

of the colours and on account of the ease with which the surface can be given a satisfactory polish.

It is clear from the observations mentioned above that the colours under discussion are in the nature of *diffraction effects* arising from a film which is not continuous, but has a close-grained structure. Interesting effects are observed when the surface of the illuminated plate is viewed through a nicol, the colour and intensity of the scattered, as well as of the regularly reflected, beams varying as the nicol is rotated about its axis. The most striking effect is obtained when the direction of observation is nearly parallel to the surface of the plate. The scattered light in this case is nearly completely polarised, and the colour of the regularly reflected light changes nearly to its complementary when the nicol is turned through 90° . The phenomena strongly recall to mind the observations of R. W. Wood on the colours of a frilled collodion film on a silvered surface, which have been discussed by the late Lord Rayleigh (*Phil. Mag.*, November, 1917), and it seems probable that the explanation of the phenomena will ultimately be found to be somewhat similar in the two cases.

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MR. MALLOCK has shown that the colour of the oxide film is an *intrinsic* property of the material of which it is composed and the material retains this property as it is gradually ground down from its original thickness to the vanishing point. Sir George Beilby's observations have confirmed this, and have further shown that the film is an aggregate in *open formation* through which oxygen molecules can penetrate to the metallic surface. For each temperature above the tempering range the thickness of the film is determined by the porosity of the aggregate to the oxygen molecules at that temperature. Direct experimental observations have shown the part played by *time of heating* at any given temperature. For example, at 275° C. a deep purple was reached in ten minutes, and this changed to blue from the margin inwards during a further period of twenty minutes. It was thus shown that the watchspring-blue, which could immediately be produced by a temperature of 300° C., could also be produced by heating at 275° for thirty minutes. Sir George Beilby's view is that the *intrinsic* colours of the films which are produced at different temperatures result from changes in molecular aggregation in relatively open formation of a similar nature to those which have been shown to occur in thin metal films, e.g. gold. This is referred to in his recently published volume entitled "Aggregation and Flow of Solids," sections 3 and 10.—ED. NATURE.

Some Terrestrial Experiments on Gravitation and Einstein's Theory.

THE object of this letter is to direct the attention of writers on Einstein's theory of gravitation to some recent experiments on the terrestrial aspects of gravitation which seem to have been overlooked, although they appear to be of great importance for the purpose of forming a just estimate of the correctness of Einstein's theory.

The first investigation referred to is that of Dr. P. E. Shaw on the effect of temperature on gravitational force (*Phil. Trans.*, 1916, A, vol. 216, pp. 349-92). On p. 390 Dr. Shaw writes:—"When a large mass attracts a small one, the gravitative force between them increases by about $1/500$ as the temperature of

the large mass rises from, say, 15° C. to 215° C." The only cause capable of producing this effect on the relativity theory seems to me to be the absorption of heat by the large mass (lead), amounting to 6 calories, or 2.5×10^8 ergs per gram, and resulting in a fractional increase of inertial mass of about 2.8×10^{-13} . We require 7000 million times this amount in order to account for Dr. Shaw's result on the hypothesis of the proportionality of the gravitative and inertial masses, which is one of the basal assumptions of Einstein's theory.

Another investigation is that of Majorana on the absorption of the gravitational flux (*Phil. Mag.*, vol. 6, No. 39, pp. 488-504, 1920), in which he finds, *inter alia*, that a lead ball weighed in *vacuo* loses 7.7×10^{-10} of its weight when it is surrounded symmetrically by 104 kg. of mercury. If the gravitational flux be assumed to be absorbed by the mercury according to an exponential law of density and thickness, the *quenching constant*, or factor of absorption, is found to be 6.73×10^{-13} per unit density and length. A possible interpretation is that the gravitational mass of a homogeneous sphere at an outside point is only a fraction of its inertial mass; according to Majorana, it is about one-third for the sun. If this interpretation be legitimate, the results of Majorana, like those of Shaw, lead to the conclusion that the gravitational and inertial masses are not proportional to one another in all circumstances.

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British Scientific Instruments.

IN the timely and encouraging leader in NATURE of January 19, with which my experience is in entire agreement, there is a point of some importance to which reference is omitted. This is the practical question of cost. I would ask permission to draw a moral for application at the present time. Without expressing any opinion as to whether this cost could be reduced by improved methods of manufacture, I would direct attention to the fact that in the impoverished state of the finances of universities and similar bodies it is impossible adequately to equip their laboratories with costly apparatus.

The moral is this: *The most effective way in which Government intervention can assist British makers of scientific apparatus is to increase the grants to universities and to research in general.* It is impossible for individual workers to purchase expensive British instruments out of their own incomes, and until the resources of the laboratories in which they work are sufficiently increased it is an unjustifiable and foolish restriction to prevent their obtaining from abroad apparatus often admittedly inferior, but capable of good use. How many laboratories can afford to obtain Hilger optical apparatus or the Cambridge string galvanometer? It is further to be remembered that as science advances the instrumental equipment for continued pushing forward tends to become more elaborate, sensitive, and accurate, and necessarily of greater cost.

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Globular Lightning Discharge.

THE following is an account of what appears to have been a genuine case of globular electrical discharge observed by the sisters of one of my colleagues, the Misses Pitman, at Eastbourne on August 17 last. Authentic instances of this phenomenon are rare, and as the conditions which accompanied this particular