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ON THE POLARISATION OF LIGHT.

DEMONSTRATION BY PROFESSOR SILVANUS THOMPSON, F.R.S.

November 16th, 1911.

PROFESSOR THOMPSON explained that he was about to give not a lecture but a demonstration in three parts. The first was to be an exhibition of polariscopic objects in parallel and convergent light. The second part related to improvements in the design of polarising prisms. In the third part he would demonstrate some recent work undertaken by him in conjunction with his colleague, Professor Coker, in the construction of improved polarising apparatus for use in engineering research—for examining specimens on a relatively large scale, such as 10 by 10 inches. For that part of the work, the specimens to be examined were transparent structures in celluloid or xylonite, which were examined in a condition of strain, so as to investigate optically the stresses that occurred in beams and other engineering structures.

Although not intending to give a lecture, Professor Thompson said that he would preface the demonstration with a few introductory remarks. He then briefly explained the polarisation of light, with the aid of mechanical illustrations, and with special reference to polarisation by reflection from black glass and by double refraction through Iceland spar. The opticians' tourmaline forceps was also mentioned, and an explanation given of chromatic polarisation by means of which it is possible to test the uniformity of thickness of a thin plate, of such a material as mica, and also to bring out by variations of colour, peculiarities of structure that are invisible by ordinary light.

The lantern was then brought into use, and a large number of remarkably fine crystalline specimens were projected by parallel plane polarised light, using the bright and dark fields to show complementary colours. These beautiful effects were much applauded by the audience, and must have been highly instructive to those who have not had the advantage of working with expensive apparatus. Amongst the objects exhibited were a series of amethystine quartzes, exhibiting successively the transition from simple quartz crystal to true amethystine structure. Some samples of toughened glass, showing coloured rings and a black cross, were exhibited, and Professor Thompson explained that the black (or white) cross traversing the coloured rings was indicative of a radial structure. Among the specimens shown was the crystalline lens from the eye of a fish, which had been put into a state of strain by the process of drying. There were also a pair of stepped series of mica plates, each showing singly the same series of colours, but when crossed giving a chess board pattern of colours, traversed by a diagonal row of black squares, wherever neutralisation occurred by the crossing of equal thicknesses at right angles. When superposed in reversed position (so as to equalise the thickness throughout), the step-wedges showed a perfectly uniform tint. A chilled-glass disc showed the glack cross characterising an invisible radial structure developed by the internal stresses resulting from severe contraction of the peripheral parts upon the interior.

The lecturer mentioned that Mr. Mackinney had just brought him some specimens of Kryptok fused lenses; and he proceeded to put them to the test of the polariscope lantern. The projection on the screen gave only a faint indication of a black cross, showing that these examples of different glasses fused together had been very successfully annealed.

Changing to the apparatus for projection by converging light, Professor Thompson demonstrated the characteristics of axis cut quartz. In this case there was no radial structure; but as the light crossed the slice of quartz in a converging beam, the thickness which the rays had to travel was a minimum for the central ray, and greater for the rays that came through obliquely. Referring to the quartz lens-tester or tourmaline forceps, he pointed out that it was practically converging light that was used in the application of the tourmalines, as light reached the eye of the observer from points in the sky extending over a wide angle.

Professor Thompson then exhibited a number of models of polarising prisms, and explained the construction of the Nicol prism, and of improved types due to various persons, including Mr. Ahrens and himself. Professor Thompson mentioned that he owned a prism which was cut by Nicol himself at the age of 79, and had been given to him by the late Mr. J. M. Bryson, optician, of Edinburgh. The speaker then spoke of a modification due to Hartnack, a German optician, who used linseed oil in the place of Canada balsam, placing the film at right angles to the optical axis of the spar. The speaker remarked that he had possessed one of these prisms, but lent it to a friend about 12 years ago, and it had not yet been returned. The use of an air-film, as suggested by Foucault, permitted a saving of spar, but caused a considerable narrowing of the field. Professor Thompson then explained an improvement of his own on Hartnack's prism, which had the advantage of permitting the spar to be cut with less waste. One of these prisms was made for him by Mr. Ahrens in 1880. His next idea for saving spar was to make the prism partly of glass; and that notion had lately been revived, using for the purpose one of the newer kinds of glass, having a more suitable refractive index. Mr. Ahrens's special method of cutting the crystals of spar so as to obtain wide-angled polarising prisms and double-image prisms, was explained by a model. He had experimented with poppy oil and balsam of copaiba for the internal film; also cutting the Nicol in the reverse way from that usual, and transposing the parts. In all, he referred to 12 different plans that he had evolved for the improvement of Nicol prisms, and mentioned that spectro-polariscopic prisms had been made also. After showing a number of different monaxial and biaxial crystals, Professor Thompson said that mica was biaxial, but in some instances came very near to the monaxial form of crystallisation; and this fact was illustrated on the screen by a series of specimens of mica from different parts of the world.

Professor Thompson then passed on to his experiments on optical stress in transparent materials under strain. For these he had had made a large polarising apparatus on the reflecting principle, using as polariser a sheet of blackened glass, about 11 inches by 24, set at the polarising angle, and uniformly illuminated by a bank of incandescent lamps behind a screen of ground glass. Binocular analysers similar to those which used to be used for the Anderton stereoscopic lantern pictures, were handed round among the audience. Professor Coker's experiments with celluloid structures were then shown, the black cross being got rid of by interposing quarter-wave plates on each side of the object. Thanks to the enterprise of Messrs. F. Wiggins & Son, very accurate quarter-wave plates had been made in mica, some 10 inches and some 12 inches square, and even, with a single join, up to 23 inches diameter. The measurement of the internal stresses shown in polarised light was made possible by superposing at any given point a test piece of celluloid, which was compressed by known forces until neutralisation was obtained, as shown by the appearance of a black patch. In this way it was possible to see visually the lines of stress in the tension and compression of models of beams, girders, and struts. Other models enabled the observer to watch the increase of stress during the coiling of a spring. The effect of notches in the side of a beam, and of rivet-holes in a girder in augmenting the stresses and increasing the liability to fracture, was also exhibited.