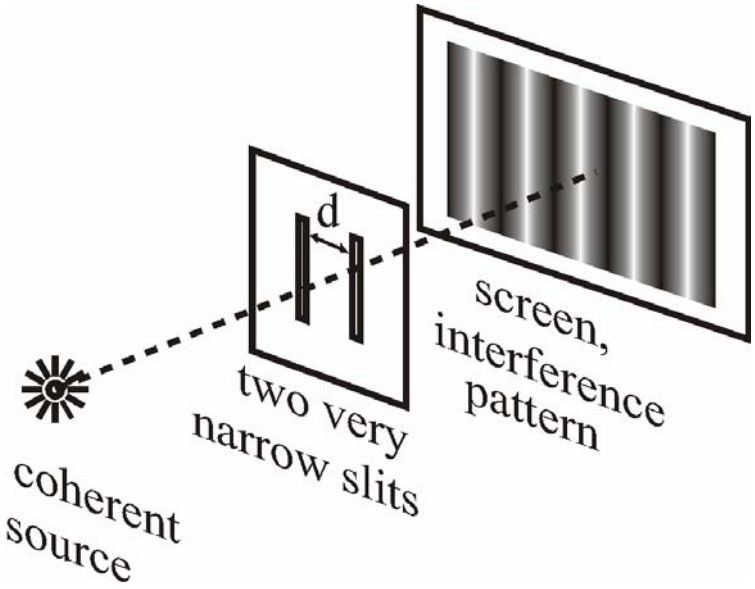
Typical experiment and pattern of light interference

Young's
double slit experiment
(diffraction)

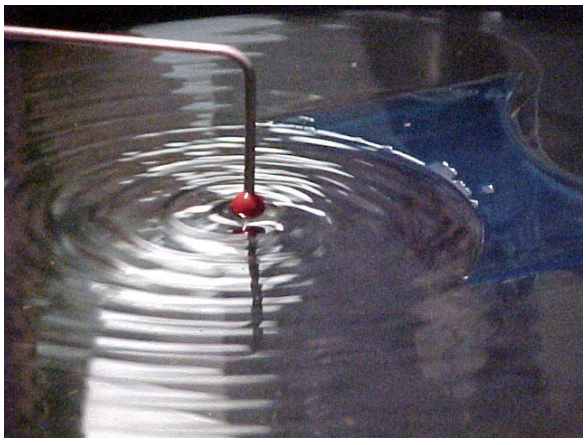


The places of constructive and destructive interference are determined by the difference in phase ($\Delta\varphi$).

Interference (two or more waves meet)

the most important phenomenon in connection with waves

Incoherent and coherent waves



Rise of coherent waves is controlled in space and time, they are synchronized somehow.

Waves (harmonic waves)

Propagation of oscillation
(Waving sea, or waving public in a stadium during a boring football match.)

$y = A \sin \omega t$ $\quad$ $y = A \sin (\omega t + \varphi)$ $\quad$ $y = A \sin (\omega t + kx)$

Phase (angle, φ) depends not only on time (t), but on space (x) as well
Two important parameters: wavelength (λ), period (T)

$$\varphi(x) = \frac{2\pi}{\lambda} x = kx \qquad \varphi(t^*) = \frac{2\pi}{T} t^* = \omega t^*$$

(k wave number)

Connection between them:

$$c = \frac{\lambda}{T} = \lambda f$$

c is the speed of propagation.

The most important phenomenon in connection with waves is the **interference**.

Application e.g.: at the discussion of different radiations
US, EMR (see in 2nd semester).

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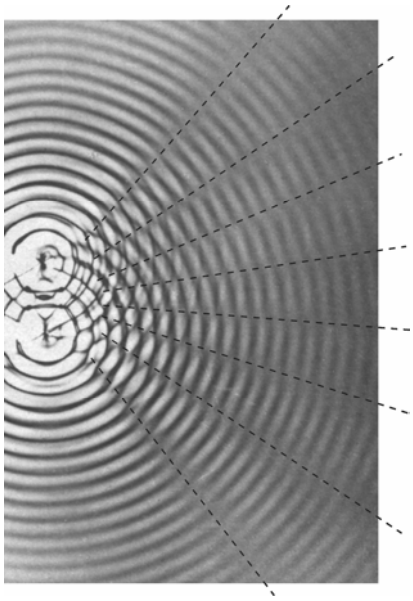
Waves

E.g. „water wave”: it can be observed directly.
Because it changes slowly enough (low frequency, f) and the typical (wave) size is large enough (long wavelength, λ).

„Light waves” are different.



At certain conditions patterns can be formed, which don't or slowly change in time, and their size is much larger than the wavelength, λ.

