Article

Definitions, Working Hypothesis & Operational Method

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ABSTRACT

Definitions, working hypothesis & operational method are described here. This will allow us to obtain later time-dependent coordinate transformations that are complementary to those already known as spatial translations and rotations.

Key Words: time-dependent, coordinate transformation, complementay, working hypothesis, coordinate system, reference frame, operational method.

2. DEFINITION OF THE COMPLEMENTARY TIME-DEPENDENT COORDINATE TRANSFORMATIONS

We here obtain time-dependent coordinate transformations that are complementary to those already known as spatial translations and rotations. We name the new coordinate transformations 'complementary time-dependent coordinate transformations'. The complementary time-dependent coordinate transformations are derived by projecting onto coordinate axes the radius vectors of geometrical points in inertial spaces (defined in 1.2 below) when traced by physical signals. Such radius vectors change systematically over time, in both direction and magnitude relative to inertial observers. Their tracing with physical signals just determines their direction and magnitude relative to an inertial observers at the moment of their projection.

3. WORKING HYPOTHESES

Any physical theory is founded on principles, working hypotheses and a working method. The working hypotheses in developing special relativity theory were i) the removal of the concepts of absolute rest, absolute motion (absolute speed) and absolute time (by requiring that all inertial, identical clocks to run at rates depending on their speeds) and ii) the change in length of the meter-sticks in uniform rectilinear motion.

Hypotheses i) were consequences of the attempts to determine experimentally the absolute speed of light with respect to an unmovable physical substratum, according to the Newtonian definition of speed, and the lack of experimental proof for such a substratum in empty space. The lack of search for alternative ways to determine experimentally absolute speeds, and the lack of natural support for identical inertial clocks to run at different rates and inertial meter-sticks to change their length in terms of their speeds make these hypotheses suspect of arbitrariness.

Our working hypotheses to deduce the complementary time-dependent coordinate transformations are i) the concepts of absolute rest, absolute motion (absolute speed) and absolute time (all inertial, identical clocks running at the same rate, no matter of their speed) and ii) the same length of the meter-sticks, no matter of their speed. They are evidently the opposite of Einstein's hypotheses. We

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use the Newtonian definition of absolute speed with respect to a physical substratum only when a distance is measured with a meter-stick in permanent touch with a physical substratum. Whenever these distances identify with paths of physical signals, the absolute speeds are determined in terms of travel times. So there is no need to identify a physical substratum at absolute rest and discard, by way of consequence, the concepts of absolute rest, absolute motion and absolute speed.

These 'Newtonian' working hypotheses are validated by obtaining the standard Lorentz transformation as a 'complementary time-dependent coordinate transformation (Ch. 9). They are also validated in Einstein's special relativity theory by that our derivation of the standard Lorentz transformation discloses (Ch. 14) the physical grounds of his unmotivated manipulations of equations that led to the Lorentz transformation in [1].

4. COORDINATE SYSTEMS AND REFERENCE FRAMES

The concepts of coordinate system and reference frame are often used in the literature with identical meaning. It is ignored with nonchalance the different nature of the two. The nonchalance is not so disinterested. Playing with the two concepts, false results are maintained in physics, altering substantially its development. It is the case of the reference frame at absolute rest and of the coordinate systems at absolute rest. The removal of the first from physics involved wrongly the removal of the last, distorting the development of special relativity theory and other theories in modern physics.

4.1. Cartesian coordinate systems

Cartesian coordinate systems are assemblies of three straight lines orthogonally crossing at a point - the origin. Cartesian coordinate systems are essential in deducing the complementary time-dependent coordinate transformations, so a better understanding of modern physics. It is for this reason that we consider them further in connection with reference frames, space (Newtonian space, Euclidian space, empty space) and inertial ("stationary" [1]) spaces. The 'abstract' coordinate systems (defined in 1.1 below) at absolute rest, which we associate to the inertial coordinate systems, will prove to be of particular importance.

4.1.1. Cartesian coordinate systems and reference frames

Reference frames are assemblies of four physical bodies fixed relative to each other. The bodies of the inertial ("stationary") reference frames move uniformly and rectilinearly as a whole. By the positions of three of these bodies with respect to the fourth one -the origin- are determined the axes of the Cartesian coordinate systems[1]. Inertial ("stationary") coordinate systems are Cartesian coordinate systems in uniform rectilinear motion. 'Abstract' coordinate systems are coordinate systems which axes are not determined by the bodies of the reference frames. Aimed by no motion at all, the 'abstract' coordinate systems at absolute rest[2] do not presume the existence in Nature of a reference frame at absolute rest. Unlike the general 'belief', the abstract coordinate systems at absolute rest will be seen further in this book to play a major role in correctly understanding special relativity theory, so modern physics.

4.1.2. Cartesian coordinate systems, space (Newtonian space, Euclidian space, empty space) & inertial ("stationary") spaces

[1] Einstein's designation of the reference frames and coordinate systems by the same definition [5] was misleading because did not allow conceiving the 'abstract' coordinate systems (defined below in this Section).
[2] Einstein's designation of the reference frames and coordinate systems by the same definition [5] was misleading because did not allow conceiving the 'abstract' coordinate systems (defined below).

Space (Newtonian space, Euclidian space, empty space) is the three-dimensional assembly of geometrical points endowed with no motion at all. Inertial ("stationary") space is an assembly of geometrical points at rest with respect to each other, aimed by uniform rectilinear motion as a whole. As all the geometrical points of a coordinate system are those of their axes, the Cartesian coordinate systems are embedded, respectively, in space and inertial spaces.

5. OPERATIONAL METHOD

Our working method consists in tracing radius vectors of geometrical points in inertial spaces with physical signals. It involves experimental procedures for measuring travel times. It is for this reason an operational method. The source of the physical signals is attached to the origin of the observer's coordinate system. The source's emission is isotropic. It takes place when the observer's coordinate system coincides with a coordinate system at rest in the inertial space to which the geometrical points belong: Only one of the emitted signals will reach a point of this space. The origin of this signal is designated by a point in empty space, and the origins of the two coordinate systems are designated by points in the inertial spaces to which they belong. The first is a point at absolute rest, while the latter two are points aimed with uniform rectilinear motions. The three origins, and the geometrical point the radius of which was traced by signal, are joined together by a mathematical relationship which, in reduced form, associates abstract coordinate systems at absolute rest with the two inertial coordinate systems.