THE RUDIMENTS OF RELATIVITY

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Lectures delivered under the auspices of the University College, Johannesburg, Scientific Society.

BY

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PREFACE

The following pages contain four lectures which were prepared as a Presidential address to the Scientific Society of this College. Although their preparation entailed a considerable amount of labour I regarded it as a normal incident of academic life, and had no intention of publishing my views. Many of my colleagues, hearing of the topic proposed for discussion, expressed a desire to be present, and the Council of the Scientific Society accordingly decided to throw the lectures open to the public. The response to that invitation was astonishing and stimulating; it showed that even in what is regarded (quite unjustly, I think) as a very frivolous and material centre there is a widespread desire for intellectual stimulus. Various members of that audience have asked me to publish my lectures; I therefore print them now substantially as delivered, although I should have preferred a less crude and incomplete form of presentation.

It will be borne in mind, I trust, that I was primarily addressing students whose scientific knowledge and reading could hardly be called extensive; it was therefore essential that I should divest the theory of its customary mathematical elegance, and present instead its physical basis and implications. The result is an absence of

precision that is hardly commendable, but perhaps the attempt at definite physical interpretation will afford a suitable introduction to a mathematical treatment.

I must express my cordial thanks to the Council of Education, Witwatersrand, for undertaking the publication of these lectures. It is largely owing to their consistent zeal and financial support that education in the Transvaal is at present so highly developed, and the fact that their activities, as in the present instance, are by no means confined to utilitarian purposes is of happy augury for the future intellectual life of the community.

JOHN P. DALTON.

Johannesburg, August 1st, 1921.

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"*In creative thought common sense is a bad master.*"

A. N. WHITEHEAD.—Introduction to Mathematics.

FIRST LECTURE.

THE BACKGROUND.

SECTION 1.—TIME-ORDER.

The object of the investigation of natural phenomena, which is the purpose of Natural Philosophy, is the introduction of order into the apparently chaotic appearances of Nature. In accomplishing this, reliance is placed upon two fundamental *a priori* relations of order. The first of these relational processes is an immediate application of the serial order involved in the idea expressed by the words "before" and "after." Of two events, A and B, which present themselves to my consciousness, I can generally state that A either precedes or succeeds B. To avoid complications, I consider only events of sufficiently short duration; otherwise there might be overlapping, and it would then be possible for event A to both precede and succeed event B. If, for example, event A were my addressing you to-night, and event B were the passage of the hands of the clock across the position usually read as 9 o'clock, then A would both precede and succeed B. We shall exclude such overlapping, and imagine that we are dealing with events of such short duration that we can relate them in definite serial order. This intuitive seriation yields us a time order in which the conscious mind can arrange its experiences.

The process is not so simple as I seem to indicate. Without the intervention of Memory the time ordering relation could not operate; the present would vanish from consciousness instantaneously; no temporal seriation of events would be possible. I just take the relation as an

acknowledged primal intuitional process, however complex it may be psychologically, and make no further attempt to analyse it.

The fact that time-order is intuitional leads to difficulties. Since it is intuitional, it is necessarily individual. There is then no guarantee that a sequence of events *a*, *b*, *c*, will present themselves in the same order to two distinct individuals. Consider, say, the discharge of a gun and the subsequent burst of the shell. A man near the target will hear the burst of the shell before he hears the report of the discharge. A man near the gun will hear the discharge before he hears the burst. And, moreover, there will be a line of positions between the gun and the target, such that to observers stationed there, discharge and burst would appear simultaneous. How then are we to account for these differences in the observed sequence of events? It would hardly be satisfactory to postulate vital differences in the mental structure of the individuals concerned, for then no coherent description of our common experiences would be possible. We must assume that the time-relational processes of the observers are identical, and that the apparent discrepancies of time-sequence originate in the circumstances of propagation. In this example we harmonize the different descriptions by ascribing finite velocities of travel through the air to the shell and to the sound, that of the shell being the higher.

Let us now consider an observer who is so placed that he hears discharge and burst simultaneously. The sounds are carried by the air. If there is no wind his position will be somewhere on a line at right angles to the join of gun and target, somewhat nearer the target, because the report of the discharge gets a start on that of the burst on account of the finite velocity of the shell. If a wind now blows across the field from the gun to the