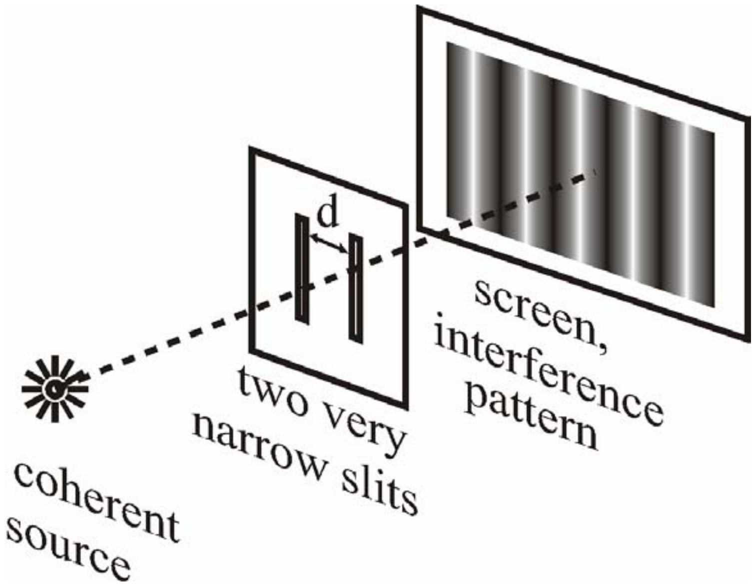
Typical experiment and pattern of light interference

Young's
double slit experiment
(diffraction)

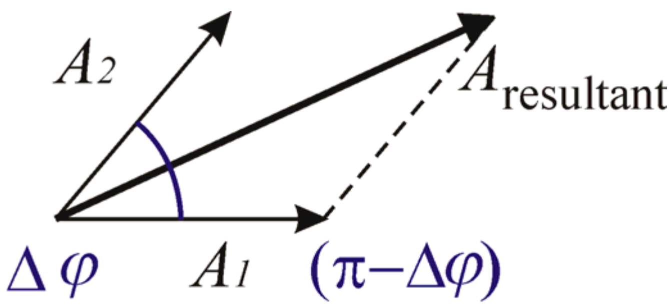


The places of constructive and destructive interference are determined by the difference in phase ($\Delta\varphi$).

Our eyes are sensitive to the light-power (P), that is proportional to the square of the amplitude.

Thus $A_{resultant}^2 \sim P_{res.}$, and $A_{res.} = A_1 + A_2$ hence $\boldsymbol{P_{res.} \neq P_1 + P_2}$.

Resultant ($A_{resultant}$) of two vectors (A_1, A_2), or the square of it, if the angle between them is $\Delta\varphi$:

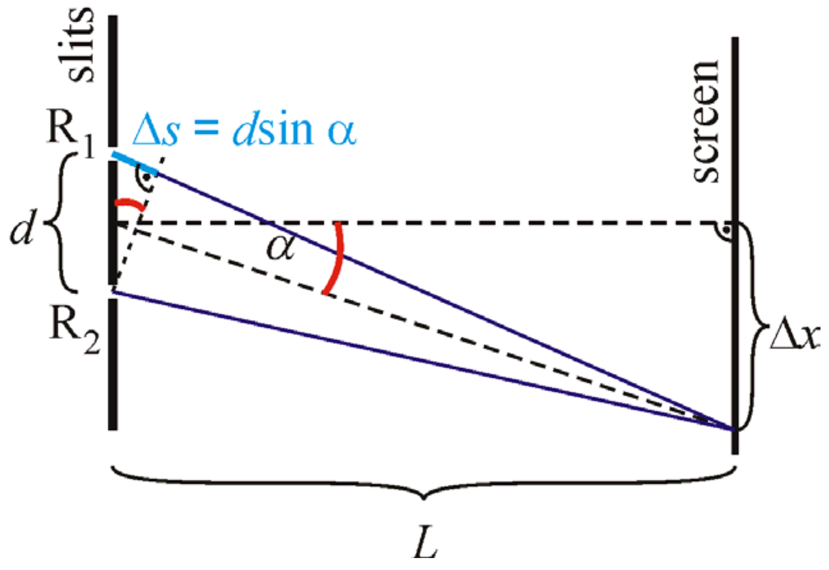


$P \sim A^2_{resultant} = A^2_1 + A^2_2 - 2A_1 A_2\cos(\pi\text{-}\Delta\varphi)$ (cosine theorem)

$P \sim A^2_{resultant} = A^2_1 + A^2_2 + 2A_1 A_2\cos\Delta\varphi$

If $A_1 = A_2 = A$, than $A^2_{resultant} = 2A^2\,(1 + \cos\Delta\varphi)$

The difference in phase ($\Delta\varphi$) is determined by the relation of difference in path length (Δs) and the wavelength (λ).



