Laser Experiments and Various Four-Dimensional Symmetries

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Received May 8, 1975

The structures of space and time associated with various four-dimensional symmetries are constructed and examined. It is interesting that some of these four-dimensional symmetries are compatible with the existence of an aether in the Einstein sense. There are two classes of infinitely many four-dimensional symmetries that cannot be ruled out by previous experiments. We discuss some laser experiments that test these two classes of four-dimensional symmetries. An interesting connection between the nonclassical aether and gravity through the equality of inertial and gravitational mass is explored.

1. INTRODUCTION

In the history of science, there has been an evolution of fundamental concepts of space and time. Knowledge of the nature of space and time cannot be obtained in an ivory tower but can be gained correctly only through practical observations and experiments. To an observer, space and time form a conceptual system with measurable quantities invented to express the coordinates of objects and events, and the relations between objects and between events. In the early period of science, direct observation of objects and events led naturally to the classical concepts of space and time, namely, both spatial length and time interval were considered to be absolute in the sense that they are not affected by the uniform motion of the rod, the clock, or the observer. The present-day view considers that both spatial length and time interval are not absolute but relative, as expounded in special relativity, which is supported by numerous experiments. Is this the final answer to the nature

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of space and time? In a previous paper, a careful analysis showed that those experiments supporting special relativity also support a new four-dimensional symmetry, in which the concept of time is universal but the light speed is not universal. In this framework, we can make a convention that the speed of light is isotropic in any arbitrary frame, say, the $f$ frame, and we may synchronize clocks in $f$ with light signals. Then we adjust each $f'$-frame clock to read the same time as its adjacent $f$-frame clock. Thus, we have a grid of clocks which read universal time, provided all these clocks have the same rate. The free mind, with the help of mathematical reasoning, is capable of inventing various world pictures. However, the question as to which of the pictures is the correct description of physical reality can only be ultimately answered by experiments.

In this paper, we consider two classes (class $C$ and class $T$) of the four-dimensional worlds. In class $C$, the world picture is characterized by a universal and absolute speed of light $c$, as in special relativity, and there are three universal and fundamental constants $\hbar$, $e$, and $c$. On the other hand, in class $T$ the world picture is characterized by a universal time. The new four-dimensional symmetry discussed in Ref. 1 is a simple example of such a world picture. There are only two universal and fundamental constants, $\hbar$ and $\bar{c}$, in world pictures of class $T$. In each class, there are infinite world pictures corresponding to each value of a real parameter $F$. The particular case $F = 0$ includes special relativity and the new four-dimensional symmetry discussed in Ref. 1. The cases $F \neq 0$ correspond to world pictures in which there is an absolute rest frame. Some laser experiments that test these four-dimensional symmetries are discussed.

There are four-dimensional symmetries that are consistent with a non-classical aether (or aether in Einstein's sense), which does not possess any classical mechanical properties. Einstein once thought that the existence of such an aether was a conceptual necessity for understanding gravitational phenomena. This line of thought has not been explored very far, due to the absence of a specific theory. Now, based on the equality of inertial and gravitational mass and the properties of space contraction and time dilation in a general four-dimensional framework, we discuss an interesting possible connection between nonclassical aether and gravity. The results of such a theory are identical to Einstein's theory of gravity for weak gravitational potential $\phi$ and hence are consistent with the present experiments. This theory is basically different from Einstein's theory in the physical origin (or basic field) that determines the metric tensors and describes the gravitational phenomena. Yet the geometrical properties of space in this theory are not fixed but determined by physical phenomena, just like Einstein's theory.

Equations (25)-(27) in this paper must be understood as the Doppler shift of the radar pulse frequency. (See also Ref. 10.)