LETTERS TO THE EDITOR.

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Uniformity in Lantern-slides.

IN illustrating a scientific lecture it is important that lantern-slides produced from photographic negatives should be of uniform density, and should well exhibit the details which they are intended to illustrate. To blame the lanternist for faults which are not his own may give relief to the lecturer's feelings of disappointment, but this plan does not conduce to the success of the lecture.

For some time past I have been experimenting on photometric methods of comparing exposures in printing from negatives of widely different density, and I find that if the tests are made with sufficient care the results exhibit a remarkable degree of uniformity.

A simple photometer can be made of a sheet of white cardboard folded into the shape of an isosceles prism or double inclined plane, the faces of which are illuminated by sources of light placed on opposite sides of the prism, the distances of the sources being regulated according to the law of inverse square. Now let two negatives under comparison be placed side by side in front of the two faces, and examined by the transmitted light reflected from the cardboard. Then, when the negatives look to be of the same density, their exposures will be proportional to the illuminations of the faces, and can be easily compared. If the negatives differ in contrast, this difference will be at once evident on adjusting the illuminations, and either the necessary modifications of treatment can be decided on or badly contrasted negatives can be set aside for intensification or omitted from the series. By a method identical in principle with the above I have been successful in testing the development of negatives and in calculating exposures in bromide enlarging. Two negatives exposed in succession with calculated exposures of twenty-five seconds and fifty minutes have given under similar development equally good prints of almost exactly the same darkness.

G. H. BRYAN.

A Probable New Fluting in the Spectrum of Magnesium Oxide.

THERE appears to be a well-marked, though faint, fluting in the spectrum of magnesium oxide which has not been hitherto recorded, consisting of seven principal edges and several fainter lines. No mention of it has been found anywhere, and Prof. Kayser, who has seen a photograph, says that it is unknown. If so, this is probably due to the fact that it would be quite invisible against even a weak continuous spectrum.

The wave-lengths of the principal edges have been determined by comparison with lines of zinc, cadmium, and manganese, and are approximately as follows:—4823, 4819, 4810, 4801, 4791, 4780, 4771. The first of these is very faint, and although almost coincident with the Mn line at 4823, appears to have a slightly greater wave-length, and is probably not due to Mn as impurity. The edge at 4780 is rather diffuse, and two faint lines have been measured between it and 4791. Between 4771 and 4731, five lines have been measured, which may also belong to the system.

The fluting is obviously related to that beginning at 5007; the spacing between the edges is of the same order, and it is only well seen when the latter is very intense. Although first observed about twelve months ago, it was only successfully photographed last February. Some of the negatives also show that the series of faint, fine lines on the less refrangible side of the violet magnesium triplet extends much further into the visible spectrum than catalogued by Eder and Valenta.

E. E. BROOKS.

Leicester Municipal Technical School, June 18.

The Halos round Zircons in Biotite.

WITH reference to the action of radium on glass, and its removal by exposure to sunlight, the following unintentional experiment may possibly be of interest. Many years ago I had a section of a piece of granite prepared, and then another after the stone had been made red hot in an ordinary bright fire.

In the unheated rock the zircons in the brown mica show good halos, and these have not been obliterated by the strong heating. This may be worth mentioning, as the experiment may possibly not have been attempted by anyone else, either from lack of motive or the difficulty of getting a good slice after the rock has been made brittle by the heat.

A. R. HUNT.

Southwood, Torquay, June 20.

LORD KELVIN'S PHILOSOPHY.[1]

Explanation in Terms of Force or of Motion? Action across Empty Space or through a Medium?

ONE of the most interesting and important outcomes of last year's meeting of the British Association at Leicester was the declaration by Lord Kelvin, during a memorable discussion on the constitution of the atom, in Section A, that he had found it necessary to abandon the attempt to contemplate the material universe explicitly in terms of æther and motion, and for his own part preferred to resort to the Boscovich doctrine of centres of force acting on each other according to some curiously complex law, without specific attention to the hypothetical medium in which such forces may exist.

Now undoubtedly these ancient postulates of matter and force represent the dynamical method first made feasible by Newton's achievement in celestial physics, whereby phenomena were correlated by unexplained particles of matter acted upon by unexplained forces, of statical origin and unknown mechanism, according to a specified law of distance. This was how Newton successfully solved the problems of gravitation, and constructed the working theory of astronomy; but it had been hoped, and by some is still hoped, that the time had now come for seeking to represent, in terms of something simpler and more fundamental, the nature of matter and the origin or inner mechanism of its various forces.

The most powerful and hopeful lever wherewith to attack this great philosophical problem was the kinetic theory of elasticity and rigidity, introduced by Lord Kelvin himself. By this means it has been hoped to express force in terms of the still simpler conception of motion; in fact, to explain all the forces with which physicists have to do—electrical and chemical attraction, elasticity, magnetism, cohesion, and perhaps gravitation—in terms of the internal motions of a universally connecting fluid plenum.

But now the question arises, is it at all certain that the material universe can really be understood in terms of motion alone—motion of an all-pervading continuous fluid known as the æther of space? And would such a solution be satisfactory?

To many it has seemed that this reduction to simplicity was the closest approach to ultimate explanation and unification that could be hoped for in the domain of mathematics and physics; and during the last half-century many steps, apparently in the direction of such an achievement, have been taken by the leaders in these branches of human knowledge.

The mathematical foundation was laid by Helmholtz, when he reduced rotational or vortex motion in perfect fluid under the domain of mathematics; it was followed up by Lord Kelvin's kinetic or gyrostatic theory of elasticity and rigidity; so that mathematicians, such as FitzGerald, Heaviside, Larmor,

[1] Being thoughts suggested by the meeting of the Mathematical and Physical Section of the British Association at Leicester in August, 1907; and referred to in Sir Oliver Lodge's recent Presidential Address to the Faraday Society, May 26, 1908.

