If the traveller happened to be a relativist, his faith in the transformation formulæ would receive a rude shock when, instead of the seven and a half days he had calculated, he found on returning that the earth had aged no less than two hundred years.

There is also an obvious slip as regards the speed necessary to produce so large a difference in computed time (assuming the paradox to stand good). An observer travelling out and back with a velocity of one twenty-thousandth the velocity of light, or 9·3 miles per second, would only expect a difference of *one-twelfth of a second* in either direction between his own time and earth time after two years.[1] This is perhaps fortunate for us, as the earth travels with twice this velocity, or 18·5 miles per second in its orbital course. The cannon-ball would indeed have to be projected with a velocity of *within* one twenty-thousandth of the velocity of light, *i.e.*, $v = c(1 - 1/20,000)$ or with the incredible speed of about 185,990 miles per second, to produce the result stated.[2]

This, however, which is plainly only a *lapsus calami*, is of small importance. The difficulty is created, not by the magnitude of the paradox, but by its existence, and the contradiction it opposes to common sense. If true, it throws the whole relativity doctrine into the lap of metaphysics, from which, if we are to believe M. Nordmann, Einstein was determined to rescue it. " La théorie d'Einstein est née de problèmes posés par l'*expérience*. Elle est née des faits, et son auteur insiste avec beaucoup de vigueur sur ce point. . . . Elle est tout le contraire d'un système métaphysique " (p. 134, *loc. cit.*). Obviously this paradox, in any of its forms, can never be subjected to the test of experiment ; and as it is a fundamental principle with Einstein that nothing must enter into his theory (and therefore that nothing must interfere with his theory) that cannot be so tested, is not the difficulty thereby automatically ruled out of consideration ? These are deep waters, into which a sciolist like myself has to venture carefully, even when it is done of necessity, by way of question, in search of information from competent authority.   H. C. BROWNE.

Dublin, October 26.

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THERE is, as Mr. Browne points out, a *lapsus calami* in my quotation. The supposed velocity of the cannon-ball is, not a twenty-thousandth of, but less by about a twenty-thousandth than, the velocity of light. It is an often-quoted paradox, which I heard for the first time from M. Langevin in his address to the Philosophical Congress of Bologna in 1911, and the discussion of it occupies a large part of M. Bergson's book. With regard to the paradox itself, it is, as Mr. Browne very well points out, not a paradox for the relativist but an illustration of the consequence of rejecting the principle of relativity. In exactly the same way Zeno's paradoxes were not paradoxes for Zeno but arguments for his doctrine that nothing moves. The principle of relativity is that it is possible to pass to a completely different frame of reference without breach of continuity, provided that the space-time coefficients vary to maintain the ratio constant. The paradox shows the form which the breach of continuity will assume if with common-sense we suppose the change of the

system of reference not to be compensated by a variation in the space-time co-ordinates. There are, in fact, two alternatives. I may conceive my traveller retaining the dimensions of his old system in his new system, then he will become a kind of ephemeral insect or microbe in his new environment, for his proportions will be incommensurate with his old proportions ; or, I may conceive him automatically shrinking or expanding in his dimensions proportionately to the change in his environment, then, however much the system changes, he can never become aware of it. This is what I referred to in my article as the relativity of magnitudes. The paradox disappears in the principle of relativity ; it arises because common-sense is accustomed to the view that space and time are constant and invariable.

H. WILDON CARR.

November 1.

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Waterspouts.

CORROBORATING the letter of Dr. G. D. Hale Carpenter in NATURE of September 23, p. 414, reference may be made to a note in *Monthly Weather Review*, 43, p. 550-551, 1915, where a funnel or pendant seen near Cape San Lucas, Lower California, is described and sketched ; the sheath or sleeve seen by Dr. Hale Carpenter was very striking. The phenomenon was under observation a considerable time.

Also, the following from my note-book on an observation made in Manila, P.I. :

" *1919 V. 24 d. 6 h. 15 m. P.M.*—Under a thunderstorm developing in N., from my window I saw a small tornado funnel stretching downward in N.W., obliquely toward W. or S.W. It did not reach halfway to earth ; the sun was so low that a flood of yellow light poured horizontally under the cloud, and the funnel was brilliantly lighted. The figure and description given in my note, *Monthly Weather Review*, November 1915, apply excellently, except that the brighter illumination brought out the hollow core better. The distance was greater, so that I could not very well make out the lattice pattern."

This one showed the sleeve or sheath very well. Another, mentioned in the same note in the *Monthly Weather Review*, a gauzy but large waterspout, extending clear to the water, and causing there a great powder-puff of spray, did not show the sleeve at all. (This was near San Salvador, in the Bahamas ; the position given by latitude and longitude is quite wrong, inserted by some other hand.)

WILLARD J. FISHER.

Cambridge, Mass., October 16.

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Tables of the Incomplete Gamma-Function.

I SHOULD be greatly obliged if you could allow me a little of your valuable space to state that Dr. J. F. Tocher has kindly pointed out an error in my Introduction to the above Tables. In a table on page xx the wrong argument has been inserted to the correct value of the function.

An errata slip has now been issued, and will be inserted in all future volumes sold. This slip will be supplied by the Sales Office, H.M. Stationery Office, Princes Street, Westminster, to all past purchasers of the work, and is arranged so that owners of the Tables can paste them over the offending matter.

I can only apologise sincerely to purchasers of the book for this inadvertency.   KARL PEARSON.

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University of London, University College, W.C.1.

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[1] Taking $c = 1$, and $v = 1/20,000$,

$$t = t' \div \sqrt{1 - 1/400,000,000} = t'(1 + 1/800,000,000 + \text{a negligible}),$$

when $t' = 2$ years, $t = 2 \text{ years} + \frac{63,072,000}{800,000,000}$ seconds, or $t - t'$ is less than $1/12$ second.

[2] $c = 1$, $v = 1 - 1/20,000$. $1 - v^2 = \frac{1}{10,000}$ — a negligible, or $\sqrt{1 - v^2} = \frac{1}{100}$.
Therefore $t = 100 t'$.

X 2