The Understanding of Relativity.

SIR ARCHDALL REID's difficulty (NATURE, Nov. 24, p. 808) would probably be eased, if not altogether met, by the "Introduction" of Eddington's "Mathematical Theory of Relativity," more particularly the last paragraph on p. 5.

The difficulty seems to arise from the confusion of two distinct things, an object and its measure, it being mistakenly supposed that the measure of a thing is an absolute property of it and independent of the person who measures it and of his circumstances.

The actual fact is that relativity is not concerned with things in themselves objectively considered, but with their measures, and a measure, whether of an interval of time or of length or anything else, is as much a property of the measurer—or of his instruments, which are merely extensions of himself—as it is of the thing measured, regarded objectively. A measure therefore may be expected to vary with the circumstances of the observer, amongst others, his state of relative rest or motion. It would, in fact, be strange if it did not.

Bearing this distinction in mind, there is nothing incredible in lengths, times, masses, or any other physical quantities measuring up differently according to the state of rest or motion of the system in which they occur, relative to an observer in another system. No experience is contradicted. In fact, the opposite supposition contradicts the known facts of the electromagnetic field, and it is a matter of observation that the mass of an electron changes with its velocity; and if masses, why not times? The question is not whether or not two watches tick together regarded as a purely objective occurrence, but whether one man observes the other man's watch to tick with his own.

Regarding the main question, the understanding of relativity, I would submit that one of the reasons for the comparative failure of so many expositors to make themselves understood has been an injudicious choice of a line of approach to the subject. Of all lines of approach there is none, as I am persuaded, equal to Einstein's own, at least for elementary purposes. It is a matter of much surprise that more writers have not adopted Einstein's definitions of the special and general principles of relativity and developed the subject along the line which these definitions clearly indicate.

Einstein's book suffers from obscurity in many places, but it has the supreme merit of providing a string about which the subject can candy. No doubt the difficulty in crediting the unfamiliar conclusions of relativity must take its share in this failure, but before laying so much blame upon it I respectfully suggest that Einstein's method of approach be tried more widely. I speak from experience, for I have tried this method to the exclusion of all others, and I certainly have no reason to complain of failure, if I may judge from press notices and private correspondence. My first application of this method,—very successful, as attaining its main object, and within its limitations, which were severe,—was public talk some eight or nine years ago, though perhaps the incident has now been forgotten.

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[THE modest remark made by Mr. Bolton in the concluding sentence of his letter refers, we expect, to the fact that in 1921 he was awarded the prize of about £1300 offered by the *Scientific American* for the clearest explanation of relativity for general readers.—ED. NATURE.]

The Thermal Expansion of Mercury.

IN a recently published book on "Heat and Thermodynamics," by Dr. J. K. Roberts, reference is made on pages 202 and 203 to my work on the thermal expension of mercury. Comparison is made in a table between my results obtained by the silica weight thermometer method and those published by Callendar and Moss which were obtained by the Callendar-Regnault absolute method. The author of the book referred to makes the following comment:

> Until the very considerable differences between the values at low temperatures obtained by Callendar and Moss and those obtained using weight thermometers are explained, this table must be taken as representing all that is known about the coefficient of absolute expansion of mercury. The position is obviously unsatisfactory.

It does not appear to be generally known that in a publication (*Trav. et Mém. Int. Bur. des Poids et Mes.*, 1917) there are recorded further observations on the thermal expansion of mercury for the range 0° to 100° C. carried out by Chappuis by the Callendar-Regnault method. These observations agree well with those obtained with the silica weight thermometer, as the following table shows:

COEFFICIENT OF ABSOLUTE EXPANSION OF MERCURY × 10^8.

Temperature Range. 0° to t°.	Harlow, 1914. (By Silica Weight Thermometer.)	Harlow, Revised Values to be Published Shortly.	Chappuis, Weight Thermometer of Verre Dur.	Chappuis, 1917. (By Absolute Method.)
0- 30°	18,168	18,175	18,171	18,189
0- 50°	18,188	18,192	18,183	18,206
0- 75°	18,213	18,216	18,211	18,227
0-100°	18,244	18,248	18,254	18,248

A further paper on this subject has been prepared for publication, in which later and more extensive observations on the thermal expansion of vitreous silica are applied to my observations published in 1914.

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The Magnetic Moments of Hydrogen-like Atoms.

DR. BREIT's letter in NATURE of Oct. 27 seems to imply that the magnetic moment of a hydrogen-like atom has so far been calculated only for radial quantum number zero. I therefore venture to give the general result, expecting, however, that it has already been calculated by others. The calculation is easily performed by expressing Darwin's functions in terms of Laguerre's polynomials of non-integral rank. It is convenient to write $j=k+1$ when it is positive and $-k$ when it is negative, and to write $J=\sqrt{(j^2-\gamma^2)}$, $N=J+p, n=\sqrt{(N^2+\gamma^2)}$, where p is the radial quantum number and $\gamma=2\pi Ze^2/hc$. We find that the magnetic moment is

$$\frac{j(2l+1)(2Nj+n)}{(2j-1)(2j+1)n} \text{ Bohr magnetons,}$$

l being the equatorial quantum number. This is the expression of spacial quantisation in Dirac's system.

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Corpus Christi College,
Oxford, Nov. 14.