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*Original Paper*

## Sun or Moon Light Garden Rainbow

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### Abstract

In spite of the popularity of Rainbow the subject is not known by the public because it is not taught in Physics courses in universities. We present an installation for producing a Rainbow similar with the natural one but of smaller dimensions. This installation creates better conditions to study and teach Rainbow. Every sunny day can be observed a Rainbow. The same installation is used to obtain a Rainbow in Moon light. The price of installation is around 200 USD.

**Keywords:** rainbow, physics, physics courses, undergraduate physics courses, high school physics

### Introduction

Rainbow belongs to the most wonderful natural phenomena that is mentioned even in Bible in connection with Flood and Noah's Ark [1]. The interest in the subject of Rainbow can be measured by doing a search in American Journal of Physics and The Physics Teacher with the key word RAINBOW and the result is 123 respectively 218 entries. Also the comments of the video <https://tinyurl.com/WS-VeritRainbow> give an idea of the lack of deep understanding of this wonderful natural phenomenon. In the above mentioned journals are presented several results that can help understanding but all of them miss the magic of the real Rainbow. In spite of its popularity it is very poorly known by the general public. This is because it appears unpredictable and it is not taught in universities and/or upper classes of high schools at physics courses. To observe it, it is necessary the Sun should be in the sky at an angular height of approximate 42 degrees on a clear half sky and the other half sky should be covered with clouds that give a rain. The observer looks at the rain and the Sun is at his/hers back. These conditions are not so easy to be fulfilled and this is why we can see a rainbow once or two times per year.

### Method

We built an installation that produces a curtain of water drops (Figure 1). Every gardener observed a piece of a rainbow by watering his plants. But this is just a piece of rainbow because the curtain of water drops is not homogeneous. The Rainbow obtained with our installation is like the natural one just of smaller dimensions (Figure 2). The distance between observer and the curtain of water drops is much smaller and this makes to be easily understood the importance of the axis Sun-the observer's eye. In our case if the observer changes his/hers position with 1 meter the position of Rainbow changes too. At the natural dimensions this can not be observed. With such an installation we can have a rainbow every sunny windless day and we can prepare the measurements. All measurements [2] can be done either for research or/and didactic purposes. In addition the measurements can be planned, repeated. Several changes (temperature of the water drops, salinity of the water etc.) can be done at hand and measured their effects.

## Results

The subject Rainbow is very poorly (and incompletely) covered in handbooks at universities and high schools. This is why it is so little known in the public. By mistake, it is mentioned Rainbow every time that some colors appear. Not every dispersion of light is a Rainbow. Rainbow is more than refraction and dispersion of light. All these aspects can be deeply understood dealing with this installation. Genuine research [2,3] can be planned and reproduced. Preliminary results of using this installation in research, didactics and possible touristic benefits have been published in open-access journals [4,5].



Figure 1. The installation

*Note.* Our installation has a length  $L=10$  m, height  $H=5$ m and the best point of observation is  $D=5$ m.5 pillars support one tube (or more, in our case 4 tubes) on which there are sprayers at 0.25m one from another. The water is pumped (from a water net or using a pump in a barrel). By switching on-off the pump the rainbow can appears-disappears at our will. The dimensions are not critical: The larger the better. In the picture two co-villagers who helped the authors: M.Lavric and I.Morariu. We made this installation with 200 USD.





Figure 2. Day Light Garden Rainbow

*Note.* The Rainbow is at the intersection of conic surface (axis Sun-observer's eye and with the apex in the observer's eye and has the angle  $2 \times 42$  degrees) with the plane of water drops curtain. When the observer moves the Rainbow moves too. The natural Rainbow looks like static but this is because the distance observer water drops curtain is thousand times larger than in our case and its movement can not be noticed. Using a ladder a full circle Rainbow can be observed. Also can be easily understood that every observer sees his/hers Rainbow and it moves with the observer.

Encouraged by our Garden Rainbow we asked ourselves if such a Rainbow can be obtained in Moon light. Apparently should be no problem. Technically there are some difficulties. Firstly, should be a perfect dark, no lights around. This means that we can not plan such an experiment in a city/town because of public lights. We made it in a village: Armasoia. Secondly, only 5 nights around full Moon time the Moon will have more than 97% of its maximum luminosity. Thirdly, for taking pictures we need better camera. With all these in mind we succeed (Figure 3). Such an experiment can be used to create a sudden pleasant and unexpected surprise and to measure the vital parameters of the observers [6].

In 30 minutes every observer will be sure that any superstition about Rainbow is wrong including the "pot of gold" myth (search on Google with: *rainbow, pot of gold*).



Figure 3. Moon Light Garden Rainbow

*Note.* Place and date: Armasoaia/Pungesti/Vaslui/Romania, 30 September 2023, 03:30 AM(EET) .In the picture the second author. Using Google can be seen pictures using key words “lunar rainbow” or “moonbow” but how rare are such occasions to be observed. Foto S.Mungiu.

### Discussion

It is known that the professor of Physics Walter Lewin from MIT gave his famous lecture on Rainbow [7]. Using such an installation even a beginning young teacher can give a good lecture on Rainbow in a medium size town.

### Conclusion

In our opinion the study of Rainbow can begin with a visit at such an installation in a sunny day afternoon. This can be done before noon but depends of the orientation of the installation. At ours the phenomenon can be observed afternoon. The student will be surprised by the beauty of the Rainbow, will take very original pictures, will debate about the science behind it. In a rainy day can be presented the real physics: ray tracing in the balls of water drops, how the angle of 42 appears etc. All aspects are covered in the handbooks and scientific literature [7].

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### References

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