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Quenched production of neutron-rich nuclei in fragmentation reactions of medium- mass and heavy projectiles

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Fission of 238U and fragmentation of 132 Xe projectiles at relativistic energies have been used at GSI to produced medium-mass nuclei around 132Sn [1]. The first section of the Fragment Separator made it possible the unambiguous identification of those nuclei, while the second section was used to identify the residual nuclei produced in proton and neutron removal reactions induced on a beryllium target installed at the intermediate image plane of the separator.

The one neutron removal cross sections are in good agreement with recent measurements at RIKEN for 134Sn [2], showing a clear reduction at N=84 explained by the N=82 closed shell. All measured cross sections are rather well explained by model calculations based on particle-hole excitations from shell model configurations and initial- and final-state interactions.

The proton removal cross sections are also in agreement with previous measurements [3,4]. The observed reduction in the cross sections for N=83 nuclei (133Sn and 134Sb) is explained as due to the N=82, while the relative difference between those two nuclei is attributed to the shell Z=50. The same model calculations describing the neutron removal show the observed reduction produced by the closed shells, but in general overestimate the measured cross sections by around a 40%. This quenching of the proton removal channels corresponds to a reduction of the production cross sections of neutron-rich nuclei compared to the predictions obtained with fragmentation models.

The presence of 20% short-range correlated (SRC) nucleon pairs in nuclei, and the recent confirmation of the dominance of neutron-proton SRC pairs [5] provide a possible explanation for the observed reduction in the proton-removal cross sections. The relative large number of SRC protons in neutron-rich nuclei (~30% in 132Sn), and the fact that the removal of any of those protons causes the ejection of the companion neutron because of the large relative momentum between both, would explain the 40% reduction in the cross section of the final A-1 residual nuclei produced in the single proton removal process.

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