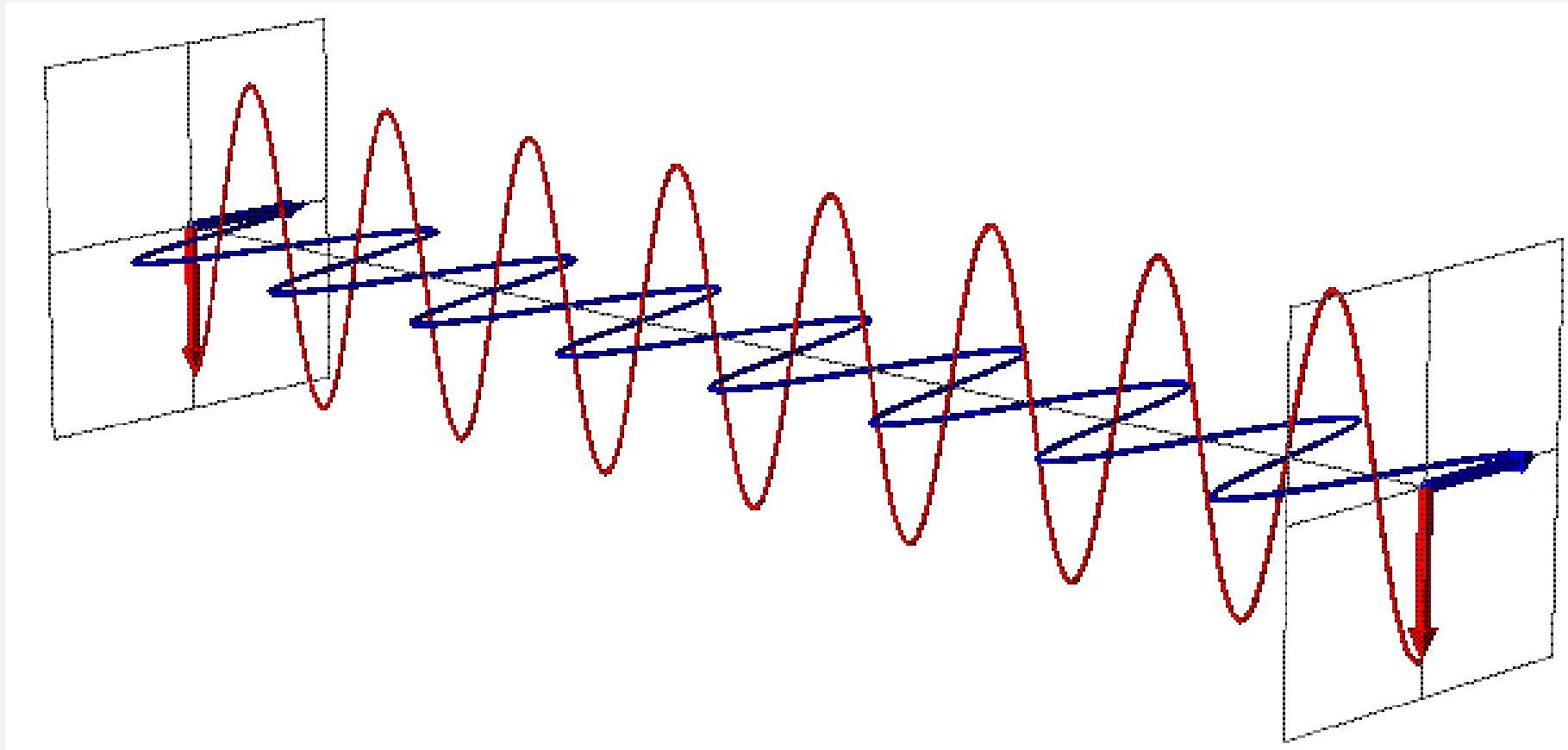


A simple wave

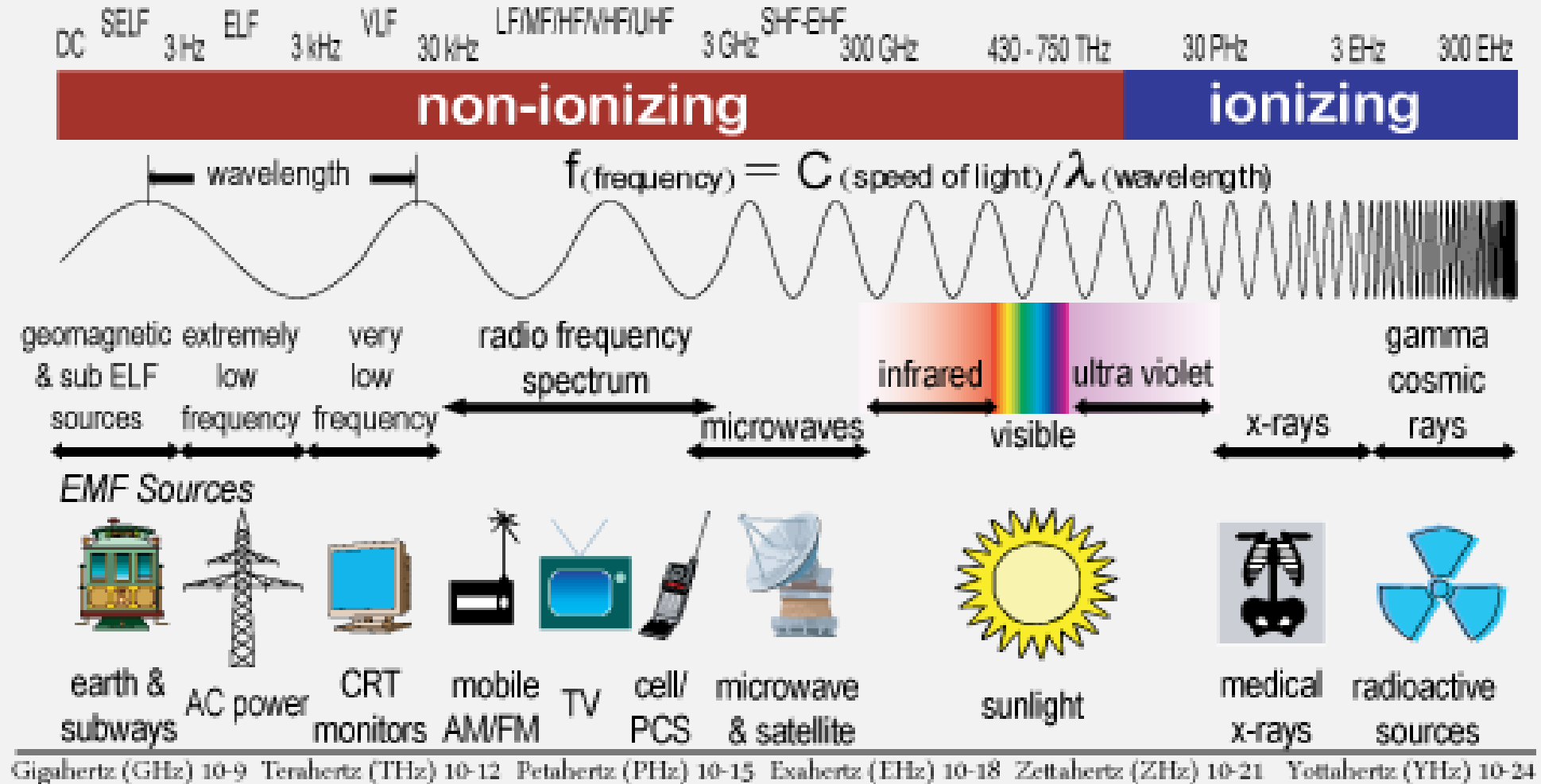
# TYPES OF WAVES

MECHANICAL	ELECTROMAGNETIC
Produced from a vibrating source	Result of vibrations between an electric and magnetic field
Need a propagation medium (e.g. air, water)	No need of propagation medium
Examples: sound wave, water wave, stadium wave	Examples: light wave, radio wave

