Letters to the Editor.

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The Effect of the Earth's Rotation on the Velocity of Light.

PROF. MICHELSON has now relieved his Newtonian mind by carrying through his heroic experiment, reported in NATURE of April 18, p. 566. He finds, as he anticipated, that the ether around the earth is not disturbed into a whirl by the earth's rotation. This was to be expected, has seemed in fact inevitable, if the ether is the universal medium in which matter subsists as independent small atomic structures, each with its field of main activity purely local, in the manner vividly illustrated in less abstract days by the vortex atoms of Lord Kelvin. Like the aberration of light, the effect under notice is of the first order (v/c), and so is conspicuous far above the very refined modern relativity so called, which is founded on second order (v^2/c^2) experiments and theory.

To those who still cherish the belief, as above expressed, that the result arises naturally from actual rotation of the earth relative to the surrounding ether, and so are not reduced to ascribing it to occult mutual influence of the universe as a whole (for the effect revealed, whether it is called rotation of the earth or not, must be relative to something other than a surrounding vacuity), a main interest of this *tour de force* will perhaps lie in a different direction. The astronomical aberration of light was discovered and elucidated by Bradley, while Newton was still living, on a basis which required the ether to be stagnant—or at most to move irrotationally near the earth as Stokes indicated. Until recently, perhaps still, this criterion has remained uncertain to about one-fifth of one per cent., for the constant of aberration remained unsettled, and so might be a varying quantity, within that degree. Prof. Michelson and Prof. Gale seem to have here missed, not very widely, a full decision on this fundamental astronomical datum by a single purely terrestrial experiment, for their margin of uncertainty as now announced appears to be only twelve times that of the most refined determinations of astronomy. (Some of the recorded deviations from the mean are, however, large, with preponderance in one direction, so as to suggest weighting which would improve the result.)

The finite velocity of light, after resting for two centuries on indirect, but of course adequate, celestial evidence, was brought down to earth by direct measures by Fizeau, Foucault, Newcomb, and Michelson. It seems noteworthy that the present experiment has just missed, by no great margin, fixing the distance of the sun, the base line of astronomy, by measurements purely optical, free from need of confirmation by other determinations whether directly parallactic or indirect results of gravitational astronomy.

JOSEPH LARMOR.

Cambridge, April 19.

THE experiments of Profs. Michelson and Gale, described in NATURE of April 18, are of such fundamental consequence that it is important to express their physical implications in the simplest possible way.

Prof. Michelson's original mathematical discussion of the experiment (*Phil. Mag.* 8 (1904), p. 716) appears to be inadequate; it wrongly supposes the path of a ray of light relative to rotating axes to be a straight line. The essential features of the problem are all reproduced if the ray of light is imagined, instead of describing a rectangle as in the actual experiment, to describe a circle, or rather a many-sided polygon inscribed in a circle. Let a be the radius and A the area of this circle. To a first approximation, the time required for a beam of light to get round the circle in either direction is $2\pi a/c$, where c is the standard velocity of light. On account of the earth's rotation, the material circle rotates in space with an angular velocity $\omega \sin\theta$. Thus while the beams of light are moving once round the circle, the mirror which constitutes both starting-point and winning-post moves round the circle a distance $2\pi a^2\omega \sin\theta/c$ to meet the ray which is travelling in the clockwise direction, thereby lengthening the course for the anti-clockwise ray by an equal amount. The difference of path for the two rays is accordingly twice this amount, or $4A\omega \sin\theta/c$, and this formula can be shown to be equally valid for the rectangular path of the actual experiment.

If the velocity of each ray in space is precisely c, the phase-difference between the two rays (in complete fringes) will be

$$\Delta = \frac{4A\omega \sin\theta}{\lambda c},$$

which is the formula used by Michelson and Gale, and verified by their experiments. If the two velocities are equal to one another, although not precisely equal to c, the formula holds as an approximation. If the velocities are unequal, the formula fails.

Freed of all hypotheses about the ether, the experiments appear to show that the velocity of light in space is the same (to within one part in 10^{11}) whether the light travels in the direction of the earth's rotation or in the contrary direction. This is in accordance with the theory of relativity. Thus the experiments do not affect the position of this theory, although a contrary result would have destroyed the theory. The experiments show either that there is no ether or else that, if there is an ether, the earth does not drag this ether into motion by its rotation.

The original Michelson-Morley experiment admits of three separate interpretations: (*a*) there is no ether; (*b*) there is an ether which accompanies the earth in its motion; (*c*) there is an ether which is at rest in space, bodies moving through it undergoing contraction in accordance with the Lorentz-Fitzgerald formula. The present experiments dispose of interpretation (*b*), which, however, is generally supposed to be adequately disposed of already by the phenomenon of astronomical aberration. Interpretations (*a*) and (*c*) remain open, and the experiments do not appear to provide the means of deciding between them.

J. H. JEANS.

The Dinosaur Region in Tanganyika Territory.

MR. C. W. HOBLEY'S interesting article in NATURE of April 18 (p. 573) ought to carry conviction as to the importance of the small collecting expedition which has been organised by the Trustees of the British Museum. In a short note published in this journal a year ago (March 8, 1924, p. 361) Gigantosaurus (or Tornieria), the main object of this expedition, was referred to in a manner which seems to be almost playful. The animal which is described as having "more slender limbs" than the American Diplodocus is a giant of stupendous size, possessing a humerus seven feet long, in its massiveness by no means suggestive of a creature of graceful or slender build. Without further qualification the description scarcely does justice to this wonderful animal.