MULTIPLE COULOMB EXCITATION AND TRANSFER STUDIES OF NEUTRON-RICH NUCLEI BEYOND N=40

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Of special importance for r-process nucleosynthesis is a fundamental understanding of shell evolution towards neutron-rich nuclei. The finding of a soft N=2 harmonic oscillator (h.o.) shell in the "Island of Inversion" (N=20) was the first discovery of changing shell structure in exotic nuclei. Recent experiments at the RIKEN Nishina Center (Japan) indicate a soft N=3 h.o. shell (Z=40) for extremely neutron-rich nuclei, which would effect the r-process flow in a dramatic way. We will discuss the underlying physics and report on our recent experiments at the radioactive ion beam facility ISOLDE using the high-granularity MINIBALL array and an upgraded silicon detector. In a series of studies we have probed the N=3 neutron h.o. shell gap around and beyond doubly-magic ^{68}Ni. In a multiple Coulomb excitation experiment using an unstable ^{72}Zn beam we were able to measure the collectivity of the shape-coexisting excited 0^+ state in ^{72}Zn in a direct way. Its low collectivity sheds light into the mixing of spherical and deformation driving configurations at N=40. The inverting role of proton $f_{5/2}$ and $p_{3/2}$ orbitals is understood from the properties of the tensor force. The detailed data set allows to extract triaxiality shape parameters for the ^{72}Zn ground state band, indicating an increased deformation beyond N=40 and clarifying on conflicting evaluated data. New shell model calculations also show that the classical $fpg_{9/2}$ configuration space has to be extended to accurately describe our new data after two-neutron transfer using a tritium target at ISOLDE, populating excited states in neutron-rich ^{74}Zn.