# EXAMPLE OF ELECTROMAGNETIC WAVE



# ELECTROMAGNETIC SPECTRUM



# PROPERTIES OF LIGHT WAVES (Reflection)

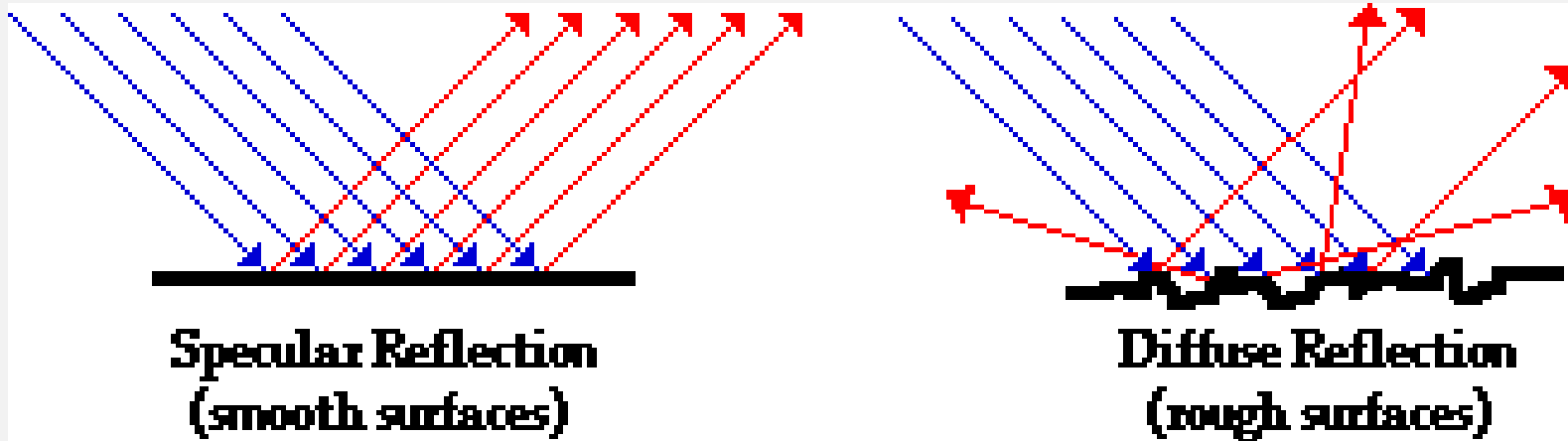
The change of the direction of a wave that bounces to a reflected surface, and the angle of the reflected wave is equal to the angle of incident wave, in respect to the surface.



[https://www.google.gr/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwiDwtTDINdAhUwxIsKHfCMBUYQjRx6BAgBEAU&url=http%3A%2F%2Fekfe.chi.sch.gr%2Fanaklasi.html&psig=AOvVaw1\\_7il2TA4Tw4SkLCXm3fGC&ust=1538068074681808](https://www.google.gr/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwiDwtTDINdAhUwxIsKHfCMBUYQjRx6BAgBEAU&url=http%3A%2F%2Fekfe.chi.sch.gr%2Fanaklasi.html&psig=AOvVaw1_7il2TA4Tw4SkLCXm3fGC&ust=1538068074681808)

