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# Precise Measurement of Small Bacterium Size by LASER Light

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**Abstract:** *LASER light is allowed to pass through water drop and when it is passed through any kind of water, we are able to see the projection of bacterium present in water. The small water drop works as spherical lens with large magnifying power. The image through water is observed to be magnified using LASER light. With the help of this projection through water, the size of bacterium which are not easily visible to us with naked eyes is calculated. Also, percent of magnification takes place with help of LASER is also calculated. The surface of water drop curves outward to make a dome and this outward or convex curvature bends light rays inward. As a result, the object appears magnified than it is. The surface of a smaller drop is even more curved bending the light rays even more inward. The result is the larger magnification; the object appears even larger. As distance between source, screen changes away from water drop the image goes increasing up to a particular distance, where proper image observed which is useful for calculation of size impurities like bacterium. The intensity of LASER light plays a major role for magnification on screen.*

**Keywords:** Bacterium, Intensity, Magnification, LASER, Water drop as a Spherical lens.

## I. INTRODUCTION

In the light of covid-19 we developed a simple and versatile project magnification effect of general simple LASER. This paper involves observations in terms of calculation of size of bacterium in various types of water. With the help of homemade microscope using single water droplet the bacterium present in it, is magnified and to observe this, is practical held for classroom use in school and colleges. et.al. [2]

Using LASER, microorganisms present in various types of water e.g., sea water, tap water etc, are observed easily. When LASER light is passed through any type of water drop the projection of bacterium present in water is displayed on screen. et.al [5]

When light rays travel through LASER travels through water drop, they are bent by convex surface of water droplet the spot of LASER on water drop extends into a large round image. The surface of water drop curves outward to make a dome and this outward or convex curvature bends light rays inward. As a result, the object appears magnified than it is. The surface of a smaller drop is even more curved bending the light rays even more inward. The result is the larger magnification; the object appears even larger. et.al. [3]

Size of bacterium, presents in that drop, which are not observed with naked eyes, enhanced to such a level so that not only possible to get its proper image but from certain calculations its size can calculated. This results rather useful to coat about various kinds of impurities present in given water. On the basis of projection of images through LASER, magnification percentage and size of bacterium can be calculated.

The reason that objects appear magnified when under water has to do with the curvature of water surface. The more curved the water droplet (glass lens) is, the higher the magnification.et.al. [4]

The Magnification is produced by a lens and is defined as the ratio of the height of image to the height of object. It is denoted by

$$M = \frac{height\ of\ the\ image}{height\ of\ the\ object} \text{ ----------(1)}$$

et.al.[1]

Magnification is dependent upon

1. Curvature of water droplet
2. Intensity of LASER

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3. Distance between image and water droplet
4. Distance between LASER water droplet

In this project images were projected on graph paper (which is used as screen) and photographs were obtained.

**Refraction**: Bending of light is known as Refraction et.al.[6]

**Reflection**: When light bounces from the surface it is known as Reflection et.al. [7]

**Optics:** It is the branch of physics that studies the behaviour and properties of light including its interactions with matter et.al.[8]

**Why does water magnifies object**?

The surface of a water drop curves outward to make a dome. This outward convex, curvature bends light rays inward. et.al.[9]

The rays of light converge when they pass through the drops of water. Thus, the drop of water behaves like a convex lens. et.al. [10]

## II. EXPERIMENTAL

**2.1 Part 1**: For calculation of magnification produced by LASER light:

**A. Diagram:**

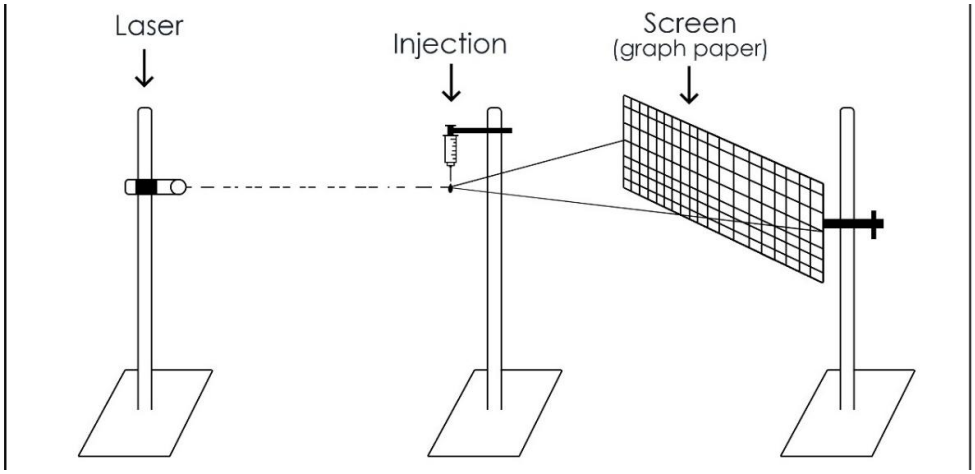


**Figure 1:** Experimental setup diagram

**B. Procedure**

Experimental arrangement is as shown in below diagram. From collected various type of water sample choose water which is more pure and put it in. Take strand of hair and mount it parallel to injection, put one end of hair in drop at the end of injection. LASER beam passes through water drop. Strand of hair is in the drop hence the projection of water drop will be displayed on the screen along the projection of strand of hair. Measure the diameter of projected hair image and then measure the diameter of hair in travelling microscope also. Now, comparing the value of diameter using travelling microscope and diameter in projection, its magnification is calculated.

