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A new Optical Interference Method to Measure He-Ne Laser Wavelength

Akram N. Muhammad[1]*, Mashaan A. Mahmood[2]
[1]*Laser and Optoelectronics Engeneering. Department, University of Technology, IRAQ.*
[2]*Ministry of Education, IRAQ.*
Corresponding author email: akram.noori51@gmail.com

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Abstract

A new optical method used in our lab to get clear fringes of interference use "He Ne laser" as a light source. These experiments construct firstly to avoid our need to sodium lamb, Secondly, a convex lens was used to obtain a large image fringes to make the parameters more accurate than using the real fringes, by using a new mathematical relationships, the wavelength was measured. The results were more accurate than the normal methods used.

Keywords: Laser source, image fringes, wavelength, convex lens.

الخلاصة

طريقة بصرية جديدة اجريت في المختبر للحصول على هدب تداخل واضحة اولا باستخدام ليزر الهليوم – نيون (He-Ne) كمصدر ضوئي بدلا من استخدام ضوء الصوديوم، وثانيا باستخدام عدسة لامة للحصول على صورة مكبرة للهدب لتكون المعلمات ادق من استخدام الهدب نفسها، وباستخدام علاقات رياضية جديدة تم قياس الطول الموجي فكانت النتائج ادق من الطرق الاعتيادية المستخدمة.

Introduction

An old methods of interference (fresnel bi prism[1], fresnel double mirror [2], Loyd-mirror and young double slit) still used to explain the idea of getting coherent sources to cause interference[3].

Young double slit has played an important role in the development of optical [4], but with sodum lamb as a light source. Recently, laser is used to satisfy that [5].

In all these experiments no real explanation used. In addition, no clear fringes are obtained as we did new mathematical relations are obtained which represents the geometrical explanations of all past methods.

Materials and Methodologies

We can get fringes by He-Ne laser beam incidence on the young double slit, as shown in Figure 1, and use the general equation to get the wavelength of the source.

But these fringes have small size which pushes us to use an Eye-pice micrometer to make it easy for seen and measurement. But by using our method, as shown in Figure 2, we get very wide and very clear fringes.

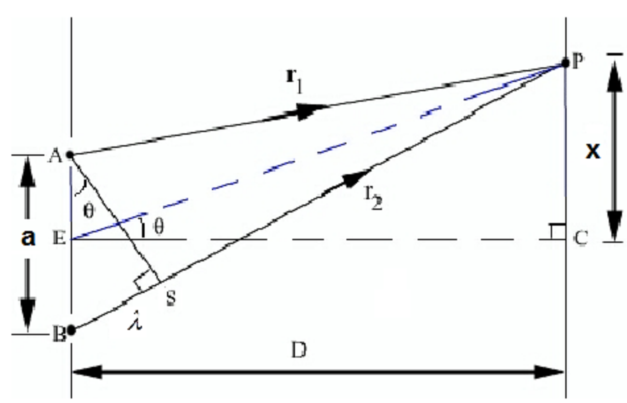

Figure 1: young's double slit experiment

Where $\lambda = \frac{ax}{D}$, a: distance between the double slit-centers, X is fringe width, D is a distance between slits and screen.

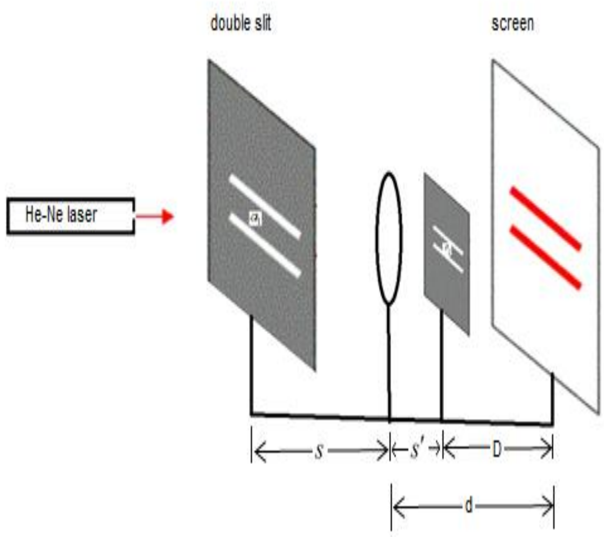

Figure 2: He-Ne laser as an interference light source.

Experimental Calculations

From Figure 2, we have: a1: slits width. a2: slits image (image width), S: slits-$\acute{S}$ lens separation (object distance), slits image-lens separation (image distance), d: lens-screen distance, D: slits image-screen distance. From lens equations for image formation we have:

$$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'} \quad (1)$$

$$\therefore s' = \frac{sf}{s-f} \quad (2)$$

$$\frac{a_2}{a_1} = \frac{\acute{S}}{S} \quad (3)$$

$$a_2 = \frac{\acute{S} a_1}{S} \quad (4)$$

By substitute (2) in (4):

$$\therefore a_2 = \frac{a_1 sf/(s-f)}{s} = \frac{a_1 f}{s-f} \quad (5)$$

$$D = d - s' \quad (6)$$

By substitute (2) in (6) where D is the distance between the image of doable slit and screen, d is the distance between the doable slit and screen. Substitute (3) in (5) we get:

$$D = d - \frac{sf}{s-f} = \frac{d(s-f) - sf}{(s-f)} \quad (7)$$

But

$$\lambda = \frac{a_2 x}{D} \quad (8)$$

By substitute (5) and (7) in (8):

$$\lambda = \frac{a_1 fx}{(s-f)} * \frac{(s-f)}{d(s-f) - sf}$$

$$\therefore \lambda = \frac{a_1 fx}{d(s-f) - sf} \quad (9)$$

Results and Discussion

Many experiments were done these results are explained in Table 1.

Our method is a new method that never used before. With the new idea the results were competitive to other results from the literature. Where the error ratio in our experience to the error ratio in Young double slit experience is inversely proportional to the magnification ratio:

$$\frac{a_2}{a_1}$$

Conclusions

This method can be used for many optical applications since the fringes are very wide which presents easy and very precise measurements. Also this method gives the students very good explanation about wave interference and wavelength measurements. Also they can use these equations to measure the refractive index of gas or thin film thickness.

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Table 1: Explain the results of six experiments:

No.	**a (cm)**	**D** $=D+s'$ **(cm)**	**f (cm)**	$x=\frac{area}{frings}$ **(cm)**	**S (cm)**	$\lambda=\frac{afx}{d(s-f)-sf}$	λ **(nm)**
1	0.12	184	+5	$\frac{23}{22}$	61	$\lambda=\frac{0.12*5*23/22}{184(61-5)-61*5}$	627.33
2	0.12	191	+5	$\frac{21}{16.5}$	70	$\lambda=\frac{0.12*5*21/16.5}{191(70-5)-70*5}$	632.93
3	0.12	191	+5	$\frac{21}{36.5}$	34.5	$\lambda=\frac{0.12*5*21/36.5}{184(34.5-5)-34.5*5}$	632.01
4	0.12	101	+5	$\frac{21}{17}$	126	$\lambda=\frac{0.12*5*21/17}{101(126-5)-126*5}$	639.35
5	0.12	190	+5	$\frac{21.5}{16.5}$	70	$\lambda=\frac{0.12*5*21.5/16.5}{190(70-5)-70*5}$	634.14

*The average wavelength = 633.15 nm, Percentage Error of experimental = 0.055%.

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