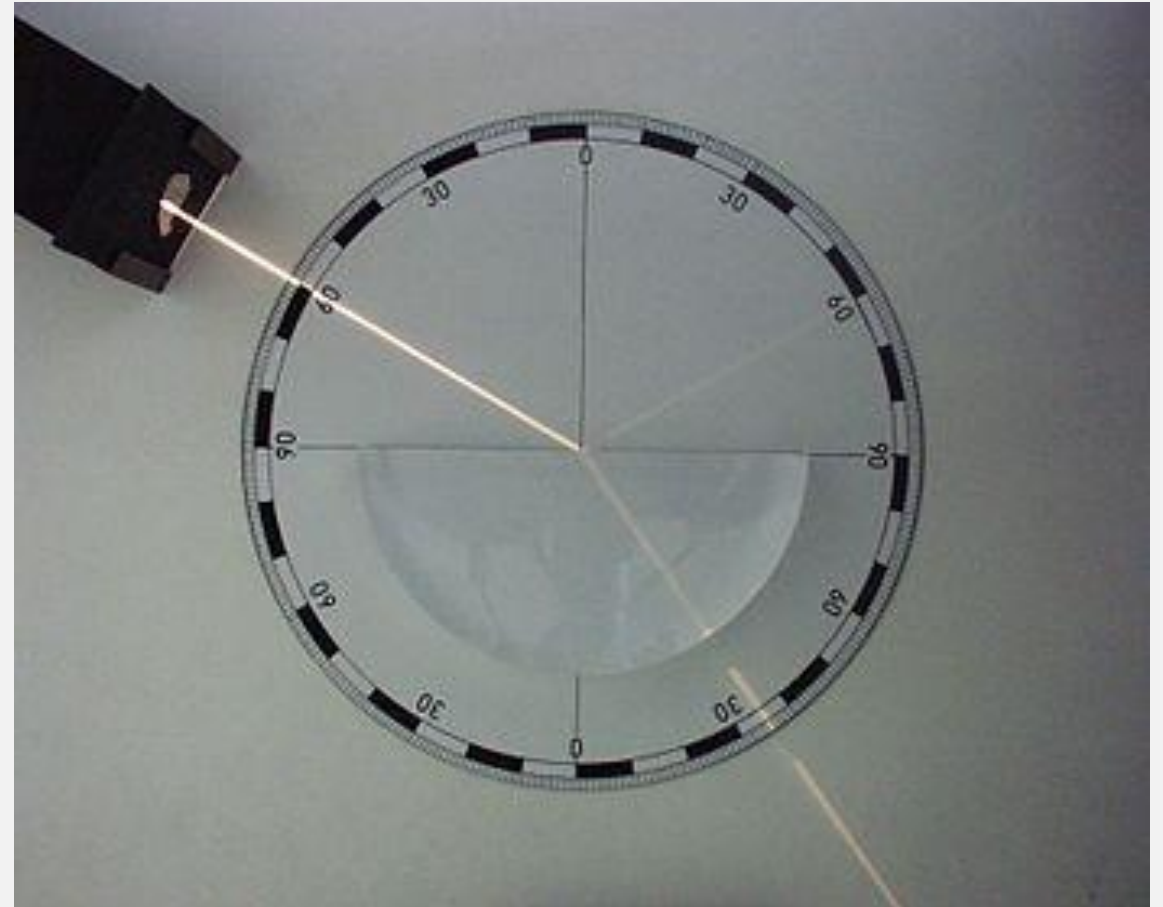
# PROPERTIES OF LIGHT WAVES (Specular vs Diffuse reflection)

- If the bouncing surface is rough and irregular, then the light is scattered in multiple directions. The phenomenon is called diffuse reflection



# PROPERTIES OF LIGHT WAVES (Refraction)

The change of the path of a wave that passes through two transparent surfaces, of different optical density



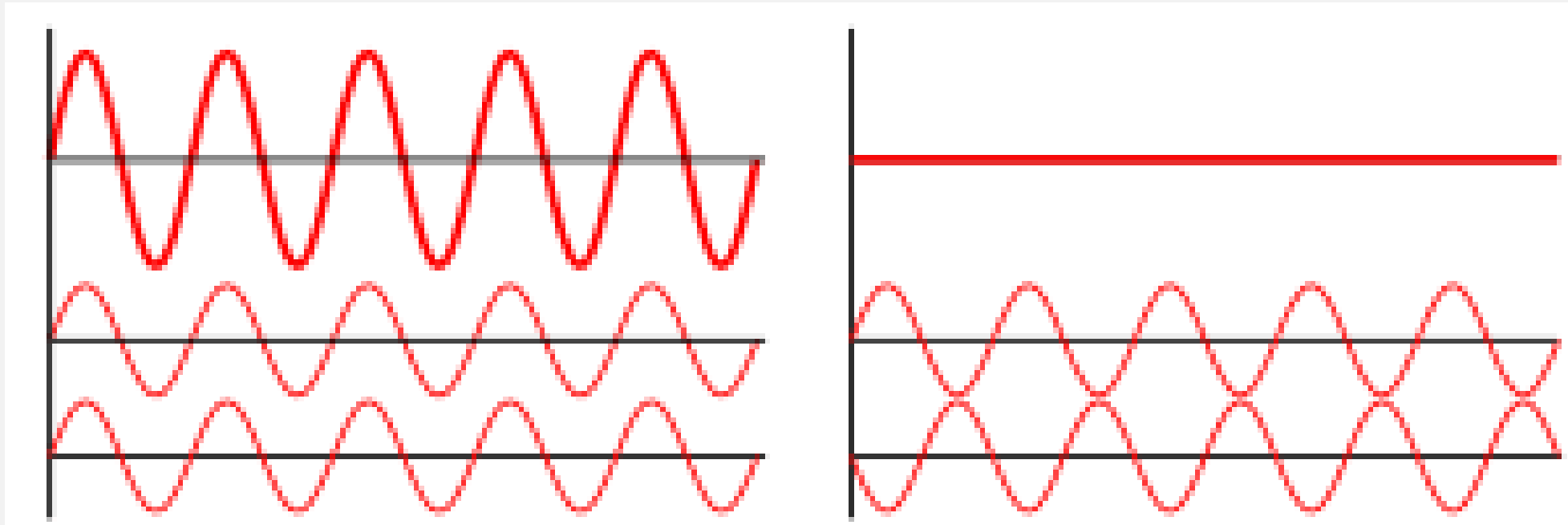
# PROPERTIES OF LIGHT WAVES (Interference)

