A Simple Explanation of the Michelson-Morley Experiment Results

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Abstract

The Michelson-Morley experiment, conducted in 1887, was designed to detect the presence of the aether—a hypothetical medium through which light was thought to propagate. The experiment's null result played a crucial role in the abandonment of the aether theory and supported the notion of the constancy of the speed of light.
This article explores a hypothesis that suggests a simple explanation for the Michelson-Morley experiment's null result based on proportional changes in the speed of light and wavelength, while the frequency and energy transmitted per unit time remain unchanged.

Introduction

The Michelson-Morley experiment aimed to measure variations in the speed of light due to the motion of the Earth through the aether. The expectation was that such motion would cause changes in the speed of light depending on the direction of travel, which would, in turn, affect the interference pattern observed in the experiment. The absence of a significant shift in this pattern led to the conclusion that the aether did not exist.

Hypothesis

A novel hypothesis suggests that if the speed of light c increases, the wavelength λ increases proportionally, while the frequency f remains constant. According to the relation $c = \lambda f$, if c and λ increase proportionally, f will not change. Consequently, the phase difference in the Michelson-Morley interferometer, which depends on the wavelength, will remain constant, resulting in no observable shift in the interference pattern.
Additionally, the amplitude of the wave decreases proportionally with the increase in the speed of light, ensuring that the amount of energy transmitted by

the wave per unit time remains unchanged. This constancy in energy transmission ensures that the interference pattern's brightness does not change, thereby not affecting the observed results.

Detailed Analysis

Speed of Light, Wavelength and Frequency Relationship

The formula $c = \lambda f$ implies that if c and λ increase proportionally, the frequency f remains unchanged. In this scenario, any changes in the speed of light due to motion through the aether would be exactly offset by changes in the wavelength, keeping the frequency constant.

Interference Pattern and Energy Considerations

The interference pattern in the Michelson-Morley experiment is sensitive to changes in the phase difference, which is given by

$$\Delta\phi = \frac{2\pi L}{\lambda}$$

If λ changes proportionally with c, the phase difference remains unchanged, meaning the interference pattern would not shift. Additionally, as the speed of light c increases, the amplitude of the light wave decreases proportionally. This decrease in amplitude ensures that the energy E transmitted by the wave per unit time, given by $E \propto A^2 f$, where A is the amplitude, remains constant. This constancy in energy prevents any change in the brightness of the interference pattern, further ensuring that the experimental results remain unaffected.

Physical Explanation for Wavelength Change with Light Speed

When the density of the medium through which electromagnetic waves propagate changes, the speed of light in that medium changes proportionally. As the medium becomes denser, it compresses the wave, reducing its amplitude. To maintain a constant emission frequency, the wave must stretch out, increasing its wavelength. Consequently, as the density of the medium increases, the speed and wavelength of the wave increase proportionally, while the frequency remains unchanged.

Conclusion

This simplified explanation illustrates why the Michelson-Morley experiment yields a null result regardless of the source's motion relative to the aether. The proportional changes in wavelength along different paths ensure that the

frequency and phase of the light beams remain consistent, leading to a stable interference pattern.

Moreover, this hypothesis—whether or not it corresponds to reality—demonstrates that the results of the Michelson-Morley experiment (and similar ones) cannot be used as definitive proof for the postulate of the constancy of the speed of light. These results do not provide a conclusive answer regarding the motion of the Earth through any medium, thus leaving open the question of whether such a medium exists or not.