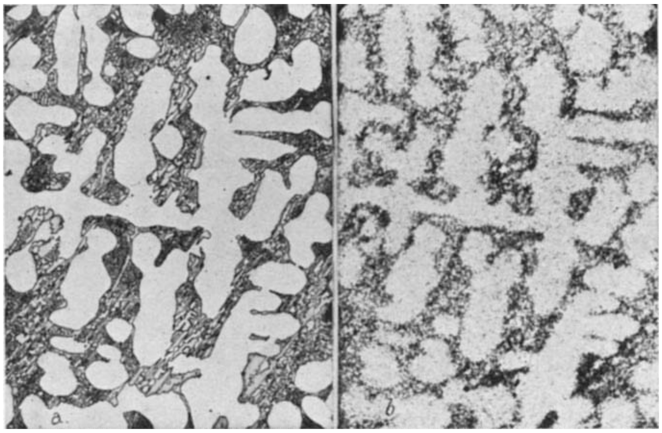

(*a*) Photomicrograph of the metal surface. Light areas: iron; darker parts: eutectic of iron and Fe_2B. × 100

(*b*) Reaction radiograph of the same surface as that shown in (*a*). Dark spots are produced by α-particles, showing position of reacting atoms of boron. × 100

I have investigated another method, which may be termed nuclear reaction radiography, since it makes use of the property of the non-radioactive element in question of reacting with an external particle radiation in such a way that a new radiation is born in the process, which is then registered on the photographic film. To use this method, the photographic film must be insensitive to the primary particle radiation used for exciting the reaction. This requirement would seem to restrict the species of available primary radiations at present to one kind, namely, neutrons. Another requirement is that the element to be detected should have a much higher probability of reacting with the primary radiation than other elements present in the material under investigation. This can be achieved in some cases by the choice of neutrons with suitable energy, making use of the fact that different reactions have different resonance energies. Finally, the radiation produced in the reaction must be of such a nature that it can be properly registered on the film.

Boron is one of those elements where the ordinary autoradiographic method fails, since no suitable radioisotope is available. Instead, conditions would seem to be favourable for the use of nuclear reaction radiography in this case. The reaction which suggests itself is:

$${}_5^{10}B + {}_0^{1}n \rightarrow {}_3^{7}Li + {}_2^{4}\alpha .$$

For thermal energy neutrons, the cross-section has the very high value of 3,000 barns. The α-particle is emitted with an energy of 1·5 MeV., which is a very favourable value for photographic trace production. The range of these particles is about 5 μ in the emulsion, and in iron it is considerably less than this. Hence, the method should be capable of yielding very high resolution. I have investigated this method, using Kodak Autoradiographic plates. These photographic plates should give very good resolution because (i) the emulsion is very fine grained, (ii) the emulsion can be stripped from the glass plate and mounted directly on the sample under investigation. A further advantage with this material is that the sensitivity to γ-radiation is very small, whereas the sensitivity to α-radiation is high.

The method has been tested on an experimental alloy made up of 98 per cent iron and 2 per cent boron. A small sample of this was ground, polished and etched, and given a thin protective coating of collodion in order to keep the surface free from tarnish in the subsequent work (otherwise it will rust very readily). The collodion film was less than 1 μ thick. The freshly stripped, wet emulsion was placed on top of this and was allowed to dry in position, which made it adhere firmly to the sample. The sample was then placed in a light-tight container, where it was irradiated for 16 min. with neutrons from a cyclotron. A block of lead, inserted between the sample and the cyclotron, served to reduce as much as possible the amount of γ-radiation reaching the emulsion. The sample was surrounded by paraffin wax in order to obtain a favourable proportion of thermal neutrons. After irradiation, the emulsion was developed and compared with the metal surface in an ordinary microscope. The results are illustrated by the accompanying reproductions. It is evident that the emulsion stripped from the sample reproduces the distribution of boron quite accurately, and that it is possible to work at quite considerable magnification.

I am grateful to the Nobel Institute for Physics in Stockholm, where Mr. S. Thulin kindly carried out the cyclotron irradiation, and to Mr. L. Erwall of the Division of Physical Chemistry at the Royal Institute of Technology, Stockholm, who placed the Kodak Autoradiographic plate material at my disposal; this emulsion undoubtedly played an important part in the success of this experiment.

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The Point-Charge in the Non-symmetric Field Theory

GAGANBIHARI BANDYOPADHYAY'S remark[1] about one of the spherically symmetric static solutions, that were given in a paper by one of us[2], is interesting, but it has not the meaning this author attributes to it. This solution cannot possibly refer to an electric charge at the centre, but only—if to anything electromagnetic—to a magnetic charge, that is, to an isolated magnetic pole. Indeed, the one component to which the six-vector is reduced in this solution is radial and is labelled by the indices 1 (referring to the radial direction) and 4 (referring to time). Now, in contrast to the conventional labelling, the present theory has to identify the electric field with the three components of the six-vector that do *not* include the index 4 (*if* the skew part of g_{ik} is to represent electromagnetism). The reason is that the theory definitely yields one and only one set of four Maxwellian vacuum equations. This set has to enunciate the vanishing of the *magnetic* four-current, not of the electric one; and this imperatively demands the association of labels indicated above. We may add that the necessity to reverse the convention is very satisfactory and is, in itself, likely to strengthen our confidence in the new theory. Indeed, very good reasons for reversing the conventional association were pointed out by Einstein[3] long ago and repeated by one of us[4] since.