The phenomenon in which two waves, that travel on the same medium, meet (inside this medium).



<https://upload.wikimedia.org/wikipedia/commons/thumb/c/c7/Two-point-interference-ripple-tank.JPG/800px-Two-point-interference-ripple-tank.JPG>

# PROPERTIES OF LIGHT WAVES (Interference)



Constructive interference:

Two waves of same phase are aggregated

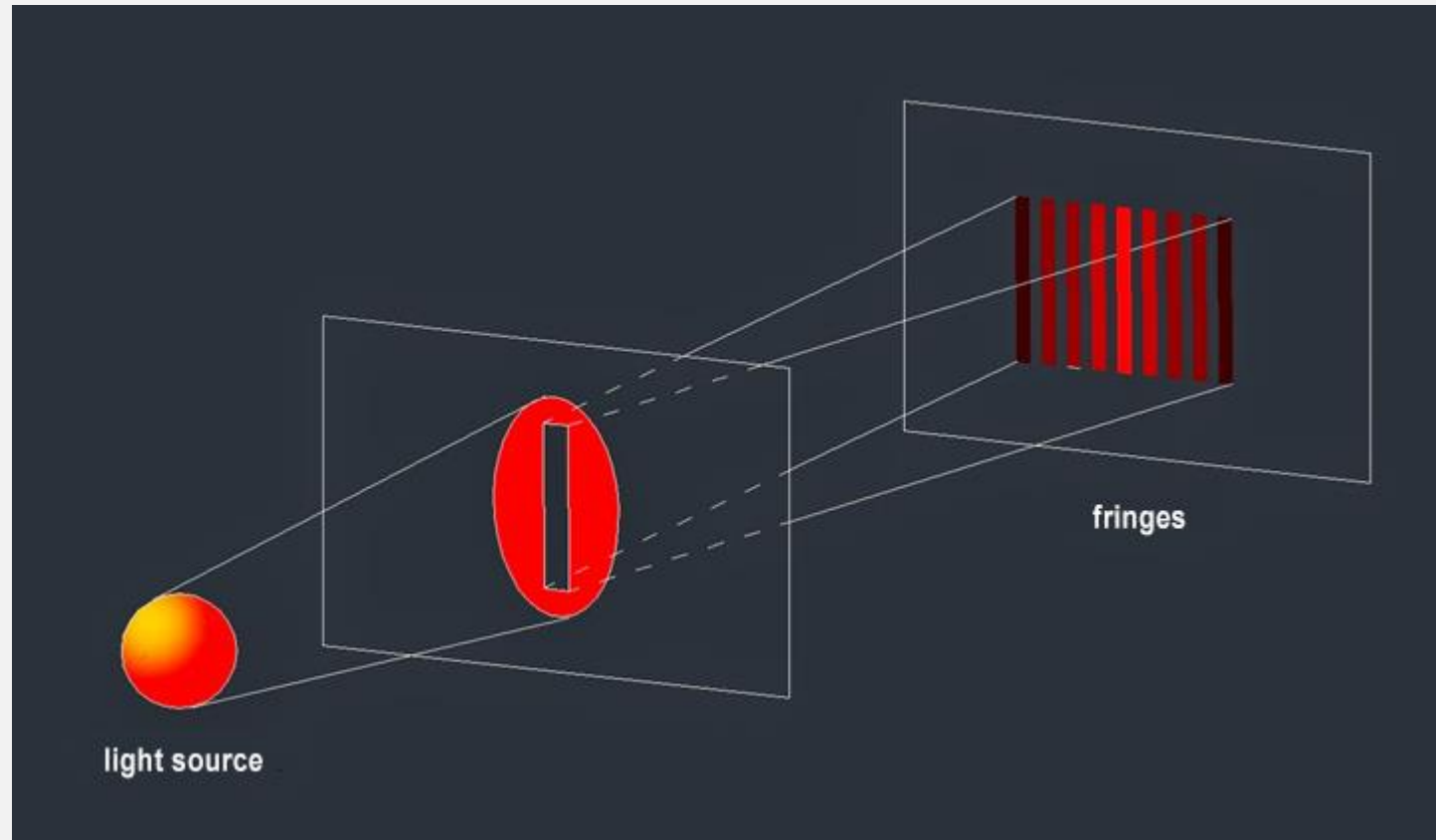
Destructive interference:

