Letters to the Editor

PROMPT publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible or the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

Fission Products of Uranium by Fast Neutrons

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IN our previous note[1] on the above problem, we reported having obtained a rhodium isotope of a half-life 34 hours and ruthenium isotopes of half-lives 4 hours and 60 hours, respectively. Since then we succeeded in obtaining a stronger ruthenium fraction and closer studies revealed that the decay curve of the 60-hour ruthenium was in reality the superposition of the growth and decay curve of the 34-hour rhodium produced from the 4-hour ruthenium and the decay curve of a ruthenium isotope of a few months period.

The experimental procedure was as follows. From the sample which was purified and irradiated exactly as before, ruthenium was separated as tetroxide, RuO_4, which was freed from all known fission products. The tetroxide was then reduced to metal and its activity measured. The decay curve showed at first a period of 4 hours.

To see if there is any daughter product of the ruthenium, rhodium was separated from this sample after 12 hours from the time of the first separation of ruthenium and tested for its activity. The decay curve showed a single period of 34 hours. We thus conclude that the 4-hour ruthenium is the mother substance of the 34-hour rhodium.

The ruthenium metal obtained from the same sample gave again a complicated decay curve, which is the superposition of the growth and decay curve of rhodium and ruthenium as mentioned above.

Recently Segrè and Seaborg[2] also reported in this column having obtained the 4-hour ruthenium as a fission product of uranium and thorium. These authors established the genetic relationship between Pd^{111} (26 mo.) and Ag^{111} (7.5 days), which we could not find owing to the lack of intensities in our case.

The above investigations were carried out as a part of the work of the Atomic Nucleus Sub-Committee of the Japan Society for the Promotion of Scientific Research. We acknowledge the assistance given by our laboratory colleagues in connection with the irradiation of samples.

[1] Y. Nishina, T. Yasaki, K. Kimura and M. Ikawa, Phys. Rev. **59**, 323 (1941).
[2] E. Segrè and G. T. Seaborg, Phys. Rev. **59**, 212 (1941).

On the Einstein Condensation Phenomenon*

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IN a recent paper, L. Goldstein[1] has discussed the behavior of an ideal Bose-Einstein gas in the presence of an external force field. He did not apply his general results to the case of a gas in a gravitational field, but in view of the long debate[2-5] on the subject of the condensation of a Bose-Einstein gas in coordinate and momentum spaces, it seems worth while to examine this particular case in more detail. Goldstein found that for temperatures below the critical temperature T_f, a condensation occurs in which a finite fraction N_0/N of the atoms are found in the regions of phase space of lowest momentum and least potential energy. His distribution function is essentially a delta function in both momentum and coordinate spaces, i.e., the condensed phase is all to be found on the bottom of the vessel with zero velocity. As it stands, of course, this result is inconsistent with the uncertainty principle, because for convenience, the preceding calculations were carried out in the partly classical limit in which an integral over the vertical coordinates was used in the sum of states. If instead, one considers the discrete character of the energy spectrum for the lowest states in the potential field present, one finds that the condensed phase is all to be found in the lowest quantum state for the vertical motion, and that the thickness of the layer on the floor is of the order

$$t=1.8(\hbar^2/m^2g)^{\frac{1}{3}}$$

(as may be estimated with sufficient accuracy by the WKB method) where g is the acceleration due to gravity, m is the mass of the atom. It is assumed here that the height of the box is large compared with t. For helium in the earth's gravitational field, one finds $t=5.5\times10^{-3}$ cm, a small but not microscopic distance. At a height $z>t_0$, the density falls off proportionally to $\exp-4.8[(z-t)/t]^{\frac{3}{2}}$.

The forces between the atoms in an actual gas and the forces due to the walls would considerably modify the above behavior, but some remnant of it might be found if the Einstein condensation plays any role in the case of liquid helium II.

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[3] G. E. Uhlenbeck, "Over statistische Methoden in de Theorie der Quanta," thesis (Leiden, 1927).
[4] L. Brillouin, *Die Quantenstatistik*, p. 142.
[5] F. London, Nature **141**, 643 (1938); Phys. Rev. **54**, 947 (1939); J. Phys. Chem. **43**, 49 (1939).