Thus Bandyopadhyay's remark[1] really means that an isolated magnetic pole, attached to a finite mass, is impossible according to the more stringent version, proposed by Einstein lately[5], of the non-symmetric theory. We might strengthen this argument by saying that, to introduce as a singularity what the field equations definitely disallow where they hold, was a daring enterprise anyhow, justified only by the endeavour to investigate, at the then undeveloped stage of the theory, *all* spherically symmetric solutions.

But what about the electrically charged mass-point ? The same paper[2] (§§ 8 and 9) fully discusses this case as well, though it is analytically far more intricate and has only recently found its explicit expression (see Wyman[6]). It is gratifying to find that the only reasonable solution with a radial *electric* field is not only *compatible* with Einstein's recent more stringent version, but, of necessity, complies with it (see equations 30*b* and 23, *l.c.*[2]).

To sum up : the new theory exhibits a pleasing lack of symmetry with regard to electric and magnetic quantities. Even in its most stringent form it admits of electrically charged mass-points, while isolated magnetic poles are well-nigh inadmissible in any form of the theory.

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[1] *Nature*, **167**, 648 (1951).
[2] Papapetrou, A., *Proc. Roy. Irish Acad.*, **51** (A), 163 (1947).
[3] *Sitz. Ber. d. Preuss. Akad.*, 414 (1925).
[4] Schrödinger, E., *Nature*, **153**, 572 (1944); *Proc. Roy. Irish Acad.*, **51** (A), 215 (1948).
[5] "Meaning of Relativity", Appendix II (1950).
[6] *Canad. J. Math.*, **2**, 427 (1950).

Effect of Cross-wind on a Projectile

The usual formula for drift of a projectile due to cross-wind is :

$$z = w\,(t - x/v) \text{ (ft.)}, \qquad (1)$$

where w is velocity of cross-wind (ft./sec.), t is time of flight (sec.), x is range through air (ft.), v is muzzle velocity relative to the air (ft./sec.). At short times of flight it is not always easy to calculate $(t - x/v)$ with reasonable speed and accuracy.

By integrating the equation of motion along the trajectory

$$mx = -\rho\,(v^2 + w^2)\,v^2 f_R, \qquad (2)$$

where m is mass of projectile (lb.), x is range along the trajectory (ft.), ρ is air density (lb./ft.^{3}), r is radius of projectile (ft.), f_R is drag coefficient, and v, w are as in (1), expanding in series and substituting in (1), we obtain

$$z = 0{\cdot}000067\, wvt^2\, d^2 f_R/m \text{ (ft.)}. \qquad (3)$$

Equation (3) is easy to use, but is valid at short times of flight only. The result is better at subsonic velocities than at supersonic velocities.

It is hoped that a full account of this will appear elsewhere.

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Negative Point-to-Plane Corona—a New Mode of the Discharge

A number of investigators[1,2] in the field of negative point-to-plane corona have reported on the unsteady nature of the discharge at high values of gap voltages. Reference has been made to the movement of the active-spot about the point, and the formation of 'plural spots'. I have found that, with certain gap geometries, a new mode of discharge can be observed.

As the applied voltage is increased, the point discharge passes through an unstable 'switching phase', sometimes with two or more active spots, but quickly settles down to the new mode. This consists of a ring-shaped discharge fitting neatly and symmetrically about the point, almost like a halo. Its structure is similar in appearance to that of the single spot, namely, a miniature glow discharge, with a negative glow of pronounced luminosity, a Faraday dark space, followed by a diffused and flared positive column. As yet I have been unable to achieve sufficient optical resolution to observe the Crookes's dark space.

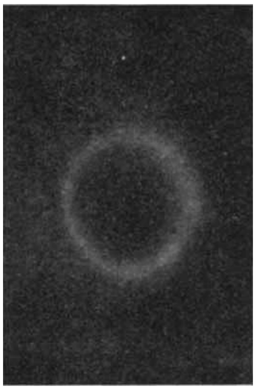

Fig. 1

It is obviously impossible to obtain a direct view on to the tip of the point, the line of vision being obscured by the plane ; however, by using a highly polished plane, the image of the point and the discharge, in the plane, may be readily seen with the aid of a suitable optical system. Observations are best carried out in total darkness with a dark-adapted eye.

Fig. 1 shows a photograph of the ring on a 1-mm. diam. steel point, taken in this way ; the point-to-plane gap was 10 mm., and the applied voltage and mean current were 10·9 kV., and 65 μamp., respectively. Fig. 2 shows a sketch of the point, drawn to the scale of Fig. 1, for the purpose of comparison.

In its new mode, the pulsating character of the corona persists, but oscillographic measurements

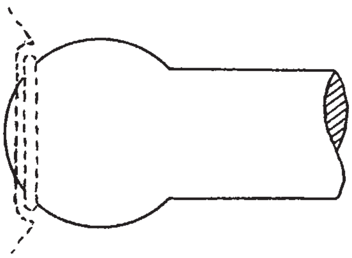

Fig. 2