



### Experiment (5)

## ***Laser beam divergence angle***

### **Objective:-**

This work is used to determine and reduce the divergence angle of a 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 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. (2), the divergence tells us how rapidly the beam spreads when it is emitted from the laser.

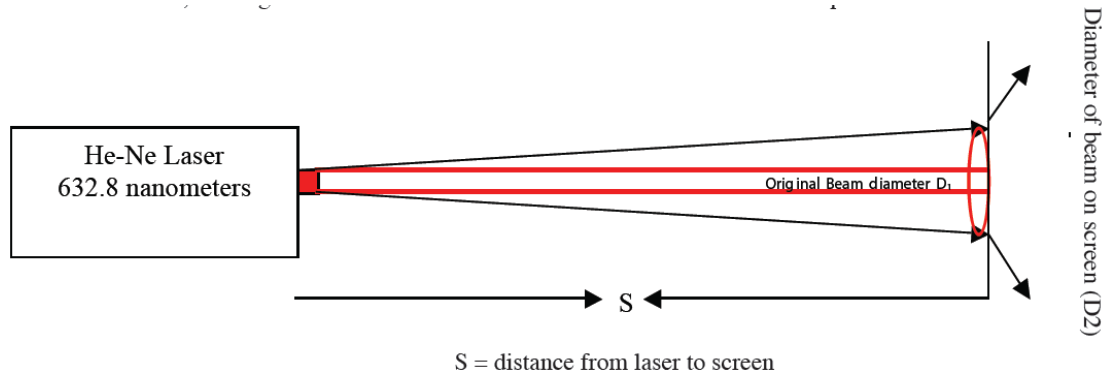
Consider a monochromatic beam of light of “infinite” extent, which passes through a circular aperture of diameter  $D$ . The beam, will now diverge by an amount dependent on the size of  $D$ .

### **Procedure:-Part A:- Without beam expander:**

1. Determine ( $D_1$ ) which represents the aperture diameter of He-Ne laser.
2. Place the He-Ne laser at distance of about ( $S=500$  mm) from the screen as in Fig. (1)



3. Determine the diameter of the beam on screen ( $D_2$ ).



**Figure(1): The setup without beam expander.**

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

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

5. Plot a graph between  $D_3$  as a function of  $S$  and find the slope.

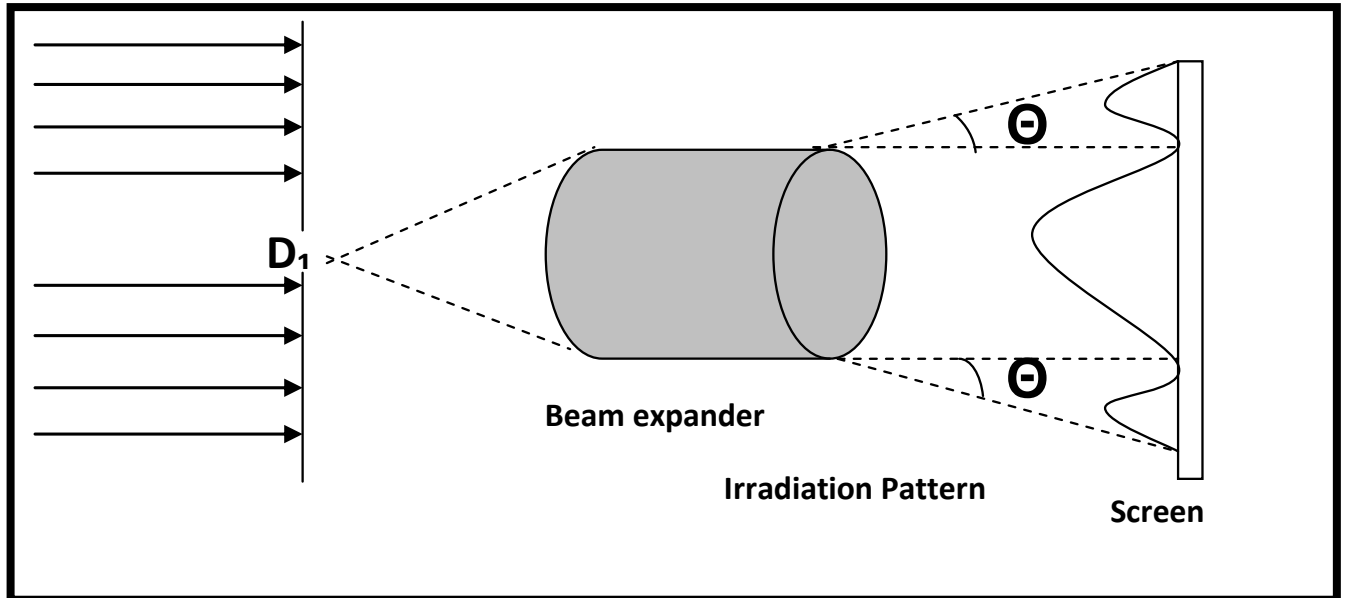
6. Slope =  $\tan \theta$

Where:

$\theta$ : 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.(2).



**Figure (2): Beam divergence from a circular aperture.**

**Discussion:-**

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

Q2:- What are the main properties of laser beam?

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

and the power of the beam is 5 mW, what is the intensity at a point at 2 m distance from the laser?

Q4:- The divergence of laser a 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 average distance the from the earth to the moon is  $3.8 \cdot 10^5$  Km).