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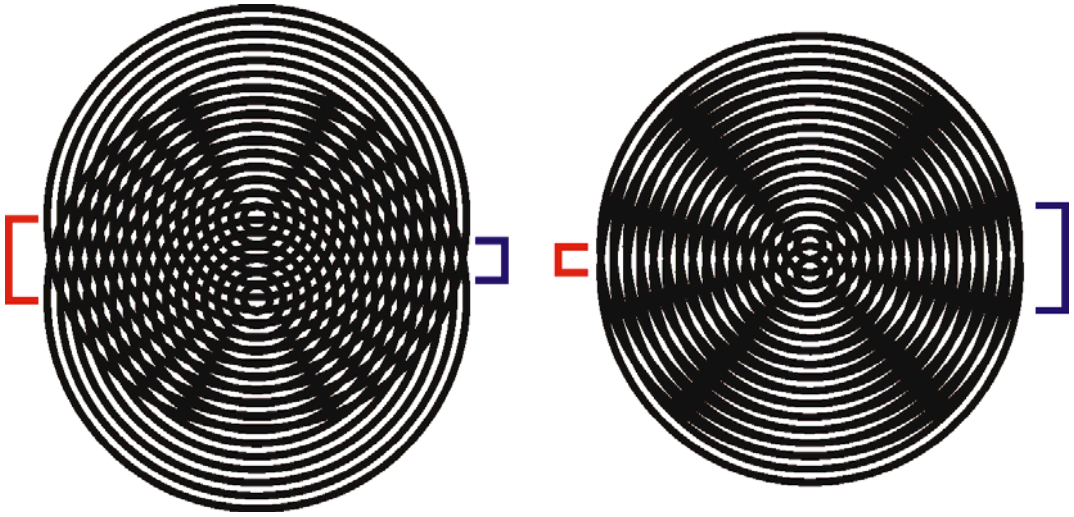
Light interference

Nothing but the produced patterns can be observed.
Conditions for existent of observable patterns in the case of point like sources:

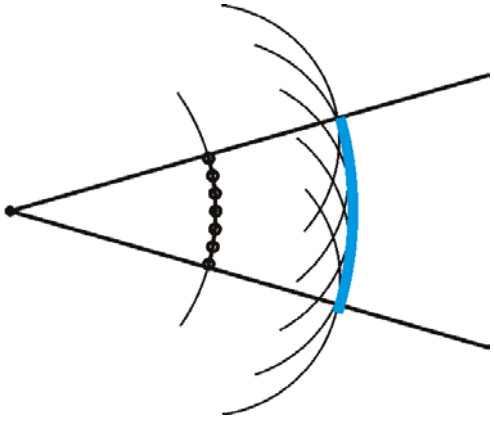
1. coherent waves (e.g. difference of phases ($\Delta\varphi$) is constant)
2. distance of sources is commensurable with the wavelength (λ).



The smaller the distance of sources (red mark),
the bigger the typical size of the pattern (blue mark).

Physical or wave optics
(other model)

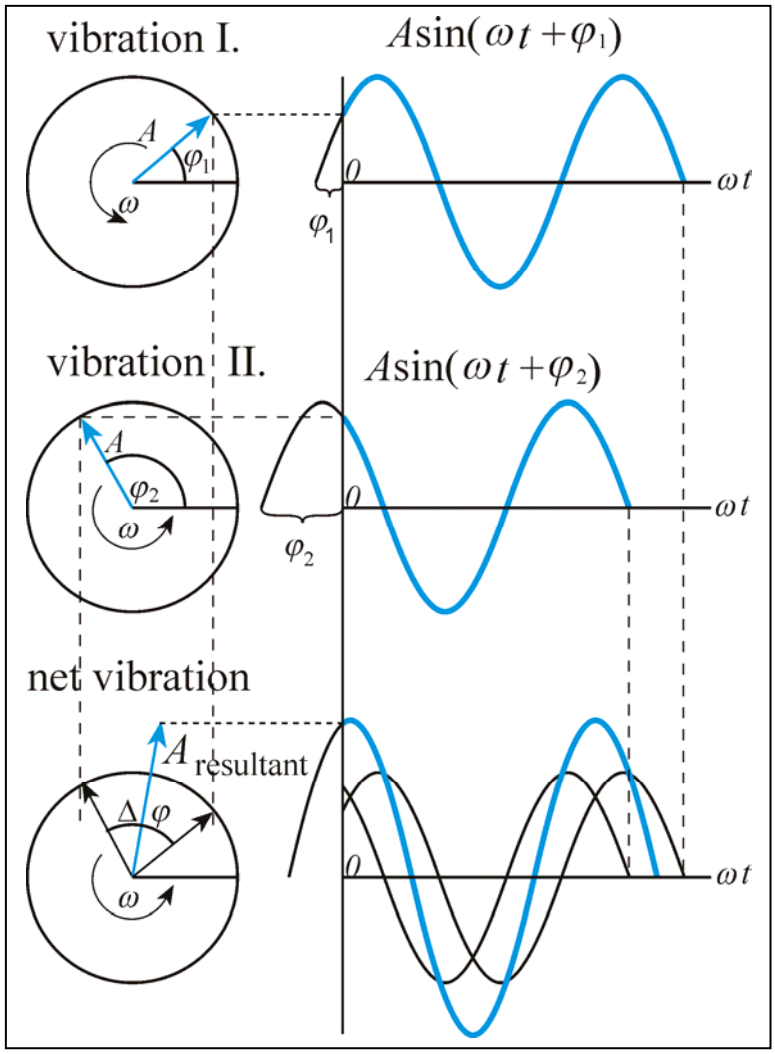
Its bases: **Huygens–Fresnel-principle**