Two waves of opposite phase are aggregated

<https://snl.no/interferens>

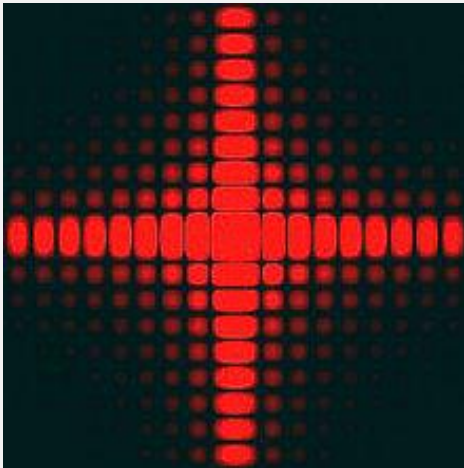
# PROPERTIES OF LIGHT WAVES (Diffraction)

The phenomenon in which waves change direction when they pass through an opening or around a barrier in their path, and a formation of bright and dark fringes happens



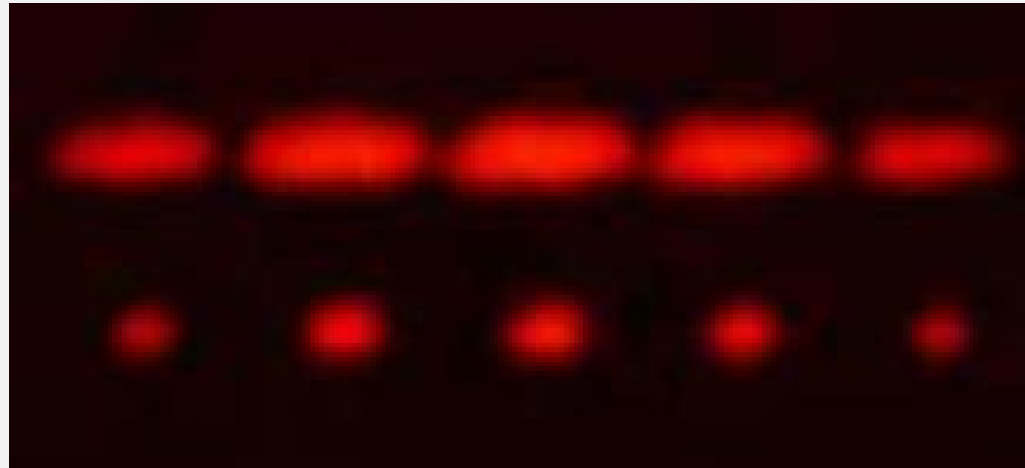
# PROPERTIES OF LIGHT WAVES (Diffraction)

