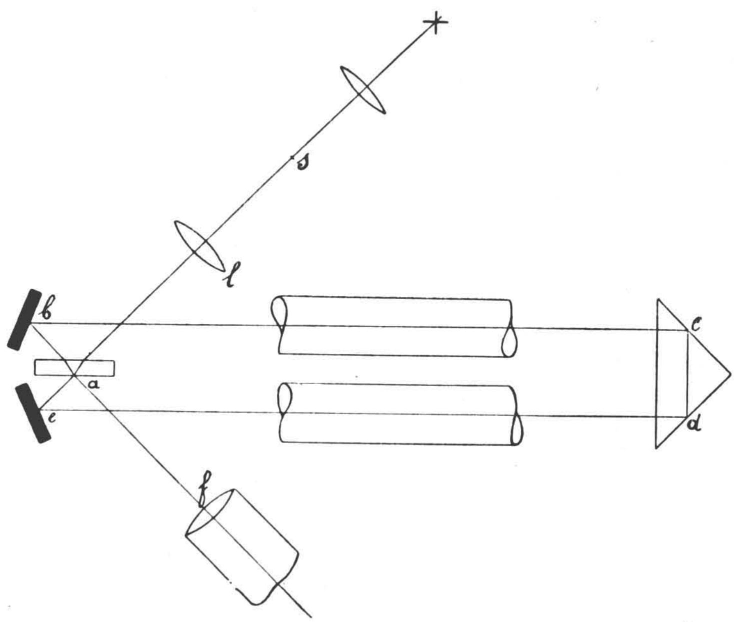
Physics. — *"An Interference Phenomenon Due to the Introduction of Sodium Vapour into one of the Paths of the* FIZEAU-MICHELSON *Interferometer-Arrangement".* By G. C. DIBBETZ Jr. and Prof. P. ZEEMAN.

(Communicated at the meeting of November 26, 1921).

When sodium vapour is introduced into one of the paths of light of the interference-arrangement used in FIZEAU's experiment, surprising shifts of interference fringes may be observed. In order to observe these shifts we must arrange that the sodium vapour acts as a prism, and that by means of a spectroscope the change of the distance of the interference fringes with wavelength can be watched by projecting the interference fringes on the slit of the spectroscope.



The above figure is reproduced from an earlier paper[1]) on FRESNEL's convection coefficient for light of different colours in water, in which use is made of MICHELSON and MORLEY's interferometer. In *a* the ray meets MICHELSON's slightly silvered mirror. There the

[1]) ZEEMAN. These Proc. Vol. XVII p. 445 (June 1914).

incident beam *s l a* is divided into a reflected and a transmitted one. The reflected one follows the path *a b c d e a f*, the transmitted one the path *a e d c b a f*. In some experiments the flame of a MEKÈR-burner, in which a platinum spoon with common salt was placed, was put between *e* and *d*. In another case a greater gradient of density of the sodium vapour was obtained by introducing sodium into an iron tube connected with an air-pump and closed on both sides with glass plates. By heating this tube at the bottom and cooling it at the top, the desired density distribution could be obtained.

With the flame between *e* and *d* the phenomenon was observed reproduced on the Plate in Fig. 1.

Fig. 2 represents the interference phenomenon with a sodium prism of greater density. Both photos were taken with a spectroscope with one glass prism; the first is enlarged 7 times, the second 4 times. In Fig. 1 the two absorption *D*-lines are visible. In fig. 2 the whole region round the *D*-lines has disappeared.

It will not be attempted here to give a full explanation; it would claim more space than we can afford to give it. Even without the sodium vapour the explanation of the dependence of the interference fringes on the mutual position of the five reflecting planes and on the thickness of the slightly silvered mirror is a rather complicated problem, which has not been treated in detail as yet for so far as we know.

We shall confine ourselves to a few remarks on circumstances that play a rôle in the appearance of the phenomenon.

