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Rejection of the Theory of Ether: Vivekananda's Ratiocination Heralds Einstein's Formulation

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Abstract *- Rejection of the theory of ether is a natural consequence of the steady development of scientific thoughts conducted by scientists since1881. It is indeed true that the theory of ether was totally rejected only after the epoch-making discovery of the Special Theory of Relativity by Einstein in 1905. However, the ether theory was also rejected by Swami Vivekananda in 1895. But the same had gone unnoticed by the scientific community. After a gap of ten years, the theory was rejected by Einstein. The paper aims at unlocking the scientific insights hidden in the prognostication of Swami Vivekananda.*

Keywords – *Ether, Special Relativity, Michelson-Morley experiment, Metric space*

I. INTRODUCTION

The dominance of ether theory in the nineteenth century and its final rejection in the year 1905 with the discovery of the special theory of relativity constitute a significant episode in the history of science. Though the Michelson-Morley experiment, in 1887, was a major blow to the theory of absolute ether, the concept was not fully discarded by the scientific community until the wake of the special theory of relativity by Albert Einstein. Even Einstein himself was convinced with the theory of ether during his initial days of scientific pursuit.

Strikingly enough, Swami Vivekananda, the great Indian thinker, refuted the theory of ether convincingly strictly on the basis of scientific rationale. He asserted, in 1895, that the theory of a universal cosmic ether was inadequate in accounting for space itself. He wrote in his paper titled "The Ether":

"So far as it goes, then, the theory of a universal cosmic ether is the best at hand to explain the various phenomena of nature.'[1]

He further stated: "there must be space between two particles of ether, however small; and what fills this inter-ethereal space? If particles still finer, we require still more fine ethereal particles to fill up the vacuum between every two of them, and so on."[2] The study of his work reveals a profound scientific thought inherent within the projections of the great genius.

He rejected summarily the then existing theory of Ether in 1895 in no uncertain terms. The mathematical insight was inherent in the paper itself, which was not seriously attended by the contemporary scientists, and hence the discovery was delayed for another ten years until Albert Einstein, in 1905, quashed the theory propounding the special theory of relativity.

II. HISTORICAL PERSPECTIVE

The idea of ether was first introduced by Descartes in Principia Philosophiae in the year 1644. He described ether as a transparent, massless solid at complete rest. Later in the nineteenth century, the concept of ether became pertinent. The scientific rationale behind the conceptualization was as follows: As sound needs a medium to travel through with a constant relative speed with respect to the medium, similarly electromagnetic waves need a medium to propagate. Thus, the ether was assumed to be frictionless, weightless, transparent, chemically or physically undetectable, and literally permeating all matter and space and carries light and permeates the entire universe. The scientific perception of ether can be precisely put: 'The universe is, so to speak, immersed in ether.'[3]

The properties of ether can be summed up as follows:

1. Ether has the property of invisibility.
2. It is massless.
3. It fills all the space.
4. It is of high rigidity so that light can travel quickly through it.
5. It has no drag on objects moving through it.
6. It is a medium for the transmission of electromagnetic waves.

The theory of ether was formally rejected after the discovery of the theory of relativity by Albert Einstein in 1905. The predecessors of Einstein—Lorentz, and Poincare—laid down the foundational pillar of the theory of relativity. The two important papers by Lorentz on the electrodynamics of moving bodies that were authored in 1892 and 1895 are very significant in this context. His theory was based on the Newtonian paradigm of the absolute nature of space and time. His works were marked by the assumption of the entity called ether which was considered to be an inert material that pervades the space and also accounts for the space.

It is true that the existence of a hypothetical substance called ether was not universally accepted. The theory was challenged on the basis of the following questions:

a. How is the ether constructed from its elementary particles?[4]
b. How does it reveal itself in other phenomena?[5]

Assuming the existence of a universal frame of reference with respect to which the speed of light is independent of its direction of propagation, Michelson performed an experiment in the year 1881 at Potsdam which was intended to measure the motion of the earth through the ether. The experiment was repeated with higher accuracy in high altitude by Michelson and Morley in America. The main idea was to find out the relative speed of light in two different directions along with the other objective to answer the 'puzzling questions' faced by the protagonists of the ether theory.[6] It was anticipated during those days that light propagates relative to some sort of universal frame of reference.

To understand the earth's motion through ether, Michelson and Morley used a pair of light beams formed by a half-silvered mirror. One beam of light was directed to a mirror along the path parallel to the ether current, and the other was directed along a path perpendicular to it. Both the beams were allowed to end up on a single screen. The clear glass plate ensures that both the beams pass through air and glass of the same thickness. The beams are expected to arrive at the screen in phase and show constructive interference if the transit times remain the same. On the other hand, if the ether current due to the earth's motion was parallel to one of the beams, the same will cause the beams to have different transit times, and the result would be destructive interference at the viewscreen. Although the expected outcome of the experiment was an ether drift, the result was the opposite. No ether drift was detected.[7] The consequences of the negative result are as follows:

1. Ether does not exist at all.
2. All motion is relative to a specific frame of reference.
3. The speed of light is the same for all observers.

