Revised Robertson's Test Theory of Special Relativity: Space-Time Structure and Dynamics

José G. Vargas\textsuperscript{1,2} and Douglas G. Torr\textsuperscript{1,2}

Received April 14, 1986

The experimental testing of the Lorentz transformations is based on a family of sets of coordinate transformations that do not comply in general with the principle of equivalence of the inertial frames. The Lorentz and Galilean sets of transformations are the only member sets of the family that satisfy this principle. In the neighborhood of regular points of space-time, all members in the family are assumed to comply with local homogeneity of space-time and isotropy of space in at least one free-falling elevator, to be denoted as Robertson's ab initio rest frame \cite{Robertson}.

Without any further assumptions, it is shown that Robertson's rest frame becomes a preferred frame for all member sets of the Robertson family except for, again, Galilean and Einstein's relativities. If one now assumes the validity of Maxwell–Lorentz electrodynamics in the preferred frame, a different electrodynamics spontaneously emerges for each set of transformations. The flat space-time of relativity retains its relevance, which permits an obvious generalization, in a Robertson context, of Dirac's theory of the electron and Einstein's gravitation. The family of theories thus obtained constitutes a covering theory of relativistic physics.

A technique is developed to move back and forth between Einstein's relativity and the different members of the family of theories. It permits great simplifications in the analysis of relativistic experiments with relevant "Robertson's subfamilies." It is shown how to adapt the Clifford algebra version of standard physics for use with the covering theory and, in particular, with the covering Dirac theory.
1. INTRODUCTION

A covering theory of relativistic physics means here a relevant family of physical theories which contains relativistic physics as one particular member. The relevance of this generalization has to do with its potential to improve the testing of the Lorentz transformations (LTs). The kinematical part of the covering theory has been given elsewhere,\(^{1}\) as an improvement on Robertson's original test theory.\(^{2}\)

In the process of constructing the covering classical electrodynamics, relativistic space-time emerges naturally. The extension of the covering theory to the realm of Dirac and relativistic gravitation theories becomes obvious, at least formally, once one has adopted appropriate space-time languages. The leading equations of each member theory are then nothing but representations in specific sets of axes of the leading coordinate-free equations of the family. The covering theory thus constructed provides a natural way with which to analyze the involved experiments which test the LTs.

Let us now give some remarks related to notation. This paper constructs upon certain ideas first developed by Robertson.\(^{2}\) A basic concept in both Robertson's and the present work is that of an *ab initio* rest frame \(S\). Each velocity \(V\) with respect to \(S\) will define a reference frame. It can be materialized by a sufficiently rigid body and by ticking clocks. Within the same reference frame, we can have different sets of spatial orthogonal axes, i.e., *spatial coordinate systems*, which will be related by rotations and translations. These coordinate systems, together with the ticking clocks, induce *coordinate systems in space-time* (one and only one for any given \(V\) and any given member theory). We shall use the symbol \(S\) to denote indistinguishably the rest frame or any of its associated spatial and space-time coordinate systems (we shall normally be referring to the four-dimensional systems). Similar licenses will occur when referring to the frame \(S'\) of velocity \(V\) and its associated coordinate systems. The context will remove any potential ambiguities. In the case of \(S'\), the context will also specify whether the four-dimensional coordinate systems are the general ones of the covering theory, or those of SR, or those of any other member theory of the family.

2. KINEMATICS

2.1. Robertson's *Ab Initio* Rest Frame

Free-falling elevators at regular points of space-time can be considered as local homogeneous frames of reference. Following Robertson, we assume