The Magnetic Field acting upon Neutrons inside Magnetized Iron

F. BLOCH[1] has recently discussed the nature of the magnetic forces between electron and neutron and suggested a quantitative investigation of the magnetic scattering of slow neutrons. We have tried an alternative way of getting some information on these forces by studying the precession of slow neutrons inside magnetized iron, in order to decide whether the magnetic field H or the magnetic induction $B=(1+4\pi\varkappa).H$ ($\varkappa$ being the susceptibility) determines the angle of precession[2].

In two previous letters[3], evidence has been given of the precession of polarized slow neutrons passing through a magnetic field which is perpendicular to the direction of polarization. In consequence of the inhomogeneity of the thermal neutrons (C-neutrons) this precession leads to depolarization, the slower neutrons processing more because they stay longer in the field. Polarized C-neutrons originating from paraffin cooled down to 90° K. should be practically depolarized after passing through 7 mm. of a field of 35 gauss. On the other hand, a field of 2·8 gauss along the same path will give an average precession angle of about 15° only and very little depolarization of the neutrons.

In our experiment, C-neutrons at 90° K. were allowed to pass through an iron polarizer and an antiparallel iron analyser, both magnetized to 14,000 gauss. The stray field outside those two iron bars was less than one gauss. A long coil was interposed between polarizer and analyser, its axis, the fields in the iron bars and the neutron beam being mutually perpendicular. The path of the beam within the coil was 7 mm. Currents producing 2·8 or 35 gauss inside the coil were switched on alternately. Taking more than 600,000 counts with a boron chamber (50 per cent of which were due to C-neutrons) we obtained $(0{\cdot}83\pm0{\cdot}26)$ per cent more counts with 35 gauss in the coil than with 2·8 gauss. This is the order of magnitude to be expected for the polarization effect according to our previous experiments.

An iron sheet of 0·15 mm. thickness was then placed inside the coil and the magnetic circuit was closed by connecting the ends of the sheet by means of an iron yoke. Another 600,000 counts were taken using the same currents as before. The difference between the number of counts with the high and the low field was only $(-0{\cdot}05\pm0{\cdot}24)$ per cent this time. It is seen that the polarization effect had disappeared.

We conclude from this experiment that the lower field is sufficient to depolarize the neutron beam entirely when the iron sheet is interposed. Since the path of the neutrons within the iron sheet (where depolarization must have occurred) was only 0·15 mm., the precession of the neutrons inside the iron has to be accounted for by an 'effective field' of $\sim$ 500 gauss or more. The field strength H in the iron was 2·8 gauss only, the induction B was $\sim$ 15,000 gauss; hence B, or at least 0·03 B, must have acted upon the neutrons inside the iron.

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[1] Bloch, F., *Phys. Rev.*, **51**, 994 (1937).

[2] The equivalent problem of the deflection of electrons inside magnetized iron has been discussed by C. F. v. Weizsäcker, *Ann. d. Phys.*, **17**, 869 (1933).

[3] NATURE, **139**, 756 and 1021 (1937).

The Initial Stages of Glycolysis in Muscle Extracts

WE have already made a preliminary report[1] on the preparation from rabbit muscle, by a method involving repeated extraction with phosphate solution, of solutions of the glycolytic enzyme system, which appear to be more free from associated co-enzymes than are extracts prepared by other methods. The extracts convert starch to lactic acid in the presence of muscle *Kochsaft*, but do not do so in the presence of adenosine triphosphate, magnesium ions, cozymase and a trace of hexose diphosphate; an account of their properties, with the evidence of a participation of a new co-enzyme, will shortly be given in detail elsewhere.

In view of the current interest in the earliest stages of the transformation of polysaccharide in muscle extracts[2], we should like to direct attention to the behaviour of the extracts referred to above, in the presence of the co-enzymes, namely, adenosine triphosphate and magnesium ions, which have been regarded by most workers as effecting the initial phosphorylation in the chain of reactions. The points of interest are as follows:

(1) When magnesium ions alone have been added as co-enzyme, no esterification of phosphoric acid has ever been observed.

(2) When in addition to magnesium ions adenosine triphosphate is also present, rapid esterification takes place, and the ester formed consists at first wholly of an easily hydrolysable ester with the properties of the hexose-1-monophosphoric acid recently described by Cori and Cori[3]. In the later stages of the incubation the total amount of esterification increases more slowly and the easily hydrolysable ester is gradually converted into hexose-6-monophosphate. No other ester appears to be formed under these conditions.

(3) The rate of formation of the easily hydrolysable ester is roughly the same over a range of adenosine triphosphate concentrations from M/1,000 to M/10,000, is slightly less with M/50,000 and reduced to about one quarter with M/200,000 adenosine triphosphate. The amount of adenosine triphosphate required is therefore much less than that necessary for glycolysis as a whole to take place with optimal speed, and the amount of ester formed is far in excess of that which could be formed by simple transference of phosphate from the added adenosine triphosphate to the starch. If the mechanism were of this kind, continuous rephosphorylation of adenosine diphosphate or adenylic acid would have to take place, and no means of bringing this about seems to be present. No lactic or pyruvic acid is formed, so that the possibility of rephosphorylation from phosphopyruvic acid is ruled out. Adenylic acid itself brings about no esterification.

(4) The conversion of the hexose-1-monophosphate into hexose-6-monophosphate is much accelerated by the addition of a trace of hexose diphosphate.

The results described above are not in agreement with those reported from Parnas's laboratory[4], where esterification in the absence of any added co-enzyme was observed, or with those of Lehmann and Needham[5], who were able to confirm the findings of the above-mentioned school. The possibility that starch behaves differently from glycogen in this respect is being investigated. But since an easily measurable esterification is produced even by