H 74 to H 98, 1·755, 1·761, 1·781; mean, 1·766; differences, — 0·011, — 0·005, + 0·015.

It will be seen that, even with prisms such as these, by taking the mean of different determinations, the uncertainty can hardly be as great as one half per cent.

Extremely small prisms are quite sufficient for the determination of the ratio of the dispersions of the glasses by the above method. It may, however, happen that an optician cannot afford to remove even so small a piece of glass from a disk intended for an objective, and has not a specimen of glass on the identity of which with the glass of his disk he can thoroughly rely. In such a case it is necessary to determine the optical constants of the disk by means of facets cut on the disk itself. A heavy and costly disk cannot be treated like a small prism, and mounted on a small graduated instrument in the manner I have supposed a small prism treated. To compare the ratio of the dispersions of two such disks, one of crown glass and the other of flint, the most convenient way would seem to be to leave the disk fixed, let the light pass through it first, and then achromatize it by a small prism of very low flint glass, mounted on a small graduated instrument in the manner already explained. The dispersions of the disks would be compared with each other by comparing them in succession with the same intermediate prism.

This, however, demands an additional determination beyond what was required in the other process, since the prism through which the light first passes is not the same in the two cases. The element which best lends itself to measurement is the angle of incidence on the first surface. The most convenient mode of measuring this must depend on the general disposition of the apparatus adopted to take the measurements for the angle of the disk and the deviation of some one line, which must be made in any case; it is accordingly best left to the choice of the observer.

XI. "On the Reversal of the Lines of Metallic Vapours." By G. D. Liveing, M.A., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge. No. III. Received June 19, 1878.

In our last communication to the Royal Society we described certain absorption lines, which we had observed to be produced by the vapour of magnesium in the presence of hydrogen, and certain other lines which were observed when potassium, and others when sodium, was present, in addition to magnesium and hydrogen. These lines correspond to no known emission lines of those elements; but, inasmuch as they appeared to be regularly produced by the mixtures

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described, and not otherwise, we could only ascribe their origin to the mixtures as distinct from the separate elements. It became a question of interest, then, whether we could find the conditions under which the same mixtures would give luminous spectra, consisting of the lines which we had seen reversed. On observing sparks from an induction coil taken between magnesium points in an atmosphere of hydrogen, we soon found that a bright line regularly appeared, with a wave-length about 5,210, in the same position as one of the most conspicuous of the dark lines we had observed to be produced by vapour of magnesium with hydrogen in our iron tubes. This line is best seen, *i.e.* is most steady, when no Leyden jar is used, and the rheotome (the coil we used has an ordinary self-acting one) is screwed back, so that it will but just work. It may, however, be seen when the coil is in its ordinary state, and when a small Leyden jar is interposed; but it disappears (except in flashes) when a larger Leyden jar is used, if the hydrogen be at the atmospheric pressure. This line does not usually extend across the whole interval between the electrodes, and is sometimes only seen near the negative electrode. Its presence seems to depend on the temperature, as it is not seen continuously when a large Leyden jar is employed, until the pressure of the hydrogen and its resistance is very much reduced. When well dried nitrogen or carbonic oxide is substituted for hydrogen, this line disappears entirely; but if any hydrogen or traces of moisture be present it comes out when the pressure is much reduced. In such cases the hydrogen lines C and F are always visible as well. Sometimes several fine lines appear on the more refrangible side of this line, between it and the *b* group, which give it the appearance of being a narrow band, shaded on that side. We have used various samples of magnesium as electrodes, and they all give the same results. We have also used hydrogen prepared and purified in different ways: hydrogen prepared by the action of zinc on dilute sulphuric acid, purified by an acid solution of bichromate or permanganate, and by potash, and dried by sulphuric acid; electrolytic hydrogen; hydrogen from dry formiate of soda and soda lime; hydrogen occluded by sodium and expelled by heat; and hydrogen occluded by palladium and expelled by heat. In the last two cases the whole apparatus was connected by fusion, and a Sprengel pump, also connected by fusion, employed to remove the air. In all cases the phenomena were the same.

In addition to the above-mentioned line, we observed that there is also produced a series of fine lines, commencing close to the most refrangible line of the *b* group, and extending with gradually diminishing intensity towards the blue. These lines are so close to one another, that in a small spectroscope they appear like a broad shaded band. We have little doubt that the dark absorption line, with wave-length about 5,140, shading towards the blue, which

we previously observed in our iron tubes, and described in our last communication, was a reversal of part of these lines, though the latter extend much further towards the blue than we had observed the absorption to extend. In fact, the bright lines extend somewhat more than half the distance between *b* and F, from 45 to 50 being visible, and placed at nearly equal distances from each other. They also commence close to the *b* group, *i.e.*, with a wave-length nearly 5,164, but the first two or three lines at that end are not so bright as those which immediately succeed them. The light giving these lines does not extend to more than a short distance from the electrodes, and is generally most conspicuous at the negative electrode. There is a difficulty in consequence of the flickering character of the discharge in getting any accurate measures of them, though they are bright enough, especially at the less refrangible end, to be easily seen. The comparative faintness of the light from the iron tubes appears to us almost sufficient to account for our not having seen the reversed lines so completely as the bright ones; nevertheless, it is quite in accordance with what we in other cases observed, to suppose that some of these lines may be more easily reversed at the temperature of the iron tubes than others.

XII. "An Experimental Investigation into the Velocities of Normal Propagation of Plane Waves in a Biaxal Crystal, with a Comparison of the Results with Theory." By R. T. GLAZEBROOK, B.A., Fellow of Trinity College, Cambridge. Communicated by J. CLERK MAXWELL, M.A., F.R.S. Received June 19, 1878.

(Abstract.)

In his report to the British Association in 1862, Professor Stokes called attention to the desirability of accurate measurements of the velocity of normal propagation of plane waves in a biaxal crystal, with a view to testing by the results Fresnel's theory of double refraction, and suggested then a method to determine this velocity. Let the crystal to be examined be cut into the form of a prism, two or more natural faces being left to determine accurately the position of the cut faces with reference to the axes of elasticity.

"Let us consider a plane wave of light passing through the crystal prism."

"Let V be the velocity in air, v in the crystal, let $\phi\,\phi'\,\psi\,\psi'$ have their usual meanings, let i be the angle of the prism, D the deviation of the wave normal after passing through the prism."

Let us observe the angle of incidence ϕ, and the deviation D.