The consequences of Michelson and Morley have greatly impacted the world of physics. The result of the Michelson Morley experiment was a verdict of death to the theory of calm ether-sea through which matter moves.'

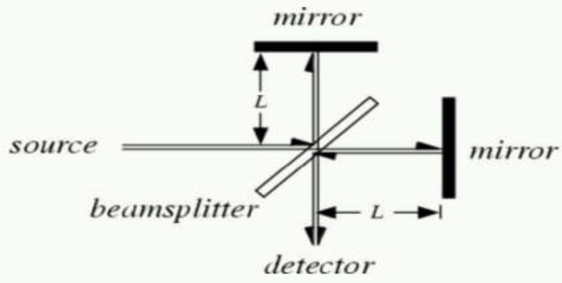

Diagram: Michelson Morley Experiment [8]

Lorentz attempted to introduce a hypothesis that would be able to explain all the predictions of the ether theory on the basis of the theory of relativity. He observed that it necessitated the assumption of a 'local time' which was different from the 'time' in the system of absolute ether. It was theorized that if the fundamental equations of the electron theory in a moving system of inertia were written in terms of local time and space variables, they would assume the same form in all inertial systems. The electromagnetic phenomena appeared to be independent of the state of motion of the system of reference. This new hypothesis was able to maintain the concept of ether for a short span of time. Einstein discovered in 1905 that the results of the Michelson-Morley Experiment shattered the concept of absolute ether. About the merit of this work, Max Planck writes:

'Einstein's work was a keystone to an arch which Lorentz, Poincare, and others had built and which was to carry the structure erected by Minkowski'.[9]

III. Swami Vivekananda's Rejection of the Ether Theory

A. Scientific Characterization of the Swami Vivekananda's proposition on the Rejection of the Prevalent Theory of Ether

In the year 1895, Swami Vivekananda summarily rejected the concept of Ether on the basis of strictly scientific rationale. He writes:

"there must be space between any two particles of Ether, however small, and what fills this inter- Ethereal space? If particles are still finer, we require still more fine Ethereal particles to fill up the vacuum between every two of them and so on. Thus, the theory of Ether, or material particles in space, though accounting for the phenomena in space, cannot account for space itself"[10]

The proposition of Swami Vivekananda may be technically summarized as follows:

a) Proposition: Ether, as composed of material particles in space, does not account for the space itself.

***b) Explanation*:** According to contemporary scientific views, ether is considered to be an elastic and material entity pervading matter and space. Since ether is made up of ethereal particles, there must be some space between any two ethereal particles. If it is considered that some finer ethereal particles fill the inter-ethereal space, then there must be some space, however small, between any two of these finer ethereal particles. The inter-ethereal space between any two of these finer particles must then be filled with finer particles. Now, there must be some element of space between any two of these finer particles. Thus, the smallest of two ethereal particles are always separated by an element of space, however small. Therefore, the ether as a material cannot fully account for the space.

***c) Analysis and Inference*:** The contemporary theory of ether, as a material entity accounting for the space, stands rejected.

The above idea may be mathematically illustrated in terms of metric:

A metric may be defined as the rule to measure the distance between any two elements of a non-empty set X.

Mathematically speaking, a metric on the set X is a function $d: X \times X \to [0, \infty)$ s.t the following conditions are satisfied $\forall\, x, y, z \in X$

(i) $d(x,y) \geq 0\,, \forall\, x, y \in X\ (nonnegativity\ property)$
(ii) $d(x,y) = 0 \Leftrightarrow x = y\ \forall\, x, y \in X$
(iii) $d(x,y) = d(y,x)\ \forall\, x, y \in X\ (symmetry\ property)$
(iv) $d(x,y) \leq d(x,z) + d(z,y)\ \forall\, x, y, z \in X\ (triangle\ inequality)$

Where X is a non-empty set, the ordered pair (X, d) is called a metric space.

If we take the set of real numbers as X, which means $X = R$ with $d(x,y) = |x - y|$, which is the absolute value of the difference (x-y) or the distance between any two randomly chosen real numbers, then

(i) $d(x,y) = |x - y| \geq 0\ \forall\, x, y \in R$
(ii) $|x - y| = 0 \Leftrightarrow x = y\ \ \forall\, x, y \in R$
(iii) $|x - y| = |y - x|\ \ \forall\, x, y \in R$
(iv) $|x - y| = |(x - z) + (z - y)| \leq |x - z| + |z - y|\ \forall\, x, y, z \in R$

Hence, $d(x,y) = |x - y|$ It is a metric, and so (R, d) is a metric space.

