



Experiment (1)

Laser beam divergence angle

Objective:-

This work is used to determine and reduce the divergence angle of He-Ne laser with and without beam expander.

Apparatus:-

He-Ne laser, Beam expander, screen

Theory:-

The laser (light amplification by stimulated emission of radiation) is a device that produces a strong beam of coherent photons by stimulated emission. A laser beam is coherent, very narrow and intense.

The directionality of the laser beam is expressed in terms of the full angle beam divergence, which is twice the angle that the outer edge of the beam makes with the center of the beam as shown in Fig. (1), the divergence tells us how rapidly the beam separates when it is emitted from the laser. Although the divergence angle can be measured in fractions of degrees or radians, the relation between degree and rad is $2\pi = 360$ degree and $1 \text{ rad} = 57.3$ degree, $1 \text{ mrad} = 0.057$ degree.

Consider a monochromatic beam of light of “infinite” extent, which passes through a circular aperture of diameter D . The beam, will now diverge by an amount dependent on the size of D .

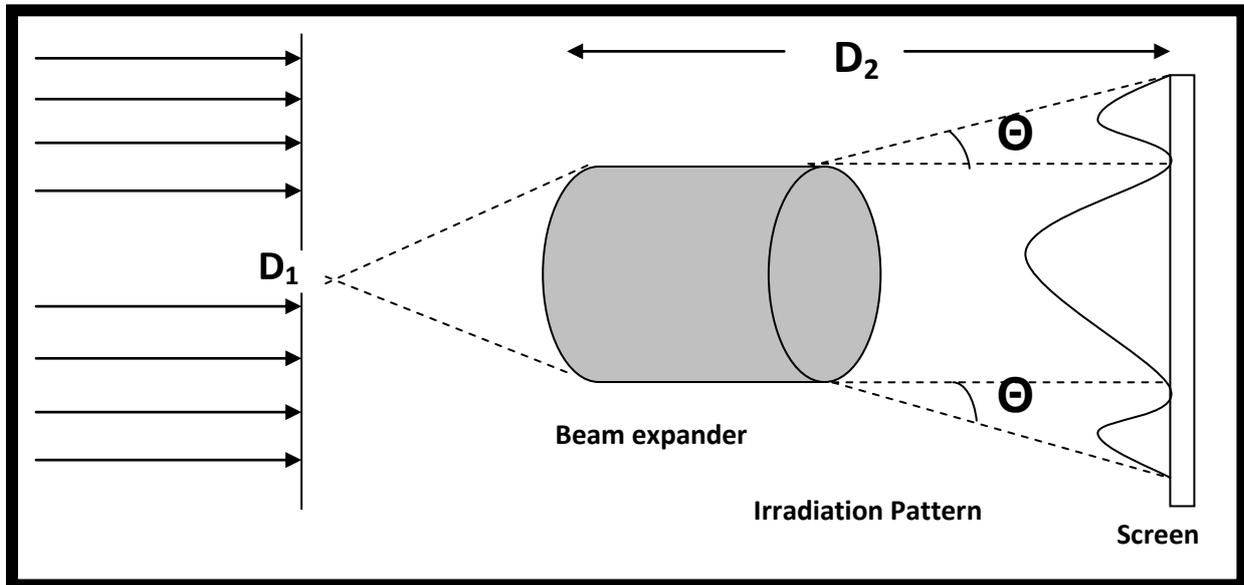


Fig (1):- Beam divergence from a circular aperture.

Procedure:-Part A:- Without beam expander:

1. Determined (D_1) which represented the diameter aperture of He-Ne laser.
2. Place the He-Ne laser at distance of about ($S=500$ mm) from the screen as in Fig. (2)
3. Determined the diameter of beam on screen (D_2).

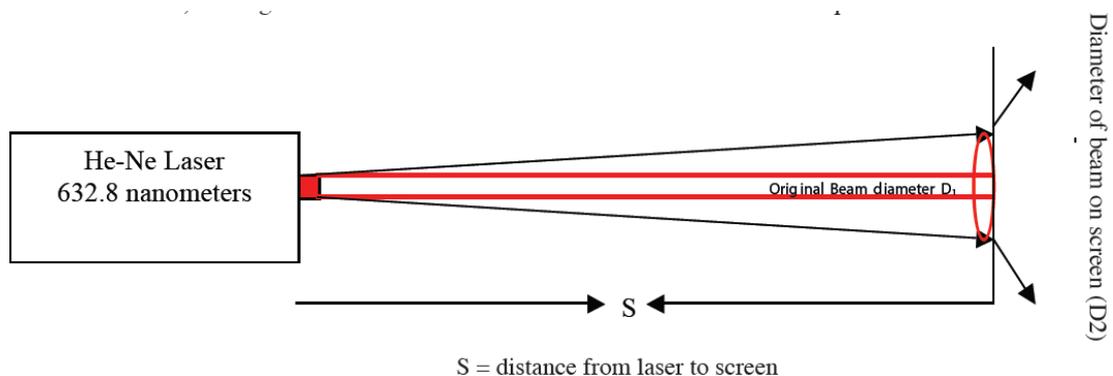


Fig.(2):- The setup without beam expander.



4. Increase the distance (S) from (500 to 3000)mm and arrange your results as in table below:

S (mm)	D1(mm)	D2 (mm)	D3=D2-D1
500			
⋮			
3000			

5. Plot a graph between D3 as a function of S to find the slope.

6. Slope = $\tan \theta$

Where:

λ : Wave length of He-Ne laser=632.8nm

θ : Divergence angle.

Part B:- With beam expander.

Repeat all the steps in Part A but S is the distance between beam expander and the screen. See fig.(1).



Discussion:-

Q1:-What is the reason for laser beam divergence?

Q2:- What is the main property of He-Ne laser?

Q3:- A laser has a divergence of 0.2 mill radians (mrad):

(i)If the beam cross section is circular, what is the solid angle of the beam?

(ii)If the power of the beam is 5 mW, what is the intensity of a point at 2 m distance from the laser?

Q4:- The divergence of laser beam after sending through a telescope is 10^{-6} rad .What is the diameter of the spot formed on the moon's surface if the laser is directed towards the earth? (The distance from earth to the moon is 3.8×10^5 km).