LETTERS TO THE EDITOR.

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Gravitation and Light.

IN a recent letter (NATURE, December 25, p. 412) and elsewhere I have expressed doubt as to the security of the inferences regarding the influence of gravitation on the light from distant celestial bodies, which are advanced as tests of the Einstein formulation. A closer and less sceptical general scrutiny is possible. The difficulty was to recognise how a theory which professes to supersede an æther with its definite space and time, by concepts purely relativist, could manage to effect direct comparison, at a distance and without tracing transmission across the intervening space, of the radiations of a molecule at the sun and those of a molecule of the same substance at the earth. This body of doctrine seems, in fact, to consist of two chapters. A blind man could work out the purely relativist theory, which would indeed represent rather closely the process of groping from point to adjacent point in space and time by which he must acquire his own scheme of knowledge. But to compare his results with the world of experience a practical astronomer is needed, with very different equipment; he relies on the rays of light, in conformity with the optical theory that prescribes their function as messengers across space.

It thus appears to be necessary to examine directly what changes in the propagation of rays of light would arise under the modified gravitation, and, if possible, to bring out more explicitly and demonstratively the further postulate that is needed to reconcile them with the proposed test-relations. The postulate which is sufficient to sustain the optical predictions proves to be this: that all the way to the sun and throughout the solar system the formula for the element of fourfold length by which the nature of the space is determined does not contain explicitly that one co-ordinate which is more especially related to time, but involves only its differential. This is, of course, a reasonable assumption; but it is of an absolute type regulating the whole space, assumed to be thus settled in advance on the Newtonian plan, not of the relativist type which would profess only to explore it gradually from place to place as it arises.

But we can analyse further and more definitely. The new theory implies that if this quadratic formula characteristic of the space involved in its product terms the differential of that co-ordinate which stands closest to time, then the velocity of the rays of light in any direction at any place would be different according as they are travelling forward or backward. That could only mean that the co-ordinates define at such a locality a frame of reference which is itself in motion. But in motion with reference to what? The relativity of language is doubtless capable of supplying an answering formula; but it would only be wrapping up in abstractions the simple statement that when at any place the quadratic characteristic of the spacial extension involves the differential of the co-ordinate specially related to time in its product terms, then there is latent in it a specification of its own mode of change at that place with respect to uniform space-time. If no such products are contained, the space is not locally in motion, and we may say that the frame of reference is fixed in the æther. That is, the fourfold space-time frame in which we set the universe is everywhere deformed and awry, but it is then nowhere in movement relative to light; or, in graphic terms, the co-ordinate system would involve a fourfold curvilinear frame instead of a rectangular one when it is set in a uniform fivefold extension, but it is to be nowhere in movement when set in that higher auxiliary space. The physical properties of the rays of light can scarcely be invoked to obtain an astronomical test of results, by providing in their vibrations a universal scale of time, without becoming to the same degree a criterion of the relation to light of the whole construction; if they can settle universal time by optical vibrations, they can equally well be applied to settle absolute space in each locality. It comes to this, that radiation can be utilised to determine the space and time absolutely.

This point of view involves no destructive criticism of the substantial and brilliant mathematical theory, which, of course, ought to evolve correctly the consequences of the postulates that are put into it. But it does demur to the popular presentation which asserts that space and time and the æther have now been transcended. The outstanding problem, stripped to its essentials, was to find whether gravitation could be brought into line with radiation in this very arresting feature: that the time which is most appropriate by far for its analytical formulation is a changing local time mixed up definitely, though very slightly, with spacial relations. The value of the new theory is that it opened out a way by which this problem could be attacked, while previously no approach was in sight; and, still more important, that it has not improbably led to an answer in the affirmative. This, of course, is a very remarkable consummation, comparable to Faraday's detection of an influence of magnetism on light, though more fundamental in that it relates to free space; it must promise substantial advance as regards the formulations on which we construct our ultimate plan of physical activity, either along its present lines or some other that would represent the result with equal approximation. But beyond that the extreme relativist developments, where they are not metaphysical dogmatics, are a very interesting extrapolation towards the possible or probable physical formulation of a universe in which bodies are moving thousands of times as fast as the stars are found to move in our own.

Reference may be made to forthcoming Proceedings of the Cambridge Philosophical Society and Monthly Notices of the Royal Astronomical Society.

Cambridge, January 17. JOSEPH LARMOR.

The Outlook of British Technical Optics.

THE symposium and general discussion on "The Microscope: Its Design, Construction, and Applications," held in the rooms of the Royal Society at Burlington House on January 14, under the auspices of the Faraday, Royal Microscopical, Optical, and Photomicrographic Societies, in co-operation with the Optical Committee of the British Science Guild, with Sir Robert Hadfield, president of the Faraday Society, in the chair, was a landmark in the history of British optics. Whether judged by the number, value, and variety of the exhibits and the papers contributed, or by the number of people who attended, the symposium was a success.

At the present time the microscope possesses a unique interest for those concerned with British optical industries. It demands greater technical knowledge and skill in its designer and producer than any other optical instrument, and the demand for it, both actually and potentially, for work of the most far-reaching importance is so great that it may fairly be said to be the keystone in the arch of an industry which has already been recognised as one of such