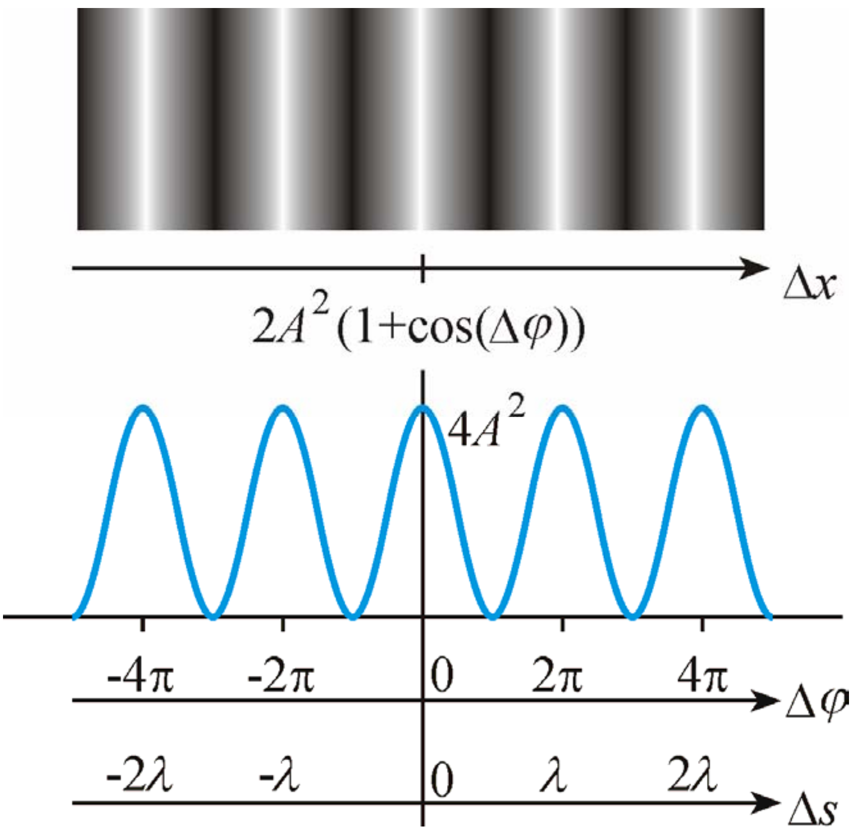
If $L >> d$,

the difference in path length
$\Delta s = d\sin\alpha.$

The difference in phase is given as:

$$\Delta\varphi = \frac{2\pi}{\lambda}\Delta s = 2\pi\frac{d\sin\alpha}{\lambda} \approx 2\pi\frac{d\Delta x}{\lambda L}$$

Demonstration:



In the case of many uniform slits, namely optical grating, very sharp maxima can be observed at places correspond to $\Delta\varphi = 2k\pi$ or $\Delta s = k\lambda$; k = 0, 1, 2,… condition.

$$2k\pi = \Delta\varphi \approx 2\pi \frac{d\Delta x}{\lambda L}$$

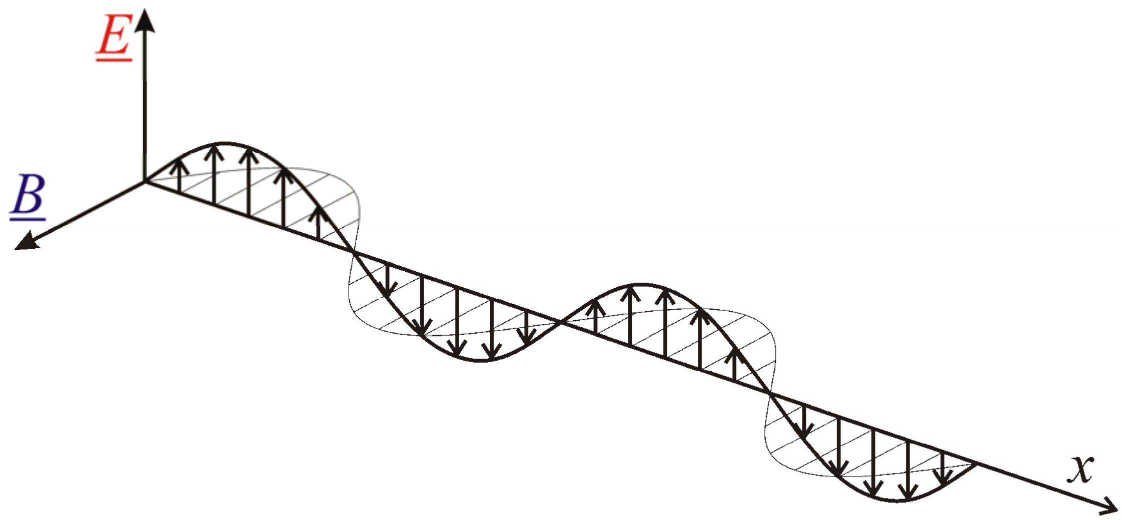
L and Δx macroscopically measurable. If λ is known, the microscopic d can be determined, consequently in general:

we can get microscopic data from macroscopic diffraction pattern.

