International Multilingual Journal of Science and Technology (IMJST)
ISSN: 2528-9810
Vol. 5 Issue 11, November - 2020

Measurement Of Speed Of Light By Various Method

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***Abstract*—For the single reflection in the mirror there is no effect on the velocity of light. But on several reflection occurs in the determination of velocity of light in our process, the reflected surface of mirror effects on the velocity of light. In this process the velocity of light can be determined accurately and easily within the distance of twenty metre. So the process of determination of velocity of light can be calculated easily in laboratory and the speed of light in any medium also can be determined.**

Keywords—Velocity of Light; History of determination of measurement; new methods of determination of velocity of light

I. Introduction

Light is electromagnetic radiation of different wavelength due to which the human eyes have sensation. Before seventeenth century, the assumption of the speed of light is infinite. In 1638, Galileo Galilee tried to measure the speed of light by covered lanterns method. He measured the time taken for any fixed distance but he didn't get success. So, he also said that speed of light is infinite. In 1667, Accademia Del Cimento also be tried to measure the speed of light by covered lanterns method. But he even didn't success in this experiment. In 1676, Danish astronomer Ole Roemer proved that the light has a constant speed by studying about the Jupiter moons and its eclipses and found that the speed of light is 2.14 x 10^8 m/s. In 1728, James Bradley made another estimate by observing stellar aberration, being the apparent displacement of stars due to motion of the earth around the sun. Knowing the speed of the earth round the sun and measure the speed of light is 3.01 x 10^8 m/s. French scientist Hippohyte Fizeau, first successful experiment on earth measured the speed of light in 1849. He used the toothed wheel and light passes the tooth of which light reflected from the mirror 8 km apart and wheel rapidly spinning until reflected light is blocked and found the velocity of light 3.15 x 10^8 m/s. In 1862, the French physicist Jean Bermand Leon Foucault modified Fizeau apparatus by replacing the toothed wheel with a rotating mirror and measured the speed of light is 2.98 x 10^8 m/s. Maxwell published his theory of electromagnetism, then it becomes possible to calculate the speed of light. In 1857, Weber and Kohlrausch used the Maxwell theory and determine the velocity of light by measuring the magnetic permeability and electric permittivity of free space method Weber and Kohlrausch in 1857. In 1907, Rosa and Dorsey obtained 299,788 km/s. It was the most accurate value at that time. In 1920, the American physicist Albert Michelson (1852-1931) also used 8-sided rotating mirror by setting experimental apparatus between two mountains of southern California and measured the speed of light is 2.99796 x 10^8 m/s. In 1958, Froome obtained a value of 299792.5 km/s using a microwave interferometer and Kerr cell shutter. After 1970, the development of lasers with very high spectral stability and accurate cesium clocks made even before measurements possible. Until then, the changing definition of meter had always stayed ahead of the accuracy of measurements of speed of light.

Nowadays, the speed of light in vacuum is defined to have an exact fixed value when given in standard units. Since 1983, the meter has been defined by international agreement as the distance travelled by light in vacuum during a time interval of 1/299,792,458 of a second. This makes the speed of light exactly 299,792.458 km/s. This definition only makes sense because the speed of light in vacuum in measured to have the same value by all observation. In this research, by deriving the formula and found the velocity of light is 3.14 x10^8 m/s.

II. Methodology and instrumentation

There are different methods for the research, mainly theoretical method, experimental method and computational method. Among them we choose the theoretical method to determine the velocity of light. Here we have consider the two similar method to find the speed of light as mentioned here first method and second method.

