of crystallisation is made possible, as was expected, by the diffusion of copper into the liquid β-brass adjacent to the solid copper crystal.

The orientation of the individual copper and β-brass crystals was determined by means of the back-reflection Laue X-ray method, with an accuracy of $\pm 0 \cdot 5°$ or better. To date, only two (of twenty) β-brass crystals have been found with a relationship accurate to within 1° :

$$\begin{array}{lll} (110)_\beta & \text{parallel to} & (111)_{\text{copper}} \\ [1\bar{1}0]_\beta & ,, & [11\bar{2}]_{\text{copper}} \end{array} \quad . \quad . \quad (1)$$

The orientations of all the β-brass crystals approximated to this relationship within a few degrees. The average deviation was about 3°. It is worthy of note that although an approximate α-β relationship does exist, the relationship is never *exact*. Possibly the matching of atomic planes and atom directions in those planes is not the governing factor which determines the orientations assumed by the β-phase.

Relationship (1) is the same as that determined by Nishiyama[1] and Wassermann[2] for the decomposition of Fe-Ni austenite.

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[1] *Sci. Rep. Tôhoku Imp. Univ.*, iv, **23**, 637 (1934).
[2] *Mitt. Kaiser-Wilh.-Inst. Eisenforsch.*, **17**, 149 (1935).

Sign of the Magnetic Moment of the Proton and of the Deuteron

THE experiments of Stern, Estermann and Frisch, which were later corroborated by us, show that the magnetic moment of the proton is about three nuclear magnetrons. This large value indicates that the theory which accounted for the electron moment will not suffice for the proton. Further, it is well known that deflection experiments are incapable of giving an indication of the sign of the nuclear moment. In the absence of a quantitative theory, this property of the proton and of the deuteron therefore becomes a matter of assumption.

We have succeeded in devising a method of making this observation of the sign which involves the use of non-adiabatic transitions in a weak rotating magnetic field: A beam of neutral hydrogen (deuterium) atoms is first deflected in a weak inhomogeneous magnetic field and then in a strong inhomogeneous field arranged to produce deflections in the opposite direction. For suitable values of the first field, it is then possible to focus atoms of all velocities in a given magnetic level on the slit of the Stern-Pirani detector. In a magnetically shielded region between the two fields is placed a set of wires carrying current which produce weak, rapidly varying magnetic fields to induce non-adiabatic transitions between the different magnetic levels. A movable selector slit allows one to sort out the atoms of positive overall moment from those with negative overall moment which have the same magnitude. On examining the moments from the two $m=0$ levels of hydrogen, it was found that the atoms in the state with negative overall moment were capable of making the transitions, but those with positive overall moment were not. Since no transitions between the $F=1$ and $F=0$ levels are produced with the method, the state with positive overall moment has $F=0$; the hyperfine structure multiplet is normal, and the magnetic moment of the proton is positive. Similar experiments with deuterium show that the deuteron moment is also positive.

Full details will appear elsewhere.

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The New Electrodynamics and the Fine Structure Constant

THE new electrodynamics put forward by M. Born[1] changes the form of Maxwell's equations. The question arises, whether this generalisation is the only one which gives a finite mass for an elementary particle and becomes, for weak fields, the Maxwellian equations.

Starting from a new form of the variational principle[2], it is possible to show that, by accepting quite obvious assumptions, there exists a group of action functions, depending on a parameter, say β, which leads for every $\beta > 0$ to a unitarian field theory, fulfilling both the conditions; that is, giving finiteness of energy and Maxwell's equations as a limiting case. Born's action function corresponds to $\beta = 1$. The choice between all the different theories can be made only by applying criterions arising from the further development of the theory. A very simple theory corresponds to the limiting case $\beta = 0$. The Lagrangian takes in this case the form (for the sake of simplicity we assume that L is dependent only on F):

$$L = \tfrac{1}{2} \log (1 + F) = \tfrac{1}{2} \log (1 + \vec{B}^2 - \vec{E}^2) \quad . \quad . \quad . \quad . \quad (1)$$

Calculating the mass m of an elementary particle, we find in natural units (in which $e = 1$, $c = 1$, b = absolute field = 1):

$$m = \sqrt{\tfrac{8}{9}} \times 1 \cdot 2361 \quad . \quad . \quad . \quad . \quad (2)$$

slightly different from the value $1 \cdot 2361$ obtained in Born's theory.

Heisenberg and Euler and Kockel[3] have shown that the scattering of light by light can be expressed as a result of non-linear correction terms to Maxwell's equation, corresponding to a Lagrangian (still in natural units):

$$L = \tfrac{1}{2} (\vec{B}^2 - \vec{E}^2) - \frac{1}{90\pi} \frac{1}{m^4} \frac{1}{\alpha} (\vec{B}^2 - \vec{E}^2)^2 + \ldots (3)$$

α being the fine structure constant. Putting in (3) the value (2) for m and comparing it with the Lagrangian (1)

$$L = \tfrac{1}{2} (\vec{B}^2 - \vec{E}^2) - \tfrac{1}{4} (\vec{B}^2 - \vec{E}^2)^2 + \ldots,$$

we can calculate $1/\alpha$, and find $1/\alpha = 130$, which is close to 137, whereas Born's theory gives $1/\alpha = 82$.

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Feb. 18.

[1] M. Born, *Proc. Roy. Soc.*, A, **143** (1934); M. Born and L. Infeld, *Proc. Roy. Soc.*, A, **144**, 425 (1934).
[2] L. Infeld. *Camb. Phil. Soc.* (in the press).
[3] Heisenberg and Euler, *Z. Phys.*, **98**, 714 (1936); Euler and Kockel, *Naturwiss.*, **23**, 246 (1935).