

abstract details of his own investigations within the reach of the non-scientific reader.

When a difficult task has been undertaken with such conspicuous success it is unfortunate that attention must be drawn to some features in which this book is open to criticism, but the fact that the problems discussed are of the highest importance and must of necessity appeal to many whose acquaintance with the experimental and natural sciences is but slight, makes it necessary to refer to some points which require modification. Thus the statements made on pages 29 and 30 regarding our present knowledge of the chemistry of protoplasm and metabolism, will not find many supporters even among the most optimistic biochemists. It is unfortunate that such confident claims should be made as they are unnecessary for the argument. It is also in many ways misleading to emphasise the inert nature of water in view of the present position of the ionic hypothesis and the views now held regarding catalysis. To turn to details, which are no less important, it may be pointed out that the expression "ammonia" is used repeatedly where *liquefied ammonia* is meant and the distinction between *water* and *sea-water* is occasionally by no means clear. Further, the arrangement of the constitutional formulæ of organic compounds leaves much to be desired, as in certain cases the sign of equality in an equation may be readily mistaken for a double bond (pp. 233, 234).

These details will, of course, present no obstacles to the trained chemist, nor will an unfortunate mistake in the formula for glycerophosphoric acid, but to other readers, struggling with the intricacies of graphic formulæ, they must be perplexing in the extreme.

It is only a sincere admiration for the way in which Prof. Henderson has carried out his task which tempts me to express the hope that the work may, in the near future, be expanded so as to include more examples of fitness and to introduce in greater detail the subjects of catalysis, osmosis, the colloidal state, and the effect of pressure in regulating the environment. A recent article by Dr. E. F. Armstrong indicates another direction in which the theory of adaptation and fitness may be profitably extended to include the action of enzymes.

It is no unimportant fact that Prof. Henderson's book is in part a reprint of lectures delivered by him in the Lowell Institute. Lecture courses of this description cannot fail to develop that breadth of view so often lacking in the young student of science, and the scheme might with advantage be copied in our own Universities.

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*A Theory of Time and Space.* By ALFRED A. ROBB. Cambridge: W. Heffer & Sons, Ltd. Pp. 16.

This extremely interesting pamphlet contains a short account of the method by which the author proposes in a forthcoming work to deal with certain paradoxes about time which appear in the Theory of Relativity in Electrodynamics. Mr. Robb has already dealt with the kinematical and geometrical formulæ of the theory from a new point of view in a little book called *The Optical Geometry of Motion*, published some two years ago; but the present pamphlet is of more philosophic interest.

The difficulties (or at any rate paradoxes) to be met are of the following kinds: "If two observers whose measuring instruments and clocks agree with each other when they are relatively at rest subsequently are in unaccelerated motion relative to each other and determine the velocity of light from any source common to both they will find the same value

for it. This fact can be shown to involve (among many other interesting consequences) that their measuring rods can no longer have the ratio 1 when used for measuring lengths in the direction of relative motion, and that their clocks can no longer be going at the same rate. The result is that two events which are contemporary as judged by the clocks of one system are not so as judged by those of the other. But if motion be purely relative it seems that we have no right to call the readings from one system '*the time*' rather than those from the other. Thus we seem to get the paradox that two events are both simultaneous and successive.

It is with this paradox that the author attempts to deal. His solution is to argue that the relation of before and after between moments is not connexive. We commonly assume that if A and B are moments of time, and A is neither before nor after B, the A and B must be identical (i.e. events at A and B are simultaneous). But this does not logically follow from the other properties of the relation. The author illustrates the independence of connexivity by considering the relations of points within and without a series of cones. He then adds that it is only of events that happen in the same point of space that we can say that if they are not successive they must be simultaneous.

A is before B if and only if it be possible for a cause acting at the moment A to have an effect at the moment B. 'B is before A' is defined in a like manner. A and B are neither before nor after each other if a cause acting at A can produce no effect at B and *vice versa*. Suppose now it is true that no disturbance travels faster than light and that a flash sent from P at A reaches Q at B, at being immediately reflected returns to P at C. No disturbance that left P after A could reach Q at B. Hence no moment at P after A can be before B. Similarly no moment at P before C can be after B. Hence no moment at P between A and C is either before or after B. So if we take this definition of before and after and accept the view that no disturbance can travel faster than light we see that we must either accept Mr. Robb's view that 'before' is not connexive or else assert that all moments between A and C are identical with B. Since the latter is impossible we must either reject Mr. Robb's definition of before and after, or the view that no disturbance travels faster than light (and this will not help us in the end if all disturbances travel with some *finite* velocity however large), or the view that 'before' is connexive. For my own part I see no very good reason to accept the definition of before and after. It is certainly not a definition in the sense that it states what we mean by before and after, for these notions are independent of causation. Hence I cannot see that we have more than a useful criterion which will not be convertible. Nevertheless it is quite worthwhile to work out the suggestion because of what it implies. If again Mr. Robb's method were the only way of avoiding intolerable paradoxes it might perhaps be accepted as involving the minimum of mental disturbance. But I am pretty certain that the paradoxical nature of the results of the theory of relativity arises merely from confusing lengths and times with the values of them at which we arrive by the only practical methods of measurement.

Mr. Robb proposes to build up a whole system of geometry on the notions of before and after as defined by him. He states that he has already carried his researches some considerable distance, and he gives a set of axioms and some results at which he has arrived. There is enough in this pamphlet and the earlier one to make us look forward with great eagerness to the appearance of Mr. Robb's complete work.

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