AN ENQUIRY CONCERNING THE PRINCIPLES OF NATURAL KNOWLEDGE

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BY

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"PHILONOUS. *I am not for imposing any sense on your words: you are at liberty to explain them as you please. Only, I beseech you, make me understand something by them.*"

BERKELEY,
The First Dialogue between
Hylas and Philonous.

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1919

TO

ERIC ALFRED WHITEHEAD

ROYAL FLYING CORPS

November 27, 1898 to March 13, 1918

Killed in action over the Forêt de Gobain giving himself that the city of his vision may not perish.

The music of his life was without discord, perfect in its beauty.

PREFACE

THERE are three main streams of thought which are relevant to the theme of this enquiry; they may, with sufficient accuracy, be termed the scientific, the mathematical, and the philosophical movements.

Modern speculative physics with its revolutionary theories concerning the natures of matter and of electricity has made urgent the question, What are the ultimate data of science? It is in accordance with the nature of things that mankind should find itself acting and should then proceed to discuss the rationale of its activities. Thus the creation of science precedes the analysis of its data and can even be accompanied by the acceptance of faulty analyses, though such errors end by warping scientific imagination.

The contributions of mathematics to natural science consist in the elaboration of the general art of deductive reasoning, the theory of quantitative measurement by the use of number, the theory of serial order, of geometry, of the exact measurement of time, and of rates of change. The critical studies of the nineteenth century and after have thrown light on the nature of mathematics and in particular on the foundations of geometry. We now know many alternative sets of axioms from which geometry can be deduced by the strictest deductive reasoning. But these investigations concern geometry as an abstract science deduced from hypothetical premisses. In this enquiry we are concerned with geometry as a physical science. How is space rooted in experience?

The modern theory of relativity has opened the possibility of a new answer to this question. The successive labours of Larmor, Lorentz, Einstein, and Minkovski have opened a new world of thought as to the relations of space and time to the ultimate data of perceptual knowledge. The present work is largely concerned with providing a physical basis for the more modern views which have thus emerged. The whole investigation is based on the principle that the scientific concepts of space and time are the first outcome of the simplest generalisations from experience, and that they are not to be looked for at the tail end of a welter of differential equations. This position does not mean that Einstein's recent theory of general relativity and of gravitation is to be rejected. The divergence is purely a question of interpretation. Our time and space measurements may in practice result in elaborate combinations of the primary methods of measurement which are explained in this work. For example, the theory of gravitational matter may involve the theory of 'vagrant solids' which is pointed out as a subject for investigation in article 39, but not developed. It has certainly resulted from Einstein's investigations that a modification of the gravitational law, of an order of magnitude which is v^2/c^2 of the main effect [v being the velocity of the matter and c that of light], will account for the more striking outstanding difficulties otherwise unexplained by the law of gravitation. This is a remarkable discovery for which the utmost credit is due to the author. Now that the fact is known, it is easy to see that it is the sort of modification which on the simple electromagnetic theory of relativity is likely to be required for this law. I have however been anxious to disentangle the consideration of the main positions of this enquiry from theories designed to explain special laws of nature.

Also at the date of writing the evidence for some of the consequences of Einstein's theory is ambiguous and even adverse. In connection with the theory of relativity I have received suggestive stimulus from Dr L. Silberstein's *Theory of Relativity*, and from an important Memoir* by Profs. E. B. Wilson and G. N. Lewis.

The discussion of the deduction of scientific concepts from the simplest elements of our perceptual knowledge at once brings us to philosophical theory. Berkeley, Hume, Kant, Mill, Huxley, Bertrand Russell and Bergson, among others, have initiated and sustained relevant discussions. But this enquiry is touched by only one side of the philosophical debate. We are concerned only with Nature, that is, with the object of perceptual knowledge, and not with the synthesis of the knower with the known. This distinction is exactly that which separates natural philosophy from metaphysics. Accordingly none of our perplexities as to Nature will be solved by having recourse to the consideration that there is a mind knowing it. Our theme is the coherence of the known, and the perplexity which we are unravelling is as to what it is that is known. In matters philosophic the obligations of an author to others usually arise from schools of debate rather than from schools of agreement. Also such schools are the more important in proportion as assertion and retort do not have to wait for the infrequent opportunities of formal publication, hampered by the formidable permanence of the printed word. At the present moment England is fortunate in this respect. London, Oxford and Cambridge are within easy reach of each other, and

* 'The Space-Time Manifold of Relativity.' *Proc. of the Amer. Acad. of Arts and Sciences*, vol. XLVIII, 1912.