Intensity pattern formed by diffraction from a square slit



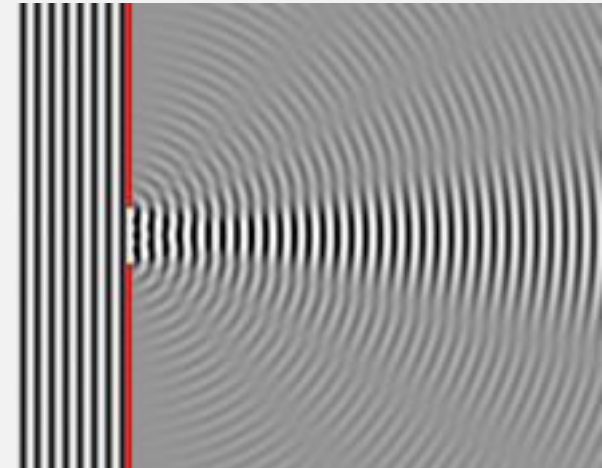
<http://psychology.wikia.com/wiki/Diffraction>

Diffraction from two parallel slits.



<https://en.wikipedia.org/wiki/Diffraction#/media/File:Diffraction2vs5.jpg>

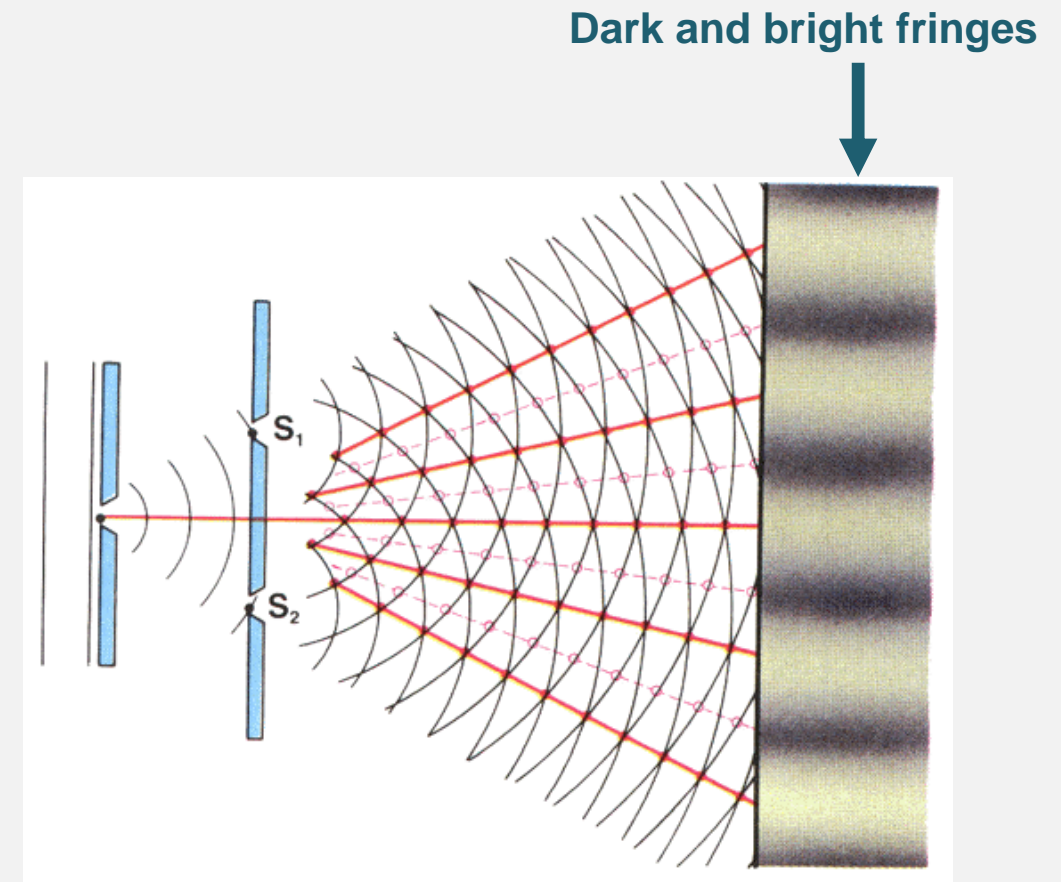
Diffraction pattern from a slit of width four wavelengths with an incident plane wave.



