PREFACE

Einstein's theory of special relativity as the first flat space–time theory has altered our concepts of space and time, and been supported directly by a variety of experiments and its successful applications to modern physics. Einstein's theory and quantum mechanics have already been the main bases of modern physics.

The key point in Einstein's theory is the postulate concerning the constancy of the (one-way) velocity of light, which contradicts the classical (nonrelativistic) addition law of velocities. This postulate is needed only for constructing well-defined inertial frames of reference or, in other words, only for synchronizing clocks (i.e., defining simultaneity). It is not possible to test the one-way velocity of light because another independent method of clock synchronization has not yet been found.

However, some different flat space–time theories, such as Edwards', Robertson's, and Mansouri–Sexl's (MS') test theories, can be found in the literature although corresponding dynamical theories have not yet been constructed. Only a few authors paid their attention to Edwards' and Robertson's theories while many authors incorrectly claimed that comparison between MS' theory and an experiment would give a test of the one-way speed of light. For this reason, many pages of this book are used to discuss different definitions of simultaneity and their implications.

The book shows that the main differences between these test theories and Einstein's special relativity are nothing but different definitions of simultaneity. In other words, they involve different postulates concerning the velocity of light. Relationships among these flat space–time theories can be summarized as follows: (a) Edwards' and MS' theories are physically, respectively, equivalent to Einstein's and Robertson's theories (see Secs. 6.5 and 7.4 for kinematics, and see Secs. 6.6 and 7.4.6 for dynamics). This means that the one-way velocity of light is not observable because any independent method of clock synchronization other than that by use of a light signal has not yet been developed; (b) Robertson's theory is physically not equivalent to Einstein's theory, so that it may be really regarded as a test theory of special relativity; (c) MS' theory is a generalization of Robertson's theory just as Edwards' theory is a generalization of Einstein's theory. We see, therefore, that MS' theory is a trivial theory in both physics and mathematics because we have known Edwards' and Robertson's theories.

In the remainder of the book we introduce the performed experiments which are regarded as the tests of special relativity. For simplicity, most of them are compared with Einstein's theory, while only a few of them are used to compare with the test theories. Of course, one could use the experiments to yield limits on the parameters in Robertson's transformations but not on the directional parameter q in Edwards' and MS' theories.

As mentioned above, corresponding dynamical theories have not yet been constructed. However, if we assume that for all physical events the four-dimensional space–time intervals defined in Secs. 6.4, 7.2.3, and 7.4.5 is invariant, the above relation (a) would be valid too for dynamic phenomena. We can say, therefore, that only Robertson's dynamics is needed to be constructed.

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