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Shell-driven Fission across the Nuclear Chart

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Results are presented from a broad, systematic study of heavy-ion induced fusion-fission mass distributions carried out at the Australian National University, covering a significant part of the chart of the nuclides. Fission characteristics of isotopes of every even-Z compound nucleus (ZCN) from 14464Gd to 21290Th were measured. Systematic evidence of shell-driven structure is present in every fission mass distribution. The results for the heavier systems are consistent with proton fusion-fission measured at lower excitation energies, near the fission threshold. In heavy ion fusion the structure is, as expected, significantly less pronounced, meaning great care must be taken in the data analysis and fitting process.
The changing shape of the heavy-ion fission mass distributions with ZCN can be visualised through the residuals from single Gaussian fits. These results are consistent with quantitative fitting of the measured 2-D mass and total kinetic energy spectra using multiple components. Both approaches demonstrate that fragment proton shell gaps at ZFF ~ 34, 36 and at ZFF ~ 44, 46 are major drivers of fission mass distributions for nuclei below the actinide region.
For all systems, a second more mass-asymmetric fission mode is required to fit the fission mass distributions. If driven by a single shell gap, it appears to be in the light fragment around ZFF ~ 28, 30 or possibly N ~ 36.
The apparent universal influence of shell gaps on fusion-fission raises questions about the influence of shells gaps in quasi-fission, where recent results suggest that shell effects do not play such a strong role as previously believed.

Type of contribution

Invited Speaker

Primary author: HINDE, David

Presenter: HINDE, David

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