Hicks, J. J. Thomson, and others, as well as Lord Kelvin himself, have, from various points of view, endeavoured to devise a scheme of spinning motion in a perfect fluid plenum which should be able to accomplish in general terms all that the æther is known *to perform*: more particularly that it should be able to imitate its faculty of transmitting the transverse or solid quiverings that we call light, yet without resisting the motion of bodies through it; and at the same time that it should be able to maintain its own turbulent or whirlpool motion in an unconfused and regularly stable condition throughout infinite time. And in this difficult undertaking they have from time to time seemed partially successful; at any rate, they have reached suggestive results and opened up stimulating vistas.

The ether must be incompressible, too, being perfectly continuous without breaks or any kind of atomic or granular structure, save such as may be conferred upon it by reason of its infra-material internal motion. An infinitesimally turbulent liquid of some kind seemed the desideratum, and many have been the attempts to devise such a liquid. An interlaced system of vortex fibres or filaments has to some seemed the most likely device; a similar scheme was a system of plates or laminar vortices; while a third modification conceived it as a collection of connected filaments all in a state of rapid internal motion, though stationary as regards locomotion in space;—what might be called a vortex sponge. By some such means it was hoped to be able to combine the elastic rigidity appropriate to a solid, with the penetrable unresistance to motion of solids through it, characteristic of a perfect fluid, and with the complete incompressibility of an ideal liquid. But the mathematical difficulties of all such treatment have been rather overwhelming; and an uncertainty about the stability or permanence of such a medium has always obtruded itself in a discouraging manner.

In fact, there has always been a troublesome amount of instability in all the schemes that have hitherto been devised, so that none of the expounders of the motion doctrine was able to announce a finally satisfactory result.

Still it was felt by most of those who have worked at the subject that the outlook in this direction would be so bright, if initial difficulties could be overcome, that it was worth a long-continued effort to see if a coherent scheme could be planned on these lines, so as to secure what, if it turned out to be the truth, would surely be a magnificent generalisation.

Indeed, it has sometimes seemed unlikely that a mode of explanation which offered such attractive features, and led so far in the right direction, could, after all, be a blind alley leading nowhere; or, to vary the metaphor, a mere will-of-the-wisp which it was waste of time to pursue.

What has certainly been made out is that motion of atomic structures, in an æther with elasticity postulated, supplies a complete working scheme on which we can rest without inquiring further as to the origin of this elasticity. Beyond this, the attempt to explain the material universe on a purely kinetic basis has not made much progress in quite recent years; and, to those competent to attack it, it has probably seemed better to let the problem lie dormant for a time, until future discoveries in mathematics or in physics threw more light upon the rocky path or provided us with better instruments for climbing it.

During the epoch of waiting it now appears that our venerated chief was deflected from further attempts in this direction, and directed his attention elsewhere. Other methods seemed to him more immediately hopeful; and whereas it had been hoped to explain force in terms of latent motion, Lord Kelvin in later years sought to expound motion in terms of force, giving up the kinetic unification of the material universe in favour of a conception more arbitrary and descriptive, and permitting himself to regard force as perhaps an equally fundamental, perhaps a more fundamental, conception than motion.

It may be that philosophers will concede the (to me) somewhat improbable proposition that an explanation in terms of force and action-at-a-distance will be as satisfactory as an elucidation in terms of motion and a continuous medium. To Lord Kelvin it would appear that both solutions were equally satisfactory, and that it was only a question of which was the most tractable. In any case it is noteworthy that he took up so clear and definite a position; it is the key to much of his recent work, and to the difficulties which he felt in accepting some of the hypotheses which are a natural consequence of the electrical theory of matter and of some of the facts of radio-activity. It now seems not unnatural that he should have sought to express and explain these great results otherwise. His attitude is both coherent and reasonable; though I would urge that most theoretical advance and discovery (in the hands of Maxwell and others) has been along the continuous and medium line, which, if not the line of ultimate explanation, is at any rate that of achievement.

At the same time, it must be admitted that, if a longitudinal impulse is transmitted by an incompressible medium at an infinite pace, the process becomes barely distinguishable from action at a distance, through a force varying according to a specified law. Or—putting what is virtually the same thought in another way—the influence of an electron, or matter-unit, whose field of force extends infinitely in all directions, need not be conceived as limited by some arbitrary boundary beyond which things can be said to be at a distance from it.

It will be remembered that some of the old philosophers saw great difficulties in the abstract conception of motion. It appears as a curious evanescent transition from one place to another, involving the attribute of "time"; it is indeed "not a being but a becoming," when position is taken as the primary conception.

But I urge that it is simplest to regard "position" and "distance" as secondary conceptions, subordinate to and arising out of our perception of motion. Unless motion is supposed to be a thing directly apprehended, it is truly rather an elusive idea. To me it seems a direct apprehension—direct information conveyed by our muscular sense. Space itself seems a *consequence* deduced from our perception of motion; and the idea of time follows from our direct perception of *rapidity* of motion. But probably to Lord Kelvin these things appeared otherwise.

The conclusion of the discussion on the constitution of the atom may be summed up thus:—

The internal energy of Lord Kelvin's model atom is static or potential. The internal energy of the hypothetical atom at which others are working is kinetic.

The disintegration of radium in the former case is comparable to the explosion of an unstable chemical compound, like gun-cotton. In the latter case it must be represented by something more akin to the flying to pieces of a single rapidly spinning unit, such as a fly-wheel.

And so for the present the matter stands.

OLIVER LODGE.