

Ether and the Theory of Relativity

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Abstract

Ether and the Theory of Relativity was the title of an Address delivered on May 5th, 1920, in the University of Leyden by Albert Einstein [1]. The central point of the address was the need to retain some kind of physical ether. Einstein's new proposal would have been unthinkable some 15 years earlier when he wrote his famous paper on special relativity. In 1905 Einstein was the first to realize that physicists should abandon the fruitless and misleading concept of the ether. In essence, he accepted the fact that light propagates through vacuum, and that vacuum really is empty [2]. In this paper we consider the reasons given by Einstein that resulted in his change of mind about the existence of the ether. We also consider an open door left by him on the potential use of the ether in the new theories of elementary particles.

Starting with a historical account of the theory of ether on the physics of the 19th century Einstein got to the point where a series of contradictions and difficulties with the ether led him to deny its existence. But his experience dealing general relativity and his philosophy of natural phenomena led him to state at the address [1]: "More careful reflection teaches us, however, that the special theory of relativity does not compel us to deny ether." Later he adds: "We shall see later that this point of view is justified by the results of the general theory of relativity." He concluded that "To deny the ether is ultimately to assume that empty space has no physical qualities whatever."

"As to the part which the new ether is to play in the physics of the future we are not yet clear. We know that it determines the metrical relations in the space-time continuum...; but we do not know whether it has an essential share in the structure of the electrical elementary particles constituting matter." [1] Here we can see that Einstein realized a potential future for ether in the new physics of the 20th century. We may think that the discovery of a non-zero cosmological constant would have been what Einstein envisioned. Further analysis of his address reveals that this is not what he meant. For the non-zero cosmological constant is a quantum effect due to regular matter. Einstein's view of the physical ether was that it could not be related to regular matter since he supposed it was more fundamental than matter. His physical ether was a new physical object.

There is at least one theoretical and one experimental work that seems to require the existence of ether with some physical relevance not associated with regular matter. Bohm-de Broglie's theory of quantum mechanics proposes the existence of a wave with some sort physical relevance [3]. These waves are known as pilot waves since they direct the trajectory of physical particles. Work on this theory continues to develop but the

physical origin of the pilot wave is still a mystery [4]. More recently, a team reported experimental work that provides some evidence simultaneous particle and wave detection beyond the limits set by Bohr principle of Complementarity [5]. The outcome of this experimental work is evidence of some sort physical reality associated with quantum waves. We will elaborate on the reasons why these two works require the existence of ether with a physical reality not associated with regular matter.

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