Letters to the Editor.

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The Exploded Ether.

THE idea of a universal physical æther seems to be getting terribly in the way. According to Dr. Jeans, in the Supplement to NATURE of March 7, p. 362, "It was something more than a coincidence that Newton, Kelvin, Clerk Maxwell, and Faraday [the advocates of an æther] were all British, while Boscovich, Einstein, and Weyl are not." Descartes is not mentioned.

One notices that the reason for supplanting Maxwell by Weyl is based on the original form of "Weyl's electromagnetic theory," which aims at absorbing electric fields into space—a theory which Einstein has steadily and consistently rejected, for the reason that its "two-foot rule" changes its length as it wanders through space, so that when it comes back to its starting-place it does not recover its original length, and (metaphorically) you don't know where you are.

Seizing on an idea of Eddington's, and utilising the Principle of Minimal Action, which is fundamental in physical formulations, Einstein has himself developed a theory analogous to Weyl's: but he has to admit that it cannot in his hands explain electricity by atomic electrons. It has, however, been claimed by another investigator that this can be got over by use of a widened foundation, and the question perhaps deserves further scrutiny by experts. A quotation is here relevant, from Prof. De Donder of Brussels, the most recent exponent of this interesting but very complex algebraic analysis: "En lisant les trois notes qu'Einstein a consacrées à la gravifique de Weyl-Eddington, on remarque que la confiance que lui inspire cette théorie va en diminuant. C'est ce qui m'a conduit à lui demander son avis actuel, afin de pouvoir le communiquer au cours de mes conférences à la Sorbonne. J'extrais de sa lettre (Leiden, 4, xii. 1923) la phrase très importante: 'Deshalb neige ich jetzt dazu, der ganzen theoretischen Entwickelung, welche auf einer Verallgemeinerung der Riemann'schen Metrik durch Verallgemeinerung der $\Gamma^{\sigma}_{\mu\nu}$ beruht, überhaupt keine *physikalische* Bedeutung beizumessen.'"

If there is a distinctively British view of the æther, it is the one that was promoted, in his usual fragmentary and erratic manner, by Kelvin, the inspirer, along with Faraday, of Clerk Maxwell. It identifies the æther as the substratum, with physical qualities, in which all matter subsists as a limited number of possible types of atomic structures, and which, moreover, binds these discrete atoms into a cosmos by their necessary interactions across it. Being the medium which makes atomic matter possible, it is not itself matter, and is not limited by any analogy to matter. It makes no essential difference whether one visualises it as an active physical medium or alternatively describes it as "space," or a "fourfold extension," endowed with physical qualities. The earlier analogies introduced waves of light and the electric field by contemplating displacement of the small parts of the æther, a varying displacement involving strain with its energy of elastic deformation. The newer representations become feasible through introducing the cognate notion of "parallel displacement" of the varying "space," as defined by the algebraic formulations of Prof. Levi-Civita. The relevant problem, as above indicated, is to carry the ideas through as far as possible, and so test the extent and appropriateness of their analogy with physical reality.

Fundamental space and time ought, one would think, to be uniform, the same everywhere. As soon as the qualities of space are made to depend on the presence of adjacent portions of matter, it ceases to be pure space and becomes an interconnecting medium with physical properties. But this subject, on its epistemological side, is far from having yet been exhausted.

JOSEPH LARMOR.

Cambridge, March 7.

Ether and Matter and Relativity.

IN the most valuable supplement to NATURE of March 7, through his Kelvin lecture to the Institution of Electrical Engineers, Dr. Jeans gives a splendid summary of the present position in physics, showing how Lord Kelvin's "two clouds" obscuring the connexion of radiation and matter, instead of dispersing, have expanded to fill our scientific vision. Incidentally, Dr. Jeans makes it clear that in his view the terms ether and force are unnecessary, since all that they connote can be represented equally well by pure geometry, and indeed much better than by Lord Kelvin's curiously mechanical mode of attack. It is marvellous what hyper-geometry can be made to express, and what high reasoning about reality can be thus carried on. But here comes the point: I suppose that much the same can be said about the non-necessity of the idea of matter. That too can be expressed geometrically, and apparently dealt with analytically, as the impenetrable centre of a warp in space, and as $G^{\nu}_{\mu} - \frac{1}{2}g^{\nu}_{\mu}G$; an expression which Prof. Eddington says behaves exactly like matter, except that it is more continuous than atomic, adding that the mind could scarcely recognise anything simpler as substantial and permanent ("Math. Theory of Relativity," p. 120). If relativists will grant that ether and matter can be *equally* dispensed with, a supporter of the ether need have no conflict with them: for ultimate questions about reality and existence can be left to philosophers.

OLIVER LODGE.

March 10.

The Source of Stellar Energy.

THE source of a star's energy is debated in recent letters by Prof. Lindemann and Dr. Jeans (NATURE, Feb. 14 and 28). Dr. Jeans's conclusion is that the liberation of energy from the sub-atomic store occurs at a rate independent of temperature and density; and if one star liberates energy more slowly than another, it is solely because the former has exhausted the more prolific material. I think that there are grave astronomical objections to this view.

First, it requires that the rate of emission of radiation by the star shall be very largely dependent on its previous history, whereas the astronomical indications are that it is so closely correlated to the present mass that there is little scope for outside factors. Consider, for example, two stars, each of which has radiated $\frac{2}{3}$ of its original mass, so that they are in the same stage of exhaustion: the first, originally of mass 3, is now of mass 1; the second, originally of mass 12, is now of mass 4. Their rates of radiation should accordingly be in the ratio 1 : 4; but both theory and observation seem to show that a star of mass 4 always radiates much more than 4 times as strongly as the sun.

Secondly, this hypothesis seems to make the stars unstable. The energy E which is liberated must be