A. **First method**:

This method consists of a cylindrical drum having diameter 'D' and with small aperture 'ds' both end of drum A to B for light passing through drum of the aperture A to B which observe on screen. The drum is connected with variable motor 'M' and a source of light 'S' is right hand side and screen is left hand side shown in figure 1,is the length of aperture A to B is 'D' which also shown in the figure. The variable motor 'M' is at rest and the points A, B and S is in a straight line then light passes from 'S' to screen which is indicated on brightness of the screen which observed on

screen. When A or B comes to S then light passes through drum of aperture which observed on screen or indicated on screen. Now motor is rotated then drum is also rotates and the point A to B comes to S then screen becomes bright or remains dark. So, rotation of drum increases the screen darkness or brightness. This process is continuing the rate of darkness and brightness is also increases. When the rotation of drum becomes faster then, the rate of darkness and brightness also goes on the same level. Therefore, light to be continue incident on the screen. When the rotation of drum is very fast, light can't passed through drum to screen. There light is entered on aperature A but not passes through B and vice-versa. Because light enters the aperature A when light becomes the aperature B then light blocks by other part of drum or covered distance 'ds' so that light can't pass through the drum and indicate on screen. This means that light covered the distance 'D' at that time the drum covered distance 'ds' in the same time. It means that the time interval for the distance covered by light 'D' and distance covered by drum 'ds' is equal. If light can't pass through drum then the light is covered the distance 'D' and drum can't covered the distance 'ds' at the same time or equal time. Finally, when the screen is just completely dark or minimum frequency of motor then interval of time for the distance covered by light 'D' and the distance covered by drum of small aperture of distance 'ds' is equal.

B. **Second method**:

This method consists of a motor 'M' is connected to a circular plane sheet having two apertures 'P' and 'Q'. Let'O' be the central of sheet aperture P and Q equidistant from the centre O and these points are at the distance 'r' from the point 'O'. The source of light 'S' passing through the aperture P and these light is reflecting on the mirror M_1 and M_2 emerged out from the aperture Q and vice-versa which observed on screen. The distance between mirror M_1 & M_2 is 'h', diameter of circular plane sheet is D and diameter of the aperture P and Q is 'ds' is shown in the figure 2. The experimental arrangement are setup as shown in the figure 2, if the aperture P comes to source of light S then light is passed though the aperture P and after reflecting light emerged out from the aperture Q and incident on screen S'. If Q comes to source S then light passing later from Q aperture and emerged out from aperture P and incident on screen S'. When the motor is rotating in very low speed then apertures of P and Q also rotates, then the screen is dark until P or Q comes to source of light S. When the aperture P comes to source S then screen be bright because light inter from aperture Q and emerged from aperture P which indicates the screen. The speed of motor is increased then the screen is dark and bright observed on the screen. If the speed of motor is continuously increases then rate of darkness and brightness is also increases. Finally the speed of motor is increasing very fast until screen is not completely dark. When the screen is completely dark, this means light covered distance 'nh' and circular plane sheet covered distance 'ds' in equal interval of time.

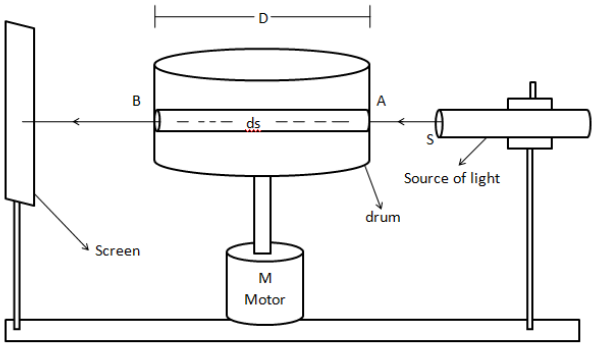

Fig.1 Determination of speed of light

III. Theory and Discussion:

There are two methods having two different theories mentioned as first and second. In the first method, the time taken by light to travel the distance D should be equal to the time taken to rotate the drum, so it travel one circumference. i.e. $T_l = T_d$, D/ C = ds / V. Therefore, C = DV / ds and hence the velocity of light is, C = 2πR D f / ds. In the second method, the time taken by light to travel the distance 'nh' by light (T_1) should be equal to the time taken to travel the distance covered by circular plane sheet 'ds'(T_d). Hence, $T_l = T_d$ **or, nh / C = ds / V,** Where, nh is the total distance covered by light. ds is the distance of sheet. Thus, the velocity of light is, C = 2πrf (nh) / ds. In this second experiment, the large number of reflections occurs in the mirrors M_1 and M_2 are used, then these mirrors also affect the velocity of light.