According to the Huygens principle, elementary waves originate from every point of a wavefront, and the new wavefront is the common envelope of these elementary waves.

Fresnel supplemented this by observing that the **superposition** principle is also in effect during the formation of the new wave front, which is nothing else than the quantitative formulation of the empirical fact that waves will propagate through each other without disturbance. Interference.

At a certain place the vibrational states are demonstrated by rotating vectors:

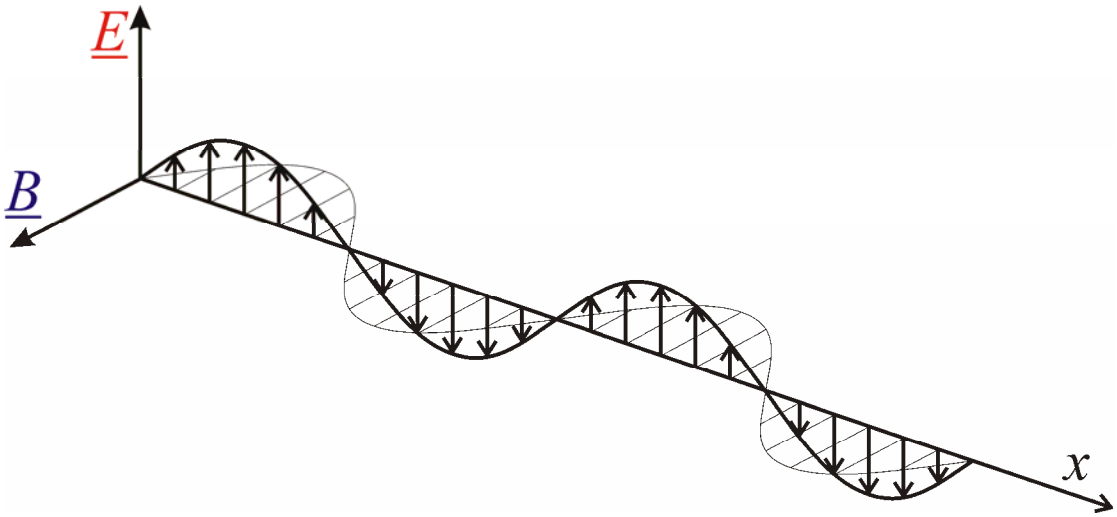


The amplitude of the net vibration ($A_{\text{resultant}}$) is given by the vector sum of the components (A).

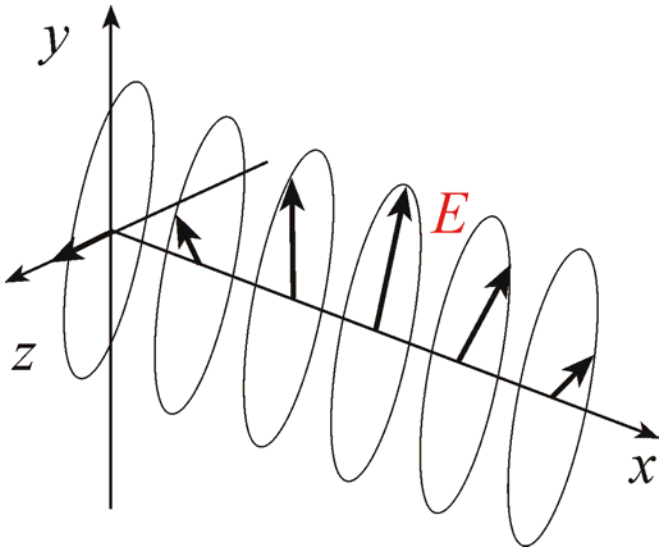
Applications:
Diffraction methods

Light is electromagnetic wave transversal

thus can be polarized **linearly** polarized light
or **plane** polarized light



But **elliptically** polarized light also exists.



Optical anisotropy

E.g. in an „anisotropic matter" the speed of a suitably linearly polarized light depends on the direction of propagation.
The reason of it is connected to the structure of matter.

Consequences, applications: double refraction, polarization microscope