Letters to the Editor.

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The Small Haloes of Ytterby.

THE following letter, received from Mr. Svein Rosseland, of the Institute of Theoretical Physics, University of Copenhagen, contains an interesting suggestion. I publish it with the writer's consent.

" . . . In connection with your letter to NATURE of April 22 on radioactive haloes in Ytterby mica I venture to comment upon the probable location of the hypothetical element in the periodic table. You make in your letter the interesting remark that the element cannot belong to the radioactive disintegration series previously known, since the life period, according to the Geiger-Nuttall relation, would have to be so immensely large, and the intensity of the radiation correspondingly feeble, that it is difficult to believe that the radioactivity of the element could be detected. This remark raises the question of the origin of the energy of the α-particles and the meaning of the above-mentioned relation.

Now it is known that the α-particles are strongly repelled by the nuclear electrostatic field of the parent atom, and it is clear that this repulsion must contribute appreciably to the energy of the particle. Without further knowledge of the exact dimensions of the nucleus and the character of the field close to it we cannot of course calculate the relative importance of this energy in the resulting energy of the particle, but we can calculate inversely a minimal radius for the nucleus of the transformation product by supposing the whole energy to be due to the nuclear electrostatic repulsion.

In this way we obtain a series of minimal radii for the elements consecutive to the α-radiating elements. The longer the life period the larger is this radius. The largest radius is afforded by uranium-X_1, where, corresponding to a range of 2·53 cm. N.P.T., it comes out as $6{\cdot}5 \times 10^{-12}$ cm. This value is so large that in view of the experiments on single scattering it seems improbable that the real radius will be much greater. But then we are led to the assumption that the main part of the energy of the α-particle from uranium-1 comes from the nuclear repulsion. As it seems unlikely that variations in the nuclear dimensions will be so large as to account for the energy of the swifter α-particles, there must be an energy term of expulsion from the nucleus, resembling in some respects the energy difference between two stationary states of an atom. If we assume the term due to electrostatic repulsion to be only slightly variable, as is the case if the nuclear dimensions vary but slightly, the variability of the ranges of the α-particles will be due mainly to variations in this energy of expulsion, and it is this which is linked to the life period of the elements according to the Geiger-Nuttall relation. It seems not wholly improbable that the difference between the constants in this relation corresponding to the different series may ultimately be due to differences in the nuclear dimensions.

If the Ytterby haloes were due to an element of an atomic number of the order found in the families of the known radioactive elements, the nuclear dimensions of its transformation product would be nearly 1·8 as large as that calculated for uranium-X_1. If, on the other hand, we reject such a size for the nucleus as improbable, we can calculate the atomic number of the element in question by assuming a law for the large scale variation of the nuclear radii, assuming at the same time the energy of expulsion of the transformation to be small. As the volume of the protons included in the nucleus on the basis of current opinion is negligibly small, it seems natural to assume as a rough approximation that the volume of the nucleus is simply the sum of the volumes of the individual electrons contained in the nucleus, where, however, this electronic volume is not necessarily equal to that calculated from the mass of the electron. This assumption is equivalent to assuming the nuclear radii to be proportional to the third root of the number of electrons in the nucleus, $A - N$, where A is the atomic weight and N the atomic number.

Calculating in this way the radius of the transformation product of the element in question corresponding to a range of 1 cm. in air we finally arrive at an atomic number in the neighbourhood of 40. Since the β-radiating element rubidium is number 37 this calculation immediately suggests that hibernium is identical with yttrium, which is related to rubidium just in the right way to account for the β-radioactivity of the latter.

This calculation of course is to be regarded merely as a suggestion, but I should be interested to know if yttrium were ever found to be associated with Ytterby mica."

The conclusion arrived at by Mr. Rosseland seems not improbable. In a paper by Ivar Nordenskjöld (Bull. of the Geol. Inst. of Upsala, vol. ix.) two analyses of the black mica of Ytterby are given, one referring to a much altered variety and the other to a less altered mica. The former contains yttrium, the latter contains none. This suggests that the yttrium has been introduced in the process of alteration. The mica containing the reversed or bleached haloes has, to all appearance, been considerably altered. It is therefore probable that it contains yttrium. On the other hand, according to Mr. Rosseland's theory, rubidium should be present, or—derived from it by loss of a β-ray—strontium. Neither of these elements appears in the analyses. Nor am I aware of any mineral analysis in which there is an association of any two of the elements in question. But it is, of course, quite possible that spectroscopic examination of yttrium minerals would reveal such traces of rubidium and strontium as would support Mr. Rosseland's deductions.

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Muscular Efficiency.

IN NATURE, April 15, 1920 (vol. 105, p. 197), there is a letter of mine on this subject, and the proposition there given relating to maximum efficiency is in the following applied to the case of the most efficient speed for a bicycle. The values chosen for the constants are merely guesswork, but the result is more or less in accordance with the facts.

The assumptions made are :

(1) The total power developed remains constant.

(2) All the power used in the acceleration of the limbs is lost.

(3) There is a perpetual leakage of power when a muscle is exerting any force.

I do not suppose that (1) is strictly true, but the tendency is in that direction.