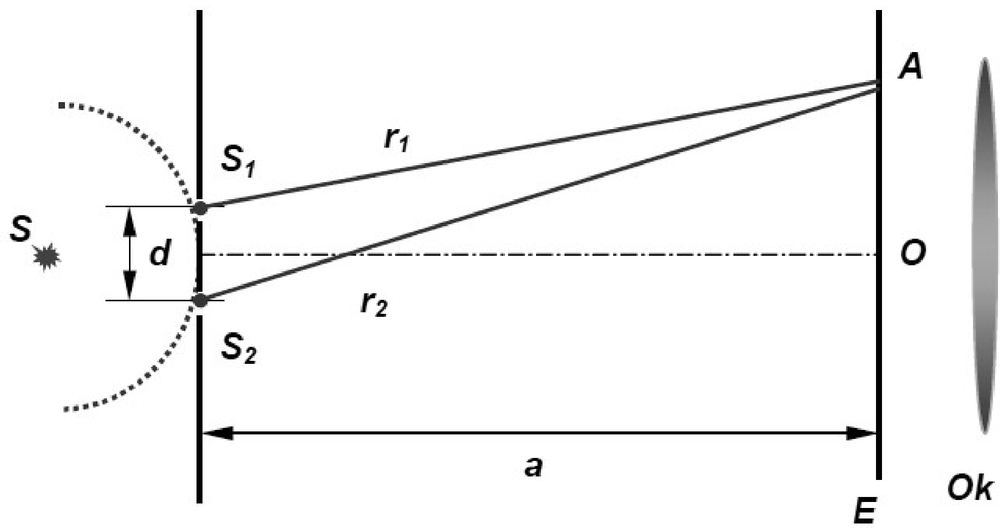
Laboratory work 3.2.1.

Young's double slit experiment.

The physical phenomenon, when two or more waves overlap in any point of the space is called interference. The interference of the light is observable, if coherent light beams (with in time constant phase difference) are used. The phase difference can be kept constant if the frequencies of the light beams are equal.

The coherent beams of light can be obtained by splitting of one beam into two parts. One of the possible setup for such splitting is a Young's double slit as shown in Fig.1. Two parallel slits with equal widths in a non-transparent screen with a distance d between them are called a *double slit*. If the monochromatic light from a real source S is incident on the normally placed double slit, then incident beams simultaneously creates oscillations in both slits S_1 and S_2.



According to the Huygen's principle points S_1 and S_2 are new sources of the waves, which are emitting in all directions and operating with equal phases. By the overlapping of these two beams the interference pattern – periodically positioned bands with minimal and maximal intensity of the waves – can be obtained. It can be observed (for optical waves) either on the screen, or by spyglass. The interference pattern to be observed is shown in the Fig.2. According to the wave theory the distance between two interference bands (the width of the band) is

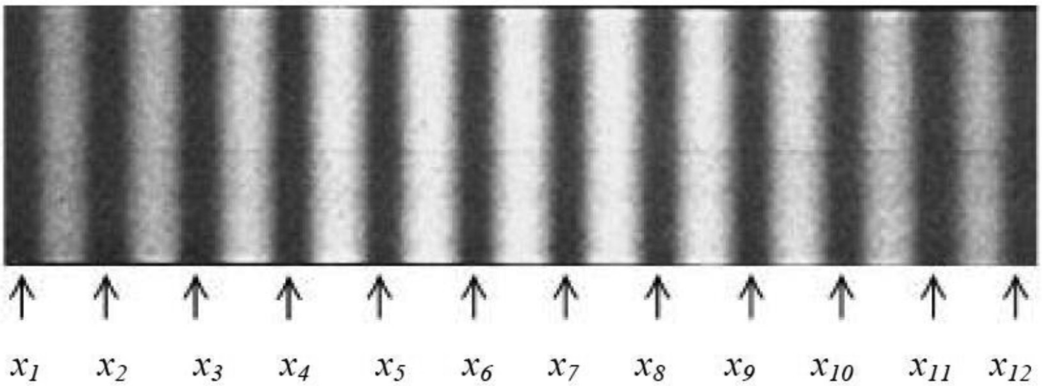
$$h_0 = \lambda \frac{a}{d} \qquad (1)$$

Where a is a distance from the light sources to the point under observation, d – distance between slits, λ – the wavelength of the light.

In the laboratory work, to increase the precision of the measurements the width of m stripes will be measured (and $m \neq 1$), therefore both sides of the Eq.(1) we have to multiply by the number of stripes m. Then, $D=mh_0$, the width of m dark (or bright) interference bands will be:

$$D = m\lambda \frac{a}{d} \qquad (2)$$

Equation (2) is used to determine the distance between slits d, if the wavelength of the incident light λ is known, or vice versa, if the width d is known, than λ can be calculated. The distance a between double slit and measuring spyglass can be from some tens of centimetres up to 1 m and has to be measured by ruler.



The distance D between central points of interference bands (dark or bright) is measured by spyglass defining the coordinates of stripes. The scale of spyglass is calibrated in millimetres and its decimal fractions. The scale of millimetres is observed together with the interference pattern by spyglass, but decimal fractions are picked from micrometric screw. If the coordinates of bands x_i are defined, it is possible to define D for different m.

Example. If the coordinate of fifth band is x_5 and of first one – x_1, than $D=x_5-x_1$, but $m=4$, (there are 4 bands between the first and the fifth ones).

The distance D between slits for the visible light usually is less than 1 mm. It is possible to measure it also by scaled microscope. By using microscope it is difficult to define the middle point of the slit, therefore, the measurements have to be done between the edges (right or left) of both slits.

Possible appointments:

1. Determine the wavelength of the source by using the double slit.

2. Determine the distance between slits, if the wavelength of used light is known.

3. Determine the distance between slits by using of the scaled microscope.

Protocol for laboratory work 3.2.1.

Young's double slit experiment.

Students: 1.

2.

Appointments:

1. Measure the width of *m* bands *(D)* at constant value of *a*.

2. Determine the distance between slits *d* and absolute error Δd, if the wavelength of used light is known.

Used measuring devices and set-up

Nr..	*Title*	*Type, number*	*Measuring diapason*	*The value of smallest scale*
1.	Ruler			
2.	Micrometric screw			

Measured data

a =

	For narrowest slit; x_i, mm	For middle slit; x_i, mm	For widest slit; x_i, mm
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Source of the light: ....

	m=	*m=*	*m=*	D_{mean}
D_1				
D_2				
D_3				

Example of calculations:

d =