sequence of levels (for the neutrons) could correspond to such a subshell:

$$\ldots 7i_{13/2}\big|_{126}\, 6g_{9/2},\ 7i_{11/2},\ 4s\big|_{150}\ldots$$

or

$$\ldots 7i_{13/2}\big|_{126}\, 6g_{9/2},\ 4s,\ 5d_{5/2},\ 6g_{7/2}\big|_{152}\ldots$$

We express our gratitude to Prof. D. D. Ivanenko for valuable suggestions and discussions.

*Note during proof reading:* After this communication was sent to press, we learned of a paper[13], the authors of which, on the basis of $\alpha$-decay energy values (among others also those of $Cf^{248}$ published for the first time) come to the conclusion that a subshell exists at $N = 152$. In view of this paper, the second of our level sequences above should be considered the more probable one.

Translated by M. G. Jacobson
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## The Problem of Spontaneous Fission and Beta-Stability

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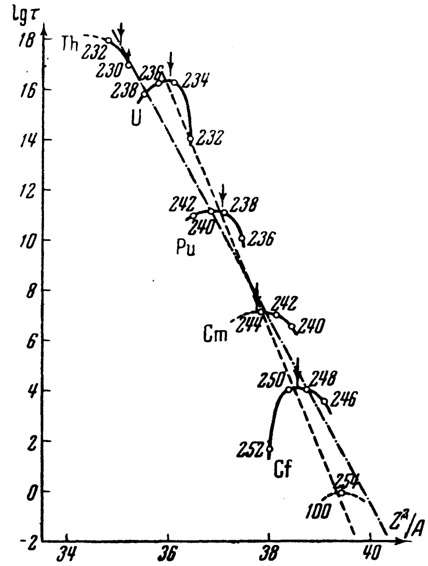
THE probability of fission of nuclei depends on the effective height of the potential barrier (that is, on the critical fission energy) and also on its width. Inasmuch as the critical fission energy, according to the theory of fission, is a




Dependence of lg $\tau$ ($\tau$ – in years) on $Z^2/A$

function of the parameter $F = (Z^2/A)$, it can be expected that the probability of fission also will depend on this quantity. It was indicated by Seaborg[1] and others[2,3] that the relationship between the logarithm of the probability of spontaneous fission (or lg $\tau$) and $Z^2/A$ is nearly linear. However, further and more detailed investigation showed that such a relationship is at least not accurate. First, the uneven nuclei, which have a relatively low probability of spontaneous fission (in comparison with the even-even nuclei) do not fit into this general relationship. Second, and this is especially important, there is observed a maximum of stability with respect to spontaneous fission among the isotopes of a given element.

We wish to call attention to the fact that the maximum stability with respect to spontaneous fission fairly accurately coincides with the maximum of $\beta$-stability for the isotopes of a given element. We can convince ourselves of this, for instance, by examining the curve expressing lg $\tau$ as a function of $Z^2/A$ (see accompanying figure). The experimental values for the lifetimes with respect to spontaneous fission $\tau$ are taken from the literature[4,5]. On the accompanying figure, points pertaining to isotopes of any one element are connected by solid lines. The curves obtained in this way sharply deviate from the linear relationship of Seaborg (the dash-dot line on the figure); they reach a maximum at some value of $A$ and fall off both in the region of the lighter as well as of the heavier isotopes of the element. The latter fact is unexpected from the point of view of elementary fission theory.

Especially sharp bends of such curves are observed for the heavy isotpes of U and Cf. The maxima of the curves pertaining to single elements all lie almost on a straight line (the dotted line of the figure), and the values of $Z^2/A$ corresponding to these maxima coincide very well with the values of $Z^2/A^*$. The values of $A^*$ are taken from a stability curve, constructed from data on $\beta$-disintegration[6] and correspond to such $A$'s, at which maximum $\beta$-stability is obtained for the isotopes of a given element. (The values of $A^*$ are indicated on the figure by little arrows.) Note that in the case of thorium it is difficult to come to a definite conclusion at present, because of insufficient data, one of which is unreliable ($Th^{230}$).

The dependence of $\lg \tau$ on $Z$ and $A$ can be expressed by an empirical formula:

$$\lg \tau_{\text{years}} = -4.85 (Z^2/A^*) + 191 - 0.063 (A - A^*)^2. \quad (1)$$

The last term is added to make the formula applicable for nuclei which are not at the maximum of stability. Let us note that in the interval of mass numbers $A$ under consideration, the values for $A^*$ are given by the approximate relationship:

$$A^* \approx 2.5\ Z + 5. \quad (2)$$

Substitution of Eq. (2) into Eq. (1) shows that when $A \approx A^*$, $\lg \tau$ is approximately proportional to $Z (\lg \tau \sim Z)$. This conclusion is confirmed also by a direct examination of the dependence of $\lg \tau$ upon $Z$.

A possible reason for the considerable deviations from the simple relationship of Seaborg above described is the incorrect form of the formula for the binding energy and hence also for the parameter $Z^2/A$. One of the most important factors, influencing the above described deviations, is the different susceptibility to deformation of the various nuclei[4]. It appears reasonable to consider that nuclei which are close to the $\beta$-stability curve and possess a greater binding energy with respect to other isobars, are less subject to deformation. On the contrary, nuclei which are located far away from the stability curve, and which have a lower binding energy, are more deformed. This deformation makes the crossing of the potential barrier easier. Such an explanation appears the nearer to the truth in view of the fact that the lower excited levels of the nuclei which are near the $\beta$-stability curve are elevated with respect to the levels of other isobars.

It is possible that some deviations from the relationship given by formula (1) in special cases are connected with the different deformations of the proton configuration (and also neutron configuration) inside the nuclei. The lower probability of spontaneous fission for uneven nuclei with respect to even-even nuclei[8] can apparently be explained in a similar manner, assuming their lower susceptibility to deformation. An assumption of this kind has already been made for the explanation of the differences in isotopic shifts between even and uneven isotopes.

For a series of valuable remarks and discussion of the problems of this paper, we express our gratitude to Professor D. D. Ivanenko.

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## On the Paper of G. M. Avak'iants "The Theory of the Transfer Equation in Strong Electric Fields."[1]

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THE necessity for a theoretical investigation of the properties of semi-conductors placed in strong electric fields has existed for a long time. The dependence of the electric conductivity obtained by Davydov[2], as is known, is not confirmed by experiment for many semi-conductors.

G. M. Avak'iants undertook the task of looking into the phenomena of transference in semi-conductors in which the electron gas is strongly heated. It should be noted that while investigation of galvanomagnetic phenomena is undoubtedly of interest, the same cannot be said of thermoelectric and of thermo- and photomagnetic effects. More than that,