Date 01-10-2021

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Experiment 2 → Particle size determination using Laser.

Aim

To determine the size of micro particles using laser.

Apparatus Required

Fine micro particles having nearly same size (say lycopodium powder), a glass plate (say microscopic slide), diode laser, and a screen.

Principle

When laser is passed through a glass plate on which fine particles of nearly uniform size are spread, due to diffraction circular rings are observed. From the measurement of radii of the observed rings, we can calculate the size of particles. Since for diffraction to occur size of the obstacle must be comparable with wavelength, only for extremely fine particles of micron or still lesser dimension, diffraction pattern can be obtained.

Diffraction is very often referred to as the bending of the waves around an obstacle. When a circular obstacle is illuminated by a coherent collimated beam such as laser light, due to diffraction, circular rings are obtained. as If

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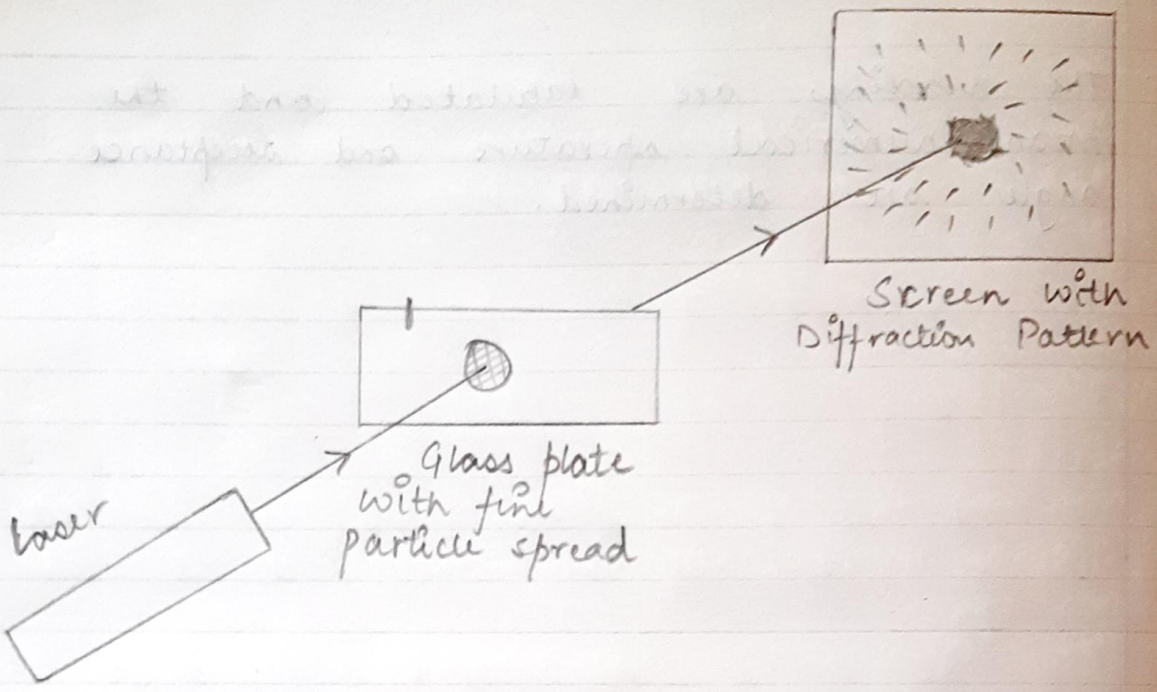

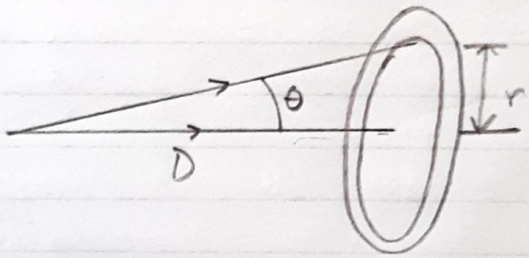

* Particle size determination using Laser

"r" is the radius of the first dark ring and "D" is the distance between the obstacle and screen on which the diffraction pattern is obtained, then.

$$\tan\theta = r/D$$

Since θ is very small in this experiment

$$\tan\theta = \theta = r/D$$

According to the theory, the diameter '2a' of the circular obstacle is given by

$$2a = \frac{1.22\, n \lambda D}{r_n}$$

where,

r_n = radius of the n^{th} order dark ring (m)

D = distance between the obstacle and the screen (m)

λ = wavelength of laser light (Å)

* Determination of Particle Size

$$2a = \frac{1.22 n \lambda D}{rn}, \quad \lambda = 6238 \times 10^{-10}$$

Sr NO	Distance (D)	diffraction order (n)	Radius of dark ring (rn)	Particle size (2a)
Unit	cm		cm	μm
1.	15	1	1.3	$= \frac{1.22 \times 6238 \times 1 \times 5 \times 10^{-10}}{1.3}$ $= 8.907 \mu m$
		2	2.6	8.781 μm
2.	20	1	1.7	8.953 μm
		2	3.5	8.697 μm
3.	25	1	2.2	8.648 μm
		2	4.4	8.648 μm
			Mean =	8.772 μm

* Result

The average size of the particles measured using laser = 8.772 μm

Procedure

1. Fine powder of particles is sprayed / spread on the glass plate.

2. Laser is held horizontally and the glass plate is inserted in its path.

3. Position of the glass plate is adjusted to get maximum contrast rings on the screen which is at a distance more than 0.5m.

4. A white paper is placed on the screen and the positions of the dark rings are marked. The radii of different order dark rings (r_n) are measured using a scale.

5. The distance between the screen and the glass plate (D) is also measured. Using the given formula,

$$2a = 1.22 n \lambda D / r_n ,$$

the average diameter of the particles is calculated.

6. The experiment is repeated for different D values.

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