Perhaps the phenomenon was not seen in England or even in Europe. The night may have been foggy, or the transit of the meteors may have taken place in the daytime there.

It does not seem impossible that Shakespeare may have heard of the display from sailors and other travellers in the east when he wrote about the close of the sixteenth century of certain stars shooting madly from their spheres. H. BEVERIDGE.

53 Campden House Road, W.8,
October 26.

Skin Effect in Solenoids.

SKIN effect in long, single layer solenoids wound with solid round wire and used at very high frequencies has been treated by Sommerfeld,¹ Lenz,² and Abraham, L. Bloch, and E. Bloch.³ (The frequency is supposed so high that the Rayleigh approximation applies.)

The last of these disagrees with the first, giving the ratio of the resistance of a closely wound solenoid to the resistance of the wire of the solenoid when stretched out straight and used at the same frequency as equal to 3.73, while Abraham, L. Bloch, and E. Bloch obtained 3.46. The writer calculated the same ratio by a different method and obtained 23.4 ± 0.02 . Going through the calculation of Sommerfeld and correcting for an error in the graphical evaluation of the area under Sommerfeld's curve, the same result (3.41) is obtained by Sommerfeld's method. For loosely wound solenoids the calculations of Abraham, L. Bloch, and E. Bloch, Lenz, and the writer are in fair agreement.

On reading this letter Prof. Sommerfeld has informed the writer that he agrees with this conclusion.

G. BREIT.

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Colour Vision and Syntony.

AFTER reading the letter of Dr. Edridge Green (NATURE, October 14, p. 513) it occurred to me that the following method, involving no head movement, of observing the movement of positive retinal "after images" might be of interest. If, in a dark room, the eyes being in a state of "dark adaptation" and one covered, a dry petrol lighter of the spring release type be flashed, a fan-shaped pattern of brilliant streamers will be seen. This pattern is followed by a similar "after image." The "after image" immediately begins to contract. This contraction continues till the after image appears as a rather thick irregular line of smaller area and greater brilliancy than the original pattern. The rapidity of the change, and the final form varies for different parts of the retina. Two points are of interest, the contraction of the image, and the increase of brilliancy.

H. S. RYLAND.

London, S.E.,
Oct. 16.

Mosaic Disease in Plants.

THERE has been considerable speculation recently upon the cause of the so-called 'virus diseases,' which occur in both animals and plants, such as typhus and Rocky Mountain fever in man, and

¹ A. Sommerfeld, "Über den Wechselstromwiderstand von Spulen," *Ann. d. Phys.*, 329, p. 609, 1907.

² W. Lenz, "Über die Kapazität der Spulen und deren Widerstand und Selbstinduktion bei Wechselstrom," *Ann. d. Phys.*, 342, p. 923, 1912.

³ H. Abraham, L. Bloch et E. Bloch, "Radio-télégraphie militaire," 1919, E.C.M.R. Report No. 4629.

"mosaic" disease in plants. These diseases are supposed to be due to the presence of some ultra-microscopic filter-passing organism. Many small bodies, some of a granular nature, have been described in connexion with these disorders, such as Rickettsia, Negri bodies, etc. As regards the mosaic disease of plants, L. O. Kunkel, a worker in Hawaii, last year demonstrated the presence of a peculiar body of amoeboid appearance in the diseased cells of maize affected with mosaic.

The purpose of this communication is to place on record the discovery of apparently similar bodies in the tissue of potato plants affected with mosaic, a disease which, so far as the potato is concerned, has become of considerable economic importance. No attempt is made at present to define the nature of this body, but it is hoped that further work may throw more light on the subject. All that can be said is that there is invariably present in the cells of mosaic potato tissue, in close association with the nucleus, an abnormal body which is definitely connected with the disease. Preparations showing these bodies were demonstrated at a recent meeting of the Association of Economic Biologists in London.

KENNETH M. SMITH.

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Einstein's Paradox.

IN his review of Bergson's new book (NATURE, October 14) Prof. Wildon Carr refers to "Einstein's paradox," which he quotes in inverted commas as follows:—"Suppose a traveller to be enclosed in a cannon-ball and projected from the earth with a velocity amounting to a twenty-thousandth of the velocity of light; suppose him to meet a star and be returned to earth; he will find when he leaves the cannon-ball that if he has been absent two years, the world in his absence has aged two hundred years." It so happens that a paradox of this identical kind was proposed to Einstein himself by M. Painlevé at the Paris conferences in April of this year. Unless I have greatly misunderstood Einstein's reply, as recorded by M. Nordmann in the *Revue des Deux Mondes* of May 1, this particular paradox, arising from the imaginary departure and return of an observer travelling with great speed from a given point and back again, was shown to be one not legitimately derivable from the restricted theory—the theoretical construction is not one to which the transformation formulæ can properly be applied (pp. 146-152).

The humble student of relativity is therefore in the position of a schoolboy who finds that what he learns from one master to-day is contradicted by another to-morrow. Bergson and Nordmann both speak with Einstein's voice; but whereas the former apparently puts the paradox before us categorically as an inescapable Einsteinian fact, the other represents it as a non-Einsteinian fiction. Which of these two views are we to accept? They cannot both be true. Einstein, as quoted by M. Nordmann, advanced good reasons for putting the paradox out of court; but as Bergson was present at some at least of the conferences it appears that these reasons did not seem to him to be convincing.

There is a certain indefiniteness of phrase about the paradox as quoted above which gives rise to doubt. The only observer mentioned is the traveller in the cannon-ball; and it is quite overlooked that he would naturally expect the difference between his time and earth time to be in exactly the opposite direction—he would expect earth time to have advanced by only one-hundredth of his own time.

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.

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

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, $t=2$ 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 $t=100t'$.

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.

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 half-way 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.

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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