THE PRINCIPLE OF RELATIVITY WITH APPLICATIONS TO PHYSICAL SCIENCE

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TO MY WIFE
WHOSE ENCOURAGEMENT AND COUNSEL
HAVE MADE MY LIFE'S WORK POSSIBLE

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PREFACE

THE present work is an exposition of an alternative rendering of the theory of relativity. It takes its rise from that 'awakening from dogmatic slumber'—to use Kant's phrase—which we owe to Einstein and Minkowski. But it is not an attempt to expound either Einstein's earlier or his later theory. The metrical formulae finally arrived at are those of the earlier theory, but the meanings ascribed to the algebraic symbols are entirely different. As the result of a consideration of the character of our knowledge in general, and of our knowledge of nature in particular, undertaken in Part I of this book and in my two previous works* on this subject, I deduce that our experience requires and exhibits a basis of uniformity, and that in the case of nature this basis exhibits itself as the uniformity of spatio-temporal relations. This conclusion entirely cuts away the casual heterogeneity of these relations which is the essential of Einstein's later theory. It is this uniformity which is essential to my outlook, and not the Euclidean geometry which I adopt as lending itself to the simplest exposition of the facts of nature. I should be very willing to believe that each permanent space is either uniformly elliptic or uniformly hyperbolic, if any observations are more simply explained by such a hypothesis.

It is inherent in my theory to maintain the old division between physics and geometry. Physics is the

* *The Principles of Natural Knowledge*, and *The Concept of Nature*, both Cambridge Univ. Press.

science of the contingent relations of nature and geometry expresses its uniform relatedness.

The book is divided into three parts. Part I is concerned with general principles and may roughly be described as mainly philosophical in character. Part II is devoted to the physical applications and deals with the particular results deducible from the formulae assumed for the gravitational and electromagnetic fields. In relation to the spectral lines these formulae would require a 'limb effect' and a duplication or a triplication of individual lines, analogous to phenomena already observed. Part III is an exposition of the elementary theory of tensors. This Part has been added for one reason because it may be useful to many mathematicians who may be puzzled by some of the formulae and procedures of Part II. But this Part is also required by another reason. The theory of tensors is usually expounded under the guise of geometrical metaphors which entirely mask the type of application which I give to it in this work. For example, the whole idea of any 'fundamental tensor' is foreign to my purpose and impedes the comprehension of my applications.

The order in which the parts should be studied will depend upon the psychology of the reader. I have placed them in the order natural to my own mind, namely, general principles, particular applications, and finally the general exposition of the mathematical theory of which special examples have occurred in the discussion of the applications. But a physicist may prefer to start with Part II, referring back to a few formulae which have been mentioned at the end of Part I, and a mathematician may start with Part III. The whole evidence requires a consideration of the three Parts.

Practically the whole of the book has been delivered in the form of lectures either in America at the College of Bryn Mawr, or before the Royal Society of Edinburgh, or to my pupils in the Imperial College. I have carefully preserved the lecture form and also some reduplication of statement, particularly in Part I.

The exposition of a novel idea which has many reactions upon diverse current modes of thought is a difficult business. The most successful example in the history of science is, I think, Galileo's 'Dialogues on the Two Systems of the World.' An examination of that masterly work will show that the dialogue form is an essential element to its excellence. It allows the main expositor of the dialogues continually to restate his ideas in reference to diverse trains of thought suggested by the other interlocutors. Now the process of understanding new conceptions is essentially the process of laying the new ideas alongside of our pre-existing trains of thought. Accordingly for an author of adequate literary ability the dialogue is the natural literary form for the prolonged explanation of a tangled subject. The custom of modern presentations of science, and my own diffidence of success in the art of managing a dialogue, have led me to adopt the modified form of lectures in which the audiences—real audiences, either in America, Edinburgh or South Kensington—are to be regarded as silent interlocutors demanding explanations of the various aspects of the theory.

Chapter II was originally delivered* in Edinburgh as a lecture to the Royal Society of Edinburgh when it did me the honour of making me the first recipient of the 'James-Scott Prize' for the encouragement of the

* June 5, 1922.