A point to which we draw attention is the particularity that the rays which travel in opposite directions, are deflected by a different amount after their passage through the sodium prism. For if the vapour prism is placed between *e* and *d*, ray *a e d* will have to travel over the long path *d c b a f*, before it reaches the object glass of the telescope, *a b c d* on the other hand only the short path *e a f*.

In this connection we may still mention that nothing has ever appeared of a dependence of the velocity of propagation of light on the intensity. We assume that this does not exist, else this dependence would already give rise to phase differences in our experiment, because one ray is weakened at the beginning of its way, another at the end.

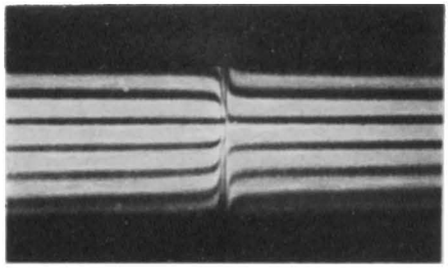
The following auxiliary experiment is also of importance. We introduce a screen with a narrow aperture between *l* and *a* in order to insulate as, it were, a ray of light. In the principal experiment an image of the interference fringes was thrown on the slit of the spectroscope by the aid of the lens *f*; now, however, we increase the distance between l and the plane of the slit. When, as in the experiment, the path of the light between the slightly silvered mirror and the lens is about 600 cm., we can by a displacement of 4.5 cm. (focal distance of the projecting lens 50 cm.), observe two sharp, coherent image points lying vertically above each other, in the image plane. The distance of the image points is a function of the wavelength. When they are projected on the slit of the spectroscope, the dependence of image distance and colour is directly observed. Fig. 3 represents a positive photo obtained with the tube of sodium under the said circumstances. The dark line on the left side and the dark line on the right side originate from one luminous point, the faint lines from the other. The difference of intensity of the lines was caused by this that the two luminous points were not thrown on the slit exactly under each other. The lines of Fig. 3 could not be observed in the neighbourhood of the absorption D-lines. In the lefthand part of the figure our lines are both curved upwards, in the righthand part both curve downwards. It is further noteworthy that the lines in the lefthand part intersect, whereas in the righthand part they diverge more and more from each other.

When we focus again the interference fringes upon the slit of the spectroscope we see the interference figure of Fig. 2 in the spectroscope.

Now it seems rather plausible that the existence of Fig. 2 is due to the shape of the lines of Fig. 3. We then expect a shift in the central part of the figure of the whole system of fringes, on the left upwards, on the right downwards. Further we expect interference fringes close together where the lines of Fig. 3 diverge greatly from each other, widely apart where the distance of these lines is small. No interference fringes are expected where the lines intersect. Thus the typical rhombic central part would arise in the figure.

It should still be pointed out that there is a narrow dark horizontal line in Fig. 2, this is due to a particle of dust on the slit. The vertical shadows in the lefthand part of the figure are the first indications of the absorption band spectrum of sodium.

G. C. DIBBETZ AND P. ZEEMAN. Shifts of the interference fringes by the introduction of sodium vapour into one of the paths of the Fizeau-Michelson interferometer arrangement



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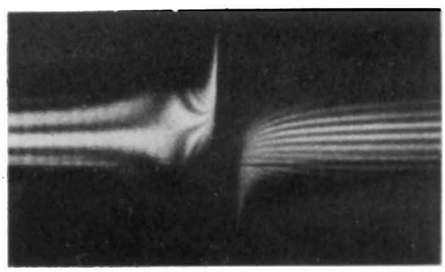

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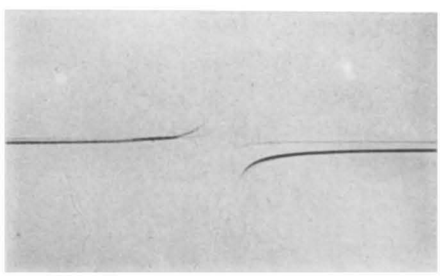

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