Measurement of the Speed of Light by Using the Interference of Microwaves

Kurashiki Amaki High School　　Takahiro Kogawa

1. Introduction

The speed of microwaves is the same as that of light. So I thought we can measure the speed of light by using microwaves.
I measured the speed of light by using the interference of microwaves.

What is ***Interference***?
Interference is a phenomenon in which two waves superimpose to form a resultant wave of greater or lower amplitude.

2. Purpose

- To prove that we can measure the speed of light by using the interference of microwaves.
- To show that we can measure the speed of light with the apparatus that we made.

3. Theory

The formula of the speed of waves:

$$v=f\lambda \quad \ldots(1)$$

v[m/s] : speed of wave　　f[Hz] : frequency
λ[m] : wavelength

In figure 1
○Equation for solid lines

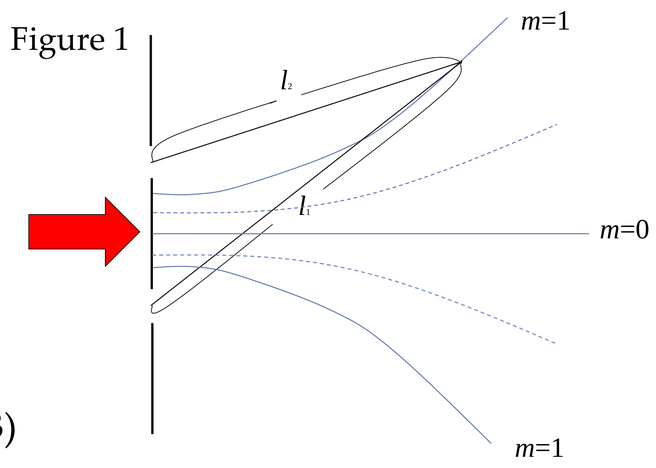
$$|l_1 - l_2| = m\lambda \quad \ldots(2)$$

○Equation for broken lines

$$|l_1 - l_2| = \left(m + \frac{1}{2}\right)\lambda \quad \ldots(3)$$

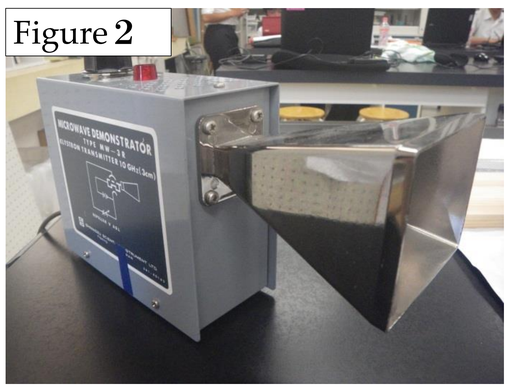
$(m = 0,1,2 \ldots)$
l_1, l_2[m] :the distance of the microwaves from each slit and the amplitude maximum or minimum points

Figure 1



4. Equipment

Figure 2



microwave demonstrator(10GHz)

Figure 3

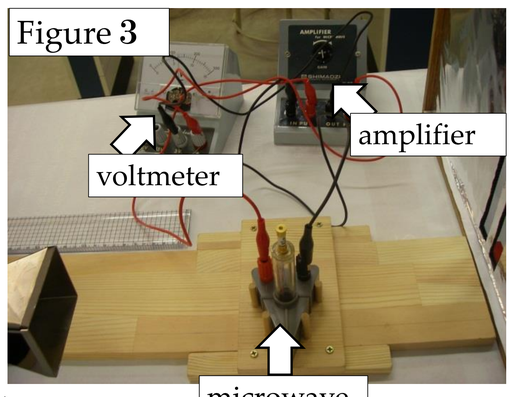
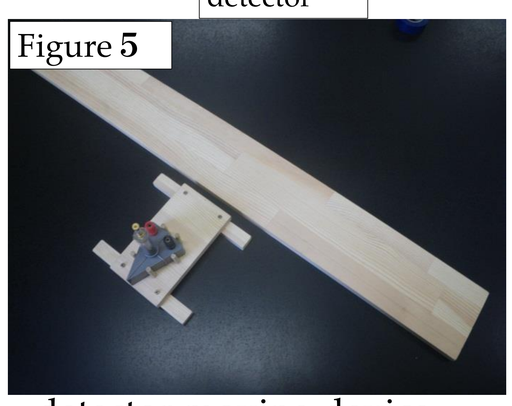


Figure 4

double-slit*

Figure 5



detector moving device

*aluminum-foil-covered board with two 15cm×2cm slits next to each other; distance between the slits: 3cm

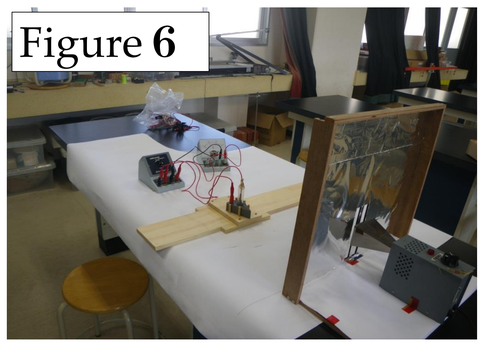
5. Experiment

1.Set-up of experiment apparatus (see Figure 8).

2.The detector was placed parallel to the two slits to search for the amplitude maximum and minimum points by looking at the voltmeter.

3.When we found the maximum and minimum points, we recorded them on the paper placed just under the detector.

Figure 6



6. Results

Table 1

	The number of points	The average of the wavelength [m]	The average of the speed of light [m/s]	Standard error of the speed of light [m/s]
All data	105	2.87×10^{-2}	2.87×10^{8}	0.06×10^{8}
maximum	40	2.26×10^{-2}	2.26×10^{8}	0.03×10^{8}
minimum	65	3.25×10^{-2}	3.25×10^{8}	0.06×10^{8}
*good data	**49**	$\mathbf{3.05}\times10^{-2}$	$\mathbf{3.05}\times10^{8}$	$\mathbf{0.04}\times10^{8}$

*good data (with the range of ±0.5[cm] from the expected wavelength)

Standard error is the standard deviation of the sampling distribution of a statistic.

- According to the reference book, the speed of light is 3.00×10^{8} [m/s].

7. Discussion

According to table 1, the speed of light for all data is **(2.87 ±0.06) ×10^8 [m/s]**.
This is near to 3.00×10^{8} [m/s] so **we can measure the speed of light in this way**, but we thought we can measure the speed more accurately, so we calculated the speed of light by using only the minimum points and by using only maximum points in order to know what we should do to get more correct value.
The value for minimum points is better than that of maximum points.
I thought the reason is that the needle of the voltmeter moves too small to read correctly.
These 65 minimum points include some failed data so we took them away and calculated the speed of light again. (3.05±0.04)×10^8 [m/s] is the data.
This is much nearer to 3.00×10^8 [m/s] than that for all minimum points.

8. Conclusion

- The speed of light can be measured by using the interference of microwaves.
- We can measure the speed of light with the apparatus that we made.

9. Future Research

- To collect more minimum points' data in order to know more accurately the value of the speed of light.
- To measure the speed of light in another way.

【Reference】　Book: Kunitomi, M. et.al. 物理(Physics)　数研出版株式会社(Suken shuppan), January 2013