**C. Conclusion from Magnification Table**

By taking number of observations using strand of hair, and comparing direct measurement of hair strand from travelling microscope it is concluded that the percentage of magnification is 52.3052%

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**2.2 Part 2:** Procedure for calculation of various bacterium for various type of water

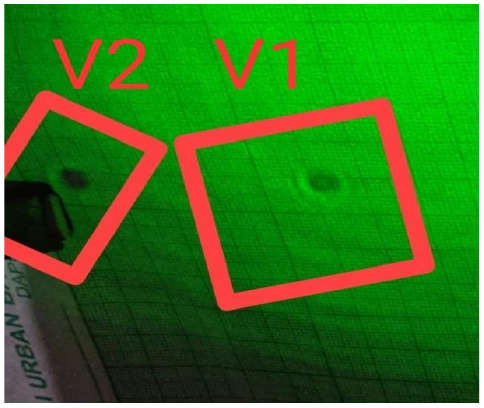


**Figure 2:** Projection through sea water

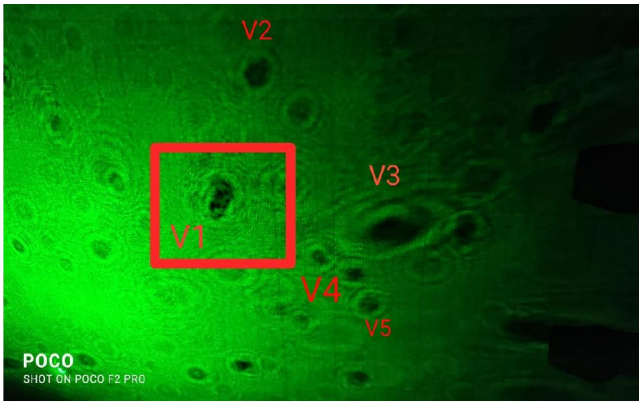


**Figure 3:** Projection through Tap Water

**A. Procedure:**

Refer fig. 1 for experimental arrangement of LASER, water drop and screen. Choose any one water from your apparatus (sea water say). LASER beam passes through water. The projection of bacterium in water will be displayed on screen. Calculate the size of every bacterium which is visible to you. Now use different waters and repeat above steps and calculate the size of bacteria on the screen and then calculate its actual size using magnification.

Observation Table for bacterium observed in Different Waters

**Observation Table 1.a:** Bacterium observed in sea water

| Type of Water | Bacterium | Observed size using LASER A (cm) | Actual size B $B = \frac{a}{52.3052}$ (cm) | Magnified (%) |
|---|---|---|---|---|
| Sea Water | $V_1$ | 1.7 | 0.03250 | 52.3% Apprx. |
| | $V_2$ | 0.5 | 0.00955 | |

**B. Conclusion**

In sea water it has found a large number of bacterium are observed and it's size by using percentage of magnification calculated as above.

**Observation Table 1.b:** Bacterium observed in Tap Water

| Type of water | Bacterium | Observed Size using LASER (cm) | Actual size B $B = \frac{a}{52.3052}$ (cm) | Magnified (%) |
|---|---|---|---|---|
| Tap water | $V_1$ | 0.5 | 0.00955 | 52.3% Approx |
| | $V_2$ | 0.5 | 0.00955 | |

**C. Conclusion**

In tap water bacterium were barely found and then size of bacterium is calculated using percentage of magnification.

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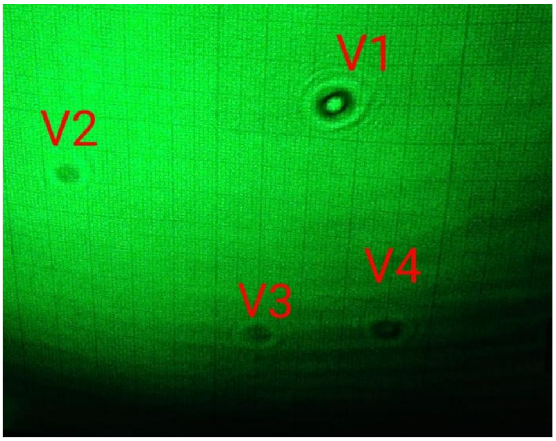


**Figure 4:** Projection through distilled water

**Observation table 1.c:** Bacterium observed in Distilled Water

| Type of Water | Bacterium | Observed Size using LASER (cm) | Actual size B $B = \frac{a}{52.3052}$ (cm) | Magnified (%) |
|---|---|---|---|---|
| Distilled Water | $V_1$ | 1.0 | 0.01911 | 52.3% Apprx. |
| | $V_2$ | 0.5 | 0.00955 | |

**Conclusion**

Distilled Water contains very smaller number of bacterium and then its size is calculated by using percentage of magnification.

