10 minutes. The total time of the experiment was about 12 hours.

As a result there was revealed the presence of 15 recoil protons the energy of which is represented graphically in Fig. 2 (protons of energy 10^6 e.v. and

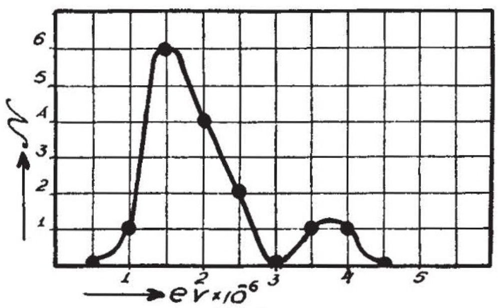

FIG. 2.

above are detected by this method). The greatest energy of the observed protons was $\sim 4 \times 10^6$ e.v. Thus the upper energy limit of the neutrons spontaneously emitted by some disintegration products of phosphorus is at any rate $\geqslant 4 \times 10^6$ e.v.

In conclusion, I wish to express my best thanks to Mr. A. Jdanoff for his kind help.

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[1] *C.R.*, **198**, 2089; 1934.

The Fundamental Paradox of the Quantum Theory

ACCORDING to the general principles of the quantum theory, physical variables $a, b, c, \ldots$ are represented by symmetric linear operators $A, B, C, \ldots$ in Hilbertian space; and the representation satisfies the following conditions:

$$a^2 \to A^2, \lambda a \to \lambda A, \text{ (}\lambda\text{ being an ordinary number)}$$
$$a + b \to A + B.$$

Since $ab = \frac{1}{2}(a+b)^2 - \frac{1}{2}(a-b)^2$, it follows that $ab \to \frac{1}{2}(AB + BA)$.

Similarly,

$$ab.c \to \tfrac{1}{4}(AB + BA)C + \tfrac{1}{4}C(AB + BA),$$
$$ca.b \to \tfrac{1}{4}(CA + AC)B + \tfrac{1}{4}B(CA + AC),$$
$$bc.a \to \tfrac{1}{4}(BC + CB)A + \tfrac{1}{4}A(BC + CB).$$

The general principles will therefore lead to a contradiction unless these three operational representations of abc are all equal. This implies that

$$A(BC - CB) = (BC - CB)A,$$

with two similar equations. Hence the commutator $(BC - CB)$ of any two operators representing physical variables must commute with every operator representing a physical variable. Therefore, by Schur's lemma, $(BC - CB)$ must be a numerical multiple, $\lambda_{BC}I$, of the unit matrix I, in any irreducible matrix representation.

Now, if $ab \to X$,

$$\lambda_{XC}I = XC - CX = \tfrac{1}{2}(AB + BA)C - \tfrac{1}{2}C(AB + BA)$$
$$= \lambda_{BC}A + \lambda_{AC}B.$$

Hence $\lambda_{XC} = \lambda_{BC} = \lambda_{AC} = 0$, and all the commutators vanish. Therefore any *two operators which represent physical variables must commute.* This result can only be reconciled with the accepted exchange relations by taking the numerical value of Planck's constant to be zero. This destroys the whole structure of the modern form of the quantum theory.

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Chromosomes of the Tulip in Mitosis

IN a recent study of the development of the male gamete in the style of *Lilium regale*, O'Mara[1] states that no equatorial plate is formed, but that at metaphase the chromosomes lie scattered in the pollen tube. Welsford[2], on the other hand, illustrates in *L. Martagon* (her Fig. 16) the complement normally arranged on a plate.

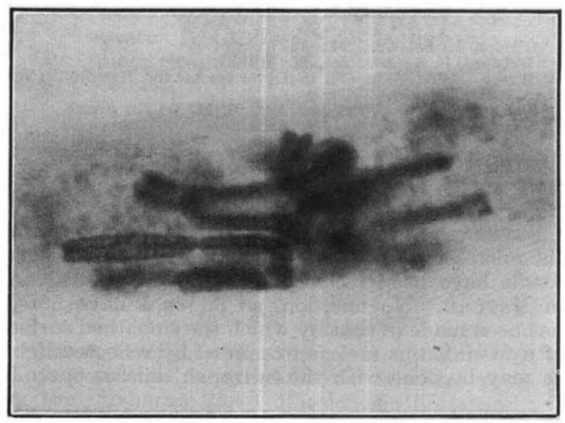

FIG. 1. Pollen tube division of *Tulipa Greigi* from an artificial culture of pollen, 24 hours after sowing on 14 per cent cane sugar agar.

I have obtained pollen tube divisions in *Tulipa Greigi* in artificial culture, using McClintock's aceto-carmine method (Fig. 1). The metaphases are perfectly normal, with a definite equatorial plate, and the anaphases resemble those of the pollen grain except that the poles of the spindle are considerably farther apart.

In my experiment, the artificial medium may permit of the formation of wider pollen tubes than in *L. regale*. It is unlikely, however, that an irregular metaphase would give the regular anaphase distribution required to produce the viable gametes of this species. More probably, therefore, a true metaphase plate is formed, though the stage may be rapid and not easy to find.

The technique which I have used further reveals the structure of the mitotic chromosomes in a way not otherwise possible. The method can only be applied to the study of mitosis in pollen grains and pollen tubes, but the thick wall of the pollen grain apparently modifies the action of the fixative.

By this fixation the chromosomes show striations which are independent in each chromatid, and are presumably caused by a slight separation of the coils of the spiral chromosome thread. It is not possible to determine the direction of coiling, but there is evidently no change of direction, since there are no breaks in the spacing of the coils.