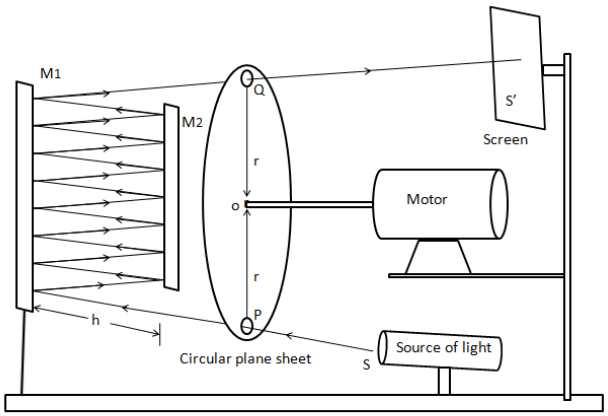

Fig.2 Determination of speed of light

The first successfully experimentally calculate the velocity of light by Amond Fizeau in 1849. He used toothed wheel and beam of light reflected from eight km away from the toothed wheel. The toothed wheel is spinning rapidly. The speed of wheel was increasing unit its motion was such that the light two way passage coincided with a movement of the wheel's circumference by one tooth. Then calculated the speed of light. The French physicist Foucault modified Amond Fizeau apparatus by replacing the

toothed wheel with rotating mirror and lens. Albert Michelson also measured the speed of light in 1926. He used the eight sided rotating mirror and twenty-two miles away from the plane mirror. When the light reflected from one face and the distance covered by the light twenty-two miles, then second face of the rotating mirror comes in its path. After forming the image made in telescope then calculate the speed of light. In this method, there is no used the mirror and so it can't be affected to calculate the speed of light. In our method, the toothed wheel replaced by circular plane sheet as shown in figure, having two holes and large number of mirrors are used, so that the mirror may affects the speed of light. The measurement of speed of light in this method, is determined for the distance within the 20 m away from circular plane sheet. So it can be done in laboratory also and can be calculated easily the speed of light in any medium.

IV. Conclusion:

If there is only one reflection occurs in the mirror, then the reflected surface of mirror can't affect on the velocity of light. This means light reflected from the surface of mirror is elastic collision between the light and the surface of mirror so that reflected mirror surface is not consumed the time. But on several reflection occurs in the mirror, then the reflected surface of mirror consumed some time. This means, the atom of the reflected mirror surface which atom of an electron found to be energy from light which goes from lower energy level to higher energy level (i.e. ground state to exited state) that means it is not a stable. This electron jumps higher energy level to lower energy level with emission of equal wavelength of light emission of this atom. That is reflected surface consumed and affects on the velocity of light.

Acknowledgement:

We would like to thank the Tri-Chandra College, Tribhuvan University. We are also thankful to the library on which we studied the book mentioned in the references.

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VI. Appendix: Results of determination of speed of light by different author used different methods.

Date	Author	Method	Result(km/s)	Error
1638	Galileo	Covered lanrerns	Inclusive	
1676	Olaus Roemer	Jupital's satelight es	214,000	
1726	James Bradley	Steller Aberration	301,000	
1849	Armand Fizeau	Toothed wheel	315,000	
1862	Leo Foucault	Rotating mirror	298,000	+0.500
1907	Rosa, Dorsay	Electromagnetic constants	299,910	+0.30
1926	Albert Michelson	Rotating mirror	299,796	+0.4
1947	Essen, Gorden-Smit	Cavity Resonator	299,792	+0.3
1958	K .D. Froome	Radio inferometer	299,792.5	+0.1
1973	Evanson et al	Lasers	299,792.4574	+0.001
1983		Adopted value	299,792.458	