IN-FLIGHT FISSION STUDIES OF RADIACTIVE SECONDARY BEAMS

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Relativistic heavy secondary beams offer the unique possibility to study the fission of unstable exotic nuclei in inverse kinematics. At the SIS-FRS facility of GSI, Darmstadt, a primary beam of 950×A MeV ^{238}U was used to produce heavy nuclei by projectile fragmentation in a copper target. By applying a combination of in-flight separation techniques, isotopically separated secondary beams of neutron deficient isotopes of uranium, protactinium, thorium and actinium were prepared. The fission of these nuclei was induced by electromagnetic interaction as well as by nuclear interaction in a lead target. The nuclear charges Z_1 and Z_2 were determined simultaneously from their energy loss in an ionization chamber. These measurements showed that the transition from symmetric to asymmetric fission takes place near N=138 [1].

In a recent experiment, we improved the quality of the data by use of a new time-of-flight detector for the fission fragments. Thus, the fission-fragment velocities could be measured which resulted in an improved Z-resolution for the fission fragments. Neighboring elements are now well separated, and via a condition on the sum of Z_1 and Z_2 it is possible to distinguish event-by-event between low-energy fission after electromagnetic excitation with an average excitation energy of about 12 MeV, and fission of highly excited prefragments resulting from nuclear reactions in the lead target.

When moving from ^{234}U to ^{222}Th, a change in the sum spectrum $(Z_1 + Z_2)$ indicates a dramatic change in the fission process induced in the lead target. Electromagnetic fission seems to be almost completely suppressed and high-energy fission dominates, although the fissionability parameter Z^2/A stays about the same. Calculations indicate that this may be attributed to the influence of the N = 126 shell which increases the fission barrier of ^{222}Th, thus reducing its fission probability and suppressing low-energy fission.

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References

1) K.-H. Schmidt, A. Heinz, H.-G. Clerc, B. Blank, T. Brohm, S. Czajkowski, C. Donzaud, H. Geissel, E. Hanelt, H. Irnich, M. C. Itkis, M. de Jong, A. Junghans, A. Magel, G. Münzenberg, F. Nickel, M. Pfützner, A. Piechaczek, C. Röhl, C. Scheidenberger, W. Schwab, S. Steinhäuser, K. Sümmerer; W. Trinder, B. Voss and S. V. Zhdanov, Phys. Lett. B 325 (1994) 313-316