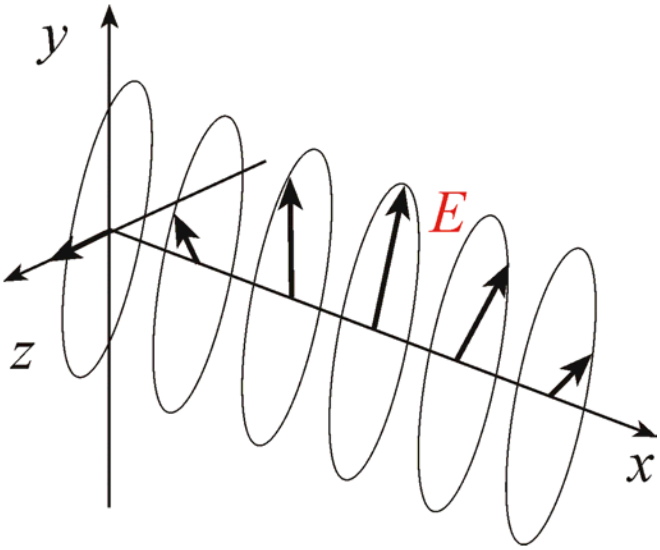
Applications: determination of the resolving power of microscopes,
but this is the bases of any diffraction methods as well (x-ray diffraction; determination of protein structure).

Light is electromagnetic wave transversal

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



But elliptically polarized light also exists.



Optical anisotropy

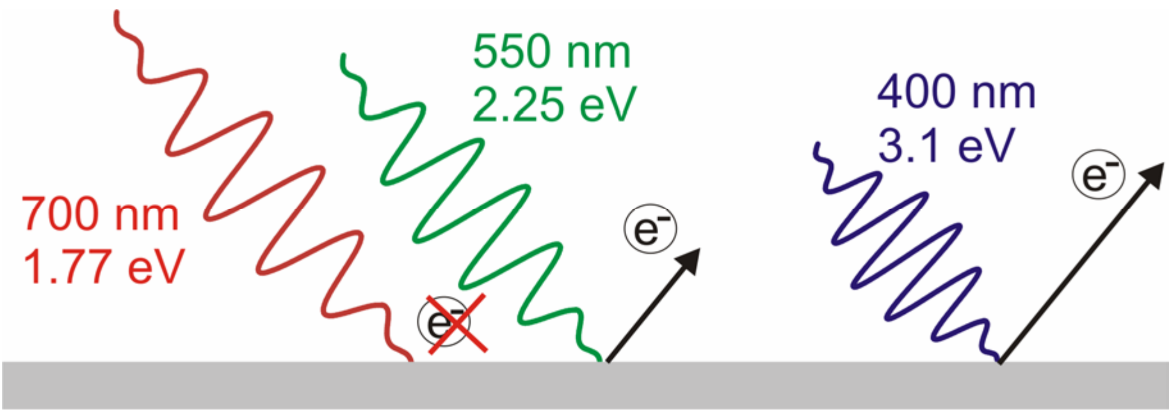
E.g. in an „anisotropic matter” the speed of a suitably linearly polarized light depends on the direction of propagation.
The reason of it is connected to the structure of matter.

Consequences, applications: double refraction, polarization microscope

Particle Properties

The photon is the elementary particle which carries the energy of electromagnetic radiation.

Photoelectric effect: An incident photon removes an electron from the bound electrons of an atom or molecule, while the photon is absorbed.



Wave-Particle Duality
Wave–particle duality is the concept that all matter and energy exhibits both wave-like and particlelike properties

Phenomenon
Can be explained in terms of waves.
Can be explained in terms of particles.

	waves	particles
Reflection	+	+
Refraction	+	+
Interference	+	-
Diffraction	+	-
Polarization	+	-
Photoelectric effect	-	+

Basics of radiometry
Source, radiation, irradiated target
Emitted power (P), intensity (J_E), (Flux density)

$$J_E = \frac{\Delta E}{\Delta t \Delta A} \qquad M = \frac{\Delta P}{\Delta A}$$

Point-like isotropic radiator
Radiation is independent of the direction in the whole solid angle.
Total emitted power per unit surface area

Simple laws: the roles of symmetry, distances and angles

Spherical symmetry
Cylindrical symmetry

(Planar symmetry)