Now, let us take any two points x_1, y_1 in between x and y. Then, for $d(x_1, y_1) = |x_1 - y_1|$

(i) $|x_1 - y_1| \geq 0\ \forall\ x_1, y_1 \in R$
(ii) $|x_1 - y_1| = 0 \Leftrightarrow x_1 = y_1\ \ \forall\, x_1, y_1 \in R$
(iii) $|x_1 - y_1| = |y_1 - x_1|\ \ \forall\, x_1, y_1 \in R$
(iv) $|x_1 - y_1| = |(x_1 - z_1) + (z_1 - x_1)| \leq |x_1 - z_1| + |z_1 - x_1|\ \forall\, x_1, y_1, z_1 \in R$

This shows that $d(x_1, y_1)$ Also forms a metric.

Similarly, for another pair of points x_2, y_2 in between the points x_1 and y_1, the distance function $d(x_2, y_2) = |x_2 - y_2|$ Also satisfies the axioms of metric. Hence $d(x_2, y_2)$ Also forms a metric.

Proceeding this way, we can show that between any two points x and y (where $d(x,y)$ Forms a metric), there are infinitely many metrics. Now, if we keep proceeding this way, then after infinite times $d(x,y) > 0$, provided x , y are two distinct points. There is always a positive distance element between any two distinct points in space.

Let there be two ether particles. Let their position be given by P (x_1, x_2) and Q (y_1, y_2). Then the distance function is $(P, Q) = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2}$. Now,

(i) $(x_1 - y_1)^2 \geq 0,\ (x_2 - y_2)^2 \geq 0$

$$\Rightarrow (x_1 - y_1)^2 + (x_2 - y_2)^2 \geq 0$$

$$\Rightarrow \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2} \geq 0$$

$$\Rightarrow d(P, Q) \geq 0$$

(ii) $d(P, Q) = 0$ (whenever the particles are not distinct)

$$\Leftrightarrow \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2} = 0$$
$$\Leftrightarrow (x_1 - y_1)^2 + (x_2 - y_2)^2 = 0$$
$$\Leftrightarrow (x_1 - y_1)^2 = 0, (x_2 - y_2)^2 = 0$$
$$\Leftrightarrow x_1 = y_1, x_2 = y_2$$
$$\Leftrightarrow (x_1, x_2) = (y_1, y_2)$$
$$\Leftrightarrow P = Q$$

(iii) $d(P, Q) = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2} = \sqrt{(y_1 - x_1)^2 + (y_2 - x_2)^2} = d(Q, P)$

Let R (z_1, z_2) be the position of another ether particle. Then

$$d(P, Q) = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2}$$
$$= \{\textstyle\sum_{i=1}^{2}(x_i - y_i)^2\}^{\frac{1}{2}}$$
$$= \{\textstyle\sum_{i=1}^{2}(x_i - z_i + z_i - y_i)^2\}^{\frac{1}{2}}$$
$$\leq \{\textstyle\sum_{i=1}^{2}(x_i - z_i)^2\}^{\frac{1}{2}} + \{\textstyle\sum_{i=1}^{2}(z_i - y_i)^2\}^{\frac{1}{2}}$$ [by Minkowski's inequality]
$$= d(P, R) + d(R, Q)$$

Hence, $d(P, Q)$ Satisfies the axioms of metric. Hence the distance between any two distinct ether particles is always greater than zero. It proves that inter-ethereal space exists, which is not filled up by any ether particle. Therefore, ether cannot account for space, and hence the theory of ether is repudiated.

IV. CONCLUSION

Rejection of the theory of ether is a natural consequence of the steady development of scientific thoughts and rigorous experiments conducted by scientists since1881. It is indeed true that the theory of ether was totally abandoned only after the epoch-making discovery of the Special theory of relativity by Einstein in 1905. The article 'The Ether' by Swami Vivekananda was published in February 1895 in the journal 'The New York Medical Times' in the USA, in which he summarily rejected the prevailing theory of Ether based on strictly scientific rationale. Though his work has hardly been acknowledged in the annals of the history of science, yet it stands out as a landmark for its uniqueness to be the first theory of its kind, which can be considered to be the logical refutation of the theory of ether. Had the scientists taken a cue from the paper presented by Vivekananda, the mathematical insight hidden in it would have manifested in the form of a path-breaking theory, and the scientific world would have been far more enriched with the facilitation of the abandonment of a flawed theory a few years earlier to that of the invention of Albert Einstein.

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