[https://en.wikipedia.org/wiki/Diffraction#/media/File:Wave\\_Diffraction\\_4Lambda\\_Slit.png](https://en.wikipedia.org/wiki/Diffraction#/media/File:Wave_Diffraction_4Lambda_Slit.png)

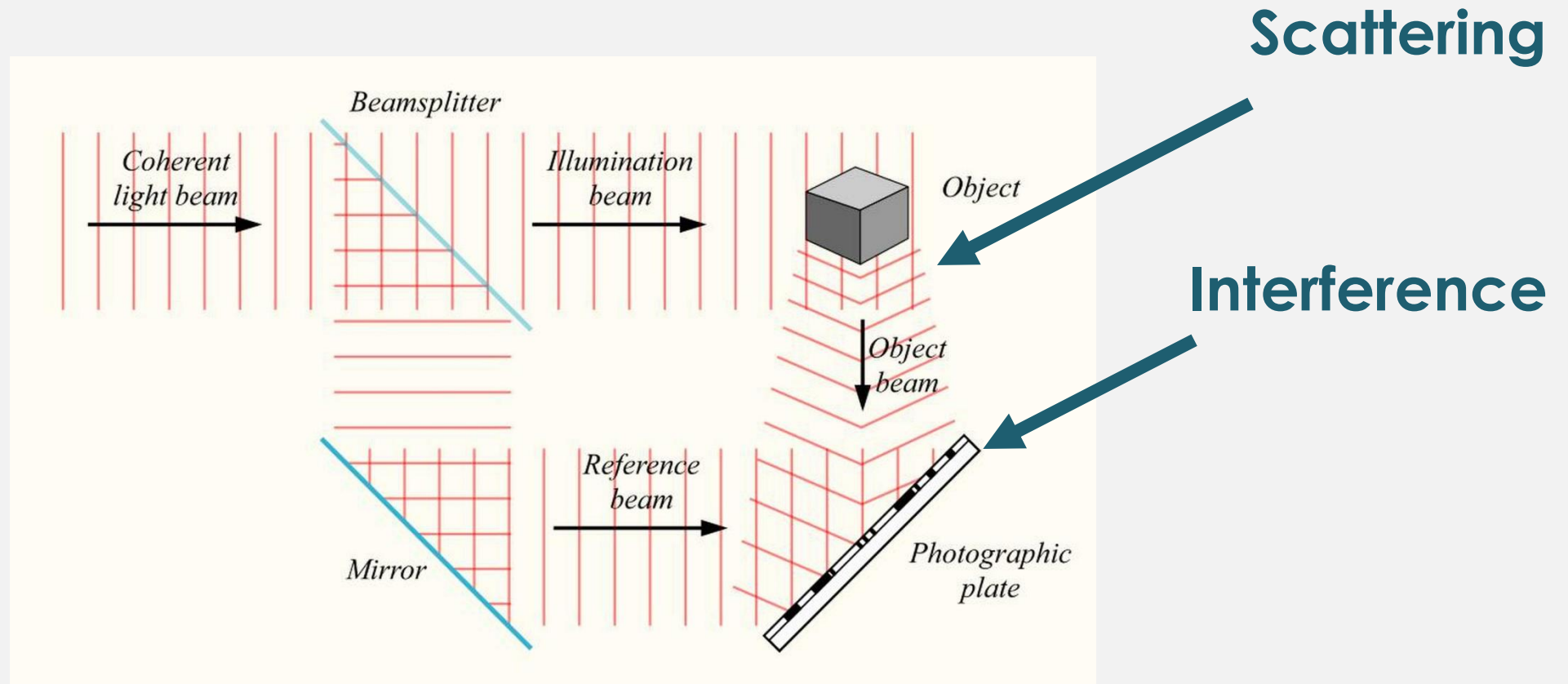
# PROPERTIES OF LIGHT WAVES (Interference)

Interference pattern created by a simple beam divided in two coherent light waves (Young's experiment).



<https://physics.stackexchange.com/questions/187685/why-light-comes-out-in-spherical-form-after-passing-through-a-slit-diffraction/187695>

# APPLYING WAVE PROPERTIES TO HOLOGRAPHY





## HOLOMAKERS PROJECT

Motivating secondary school students towards STEM careers through hologram making and innovative virtual image processing practices with direct links to current research and laboratory practices

Erasmus+ KA2 2017-1-PL01-KA201-038420

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### Declaration

This report has been prepared in the context of the HOLOMAKERS project. Where other published and unpublished source materials have been used, these have been acknowledged.

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