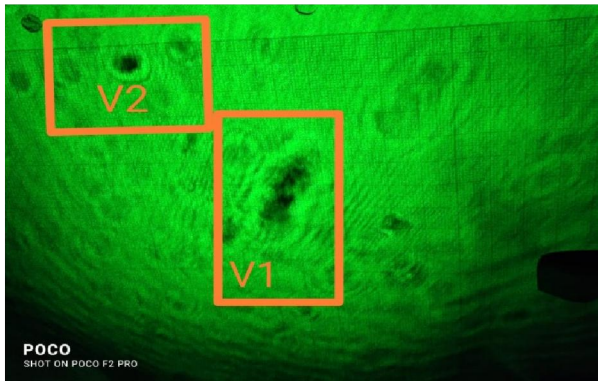


**Figure 5:** Projection through Potassium Dichromate solution

**Observation table 1.d:** Bacterium observed in Potassium Dichromate solution for distilled water

| Type of water | Bacterium | Observed Size using LASER (cm) | Actual size B $B = \frac{a}{52.3052}$ (cm) | Magnified (%) |
|---|---|---|---|---|
| Potassium Dichromate | $V_1$ | 3 | 0.05735 | 52.3% Approx. |
| | $V_2$ | 0.5 | 0.00955 | |

**Conclusion**

Potassium Dichromate helps to observe plenty of bacterium which were captured using camera more clearly and their size by using percentage of magnification is calculated easily.

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**2.3 Part 3:** Remark from Head of Department of Microbiology

One of the remark is taken from Department of Microbiology, Gram positive, short rod-shaped bacteria observed such bacteria observed in sea water may be fecal contaminated indicators such as Enterococci and clostridia. Also, human pathogens, such as streptococci, mycobacteria, bifidobacterial may be present in sea water

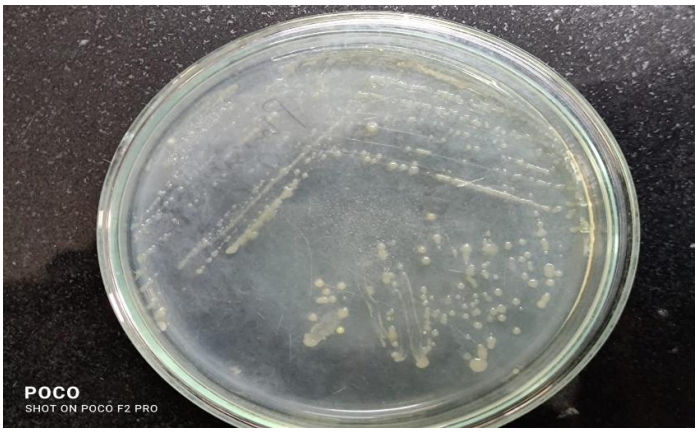


**Figure 6:** Bacterium present in Portrait dish

**Overall Conclusion:**

1. The small drop works as spherical lens with large Magnifying Power of **"52.3052%"**
2. We have determined the size of every bacterium projected on the screen and also, we have determined the percentage of magnification of bacteria.
3. The comparative study of various bacterium presented in various concentration of water can easily studied with naked eyes without any help of microscope
4. Head commented above it can be concluded that they also obtained the various bacterium observed in report are observed kin images of LASER more easily with in few seconds while they have to perform long procedure to conclude for their observation.
5. These bacterium via LASER can visualize by all observers simultaneously which are present there during performing experiments.

## III. DISCUSSION

### 3.1 Merits

1. Without the help of microscope, we can see bacterium in water easily with the size of microscopic level
2. With the help of this set up we can magnify any type image through water or liquid drop.
3. With the help of this set-up, we can identify various type of water.
4. Purity of water can be known and impurity in water can also be known
5. It is observed that, if distance between drop and screen is increased then the projection on screen goes on increasing manner up to certain specific distance
6. In microbiology department they have to do various procedures for bacterium and with the help of this set-up we found bacterium easily in 1 step
7. We can easily determine the size of bacteria with its magnified image.

### 3.2 Limitations

- It is not easy to know which type of bacteria we are looking at.

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It gives us immense pleasure to express our deep sense of gratitude to our paper guide **Mr. Digambar D. Kulkarni**, **Head Department of Physics** for his invaluable guidance**,** motivation, constant inspiration and above all for his ever-

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cooperating attitude that enables us in bringing up this paper in the present form. We are extremely thankful to him for providing all kinds of possible help and advice during the course of the course of this work.

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