# Searches for the formation of superdense nuclei in fission

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A search is carried out for superdense nuclei produced in fission and whose decay is accompanied by the emission of high-energy $\beta$ particles. It is established that at an energy $E_\beta > 20$ MeV the electron yield does not exceed $2\times 10^{-8}$ per event of fission of californium-252.

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1. The $\beta$ emission of the fission products of a number of heavy nuclei have been investigated in recent years.[1-3] These studies, however, were made at electron energies $E_\beta$ up to 10 MeV and yielded no information on the hard part of the spectrum ($E_\beta > 10$ MeV).

Yet the region $E_\beta \gtrsim 15$ MeV is of interest from the point of view of observing "unusual" events that can occur in fission, such as production of nuclei near the limits of nuclear instability or, for example, the appearance in the fission of superdense fragments[4] whose decay is accompanied by emission of high-energy $\beta$ radiation. The expediency of searching for such superdense nuclei (SDN) was pointed out in[5].

A recent paper[6] describes an attempt to detect SDN among the fission fragments by means of the hard gamma and neutron emission. We have undertaken investigations of the high-energy part of the electron spectrum ($E_\beta > 10$ MeV) of the fission products of californium-252. The preliminary results were published in[7]. An increase in the sensitivity of the experiment was attained by placing the installation in an underground laboratory (depth 80 m water equivalents) and improving the characteristics of the apparatus.

2. The installation consisted of a scintillation $\beta$ spectrometer. The electrons emitted by the $^{252}$Cf source were energy-analyzed by a plastic scintillator of 10 cm diameter and 11 cm height (principal detector). To decrease the background due to the neutron and $\gamma$ radiation and the cosmic-ray background, we used a thin (0.4 mm) flow-through detector made of scintillating plastic; the pulses from the detector authorized the analysis of the events registered in the principal scintillator. An additional decrease of the cosmic-ray background was obtained with an anti-coincidence scintillator plate measuring $1.1\times 1.2$ m and covering the spectrometer from above. Calibration measurements have shown that the scale is linear within 3% and the resolution at an electron energy 1 MeV is 17%.

3. We used californium-252 sources of intensity $1.8\times 10^5$–$10^3$ fissions/sec. The principal background component that determined the sensitivity of the method were the random coincidences between the heavily loaded flow-through detector and the

  

hard radiation accompanying the fission of $^{252}Cf$, which was registered by the principal scintillator. Control measurements of the possible superposition of the pulses in the principal detector have shown that at $E_\beta > 14$ MeV their contribution is negligibly small.

The measurement results are presented in the form of a table (the error contains one standard deviation). It is seen from Table I that within the limits of the experimental sensitivity the effect is practically nonexistent. We assume a value $2\times10^{-8}$ per fission as the upper limit of the yield of the $\beta$ particles with energy $E_\beta > 20$ MeV in the fission process.

TABLE I.

| Electron energy, MeV | > 14 | > 16 | > 18 | > 20 |
|---|---|---|---|---|
| $\beta$/fission | $(1.5 \pm 1.4)\cdot10^{-7}$ | $(3.5 \pm 3.0)\cdot10^{-8}$ | $(0 \pm 2.2)\cdot10^{-8}$ | $(0 \pm 2.0)\cdot10^{-8}$ |

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