Homemade Interferometer Based on a Non-Ideal Beam Splitter and a Home Mirror

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Abstract: A homemade interferometer based on a non-ideal beam splitter and an only one home mirror is presented. Its interference pattern presented dark and bright rings when the mirror was tilted. © 2021 The Author(s)

1. Introduction

Photonic and optoelectronic devices are fundamental elements in many technologies linked to telecommunications and energy which are of great importance in actuality [1]. For this reason it is very important that undergraduate students of Communications and Electronic Engineering programme have basic knowledge of optics. At the University of Guanajuato, in Mexico, students of this programme must course a series of optics courses, one of them is called Optics and Acoustics. This subject involves both class lectures and lab sessions. Class lectures consists in the presentation of the theory and description related examples following a textbook [2, 3]. For example, for the topic of interference, students study about general concepts of interference and interferometers. Lab sessions represent an exciting experience for students since they can test out theory. In one of the laboratory sessions, a commercial Michelson interferometer is used to obtain interference patterns and to analyze how these are changed when the optical path difference is modified. Besides for this topic, student have to present an optic device made by themselves. However, in some occasions it is not possible for students to have access to the University labs, therefore it is important to design experiments that students can implement in their own houses. Here, we focussed in the design of a homemade interferometer of low cost components based in the operation principle of a mirrored interferometer, which allowed students to obtain an interference pattern of alternatively bright and dark rings.

2. Theory

The total intensity in a point *P* in the space resulting from the interference of two waves propagating at different directions is described as [3]:

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\, Cos\, \delta \tag{1}$$

where the phase difference is $\delta = 2\pi\,(DCO)/\lambda$, λ is the wavelength of the waves and *DCO* is the optical path difference between the two waves in a point *P* of the space. A maximum intensity (constructive interference) is obtained when δ is an integer multiple of 2π, and a minimum (destructive interference) when δ is an odd integer multiple of π.

2.1. Michelson interferometer

The diagram of a commercial Michelson interferometer, used in laboratory to obtain interference of two waves, is shown in figure 1.a. Here, the light of a laser is divided in two waves (W1 and W2) by a beam splitter B. The interference between W1 and W2 is observed in a screen S after of that these followed the paths B-E1-B-S and B-E2-B-S, respectively. Here, the *DCO* for the center ring is twice the distance difference *d* that exists between the mirrors, E1 and E2, and the beam splitter.

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As an example, two interference patterns obtained are shown in figures 2b and 2c. Here, the destructive and constructive interference can be appreciated easily in the center ring of each figure. Once students obtain a visible interference pattern, they can change the position (*d*) of the movable mirror E1 to visualize how the rings of the pattern change from bright to dark and vice versa. Finally, with this commercial interferometer, students can calculate the wavelength of the laser using the measured value of *d*.

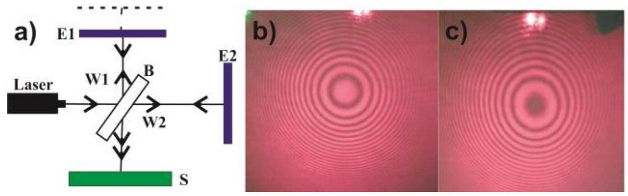

Fig. 1. a) Diagram of the Michelson interferometer and b)-c) example of interference patterns.

3. Homemade interferometer

The homemade interferometer proposed is also a mirrored interferometer which diagram is shown in figure 2a. It was designed in such a way that students can implement it by their own with easily accessible materials. Basically, only a laser of visible light, a non-ideal beam splitter and a piece of home mirror are required. Here, the beam splitter does not have an ideal behavior since it presents a third light beam (W3) in the same direction that the first light beam W1 and at 90º from the incident light beam. This first beam is reflected with a mirror E1 to recombine it with W3 on a screen S (figure 2a).

4. Fabrication of the homemade interferometer and results

The picture of a homemade interferometer, implemented by one of the students of the University of Guanajuato, is presented in figure 2b. It is observed the three principal elements, a laser operating @532 nm and 5000 mW, one round piece of home mirror and the beam splitter, obtained of a compact disc player. Here, when the mirror is tilted the optical path difference change turning the central ring can from dark to bright (figures 2.c and 2.d).

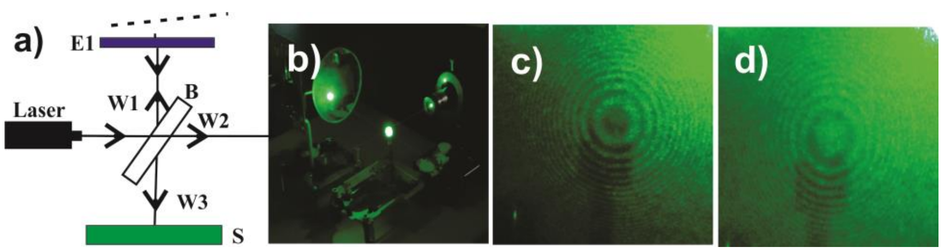

Fig. 2. a) Diagram and b) picture of the homemade interferometer; and c)-d) its interference patterns.

5. Conclusions

In this work, a homemade interferometer based on only one mirror is proposed. By using this device, the interference phenomena can be easily visualized. Finally, the implementation of this device represents for students the opportunity to apply their knowledge and to have an interesting approach to the wonderful world of interferometry.

6. References

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