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Direct evidence of melting shell-gap of the neutron-rich nuclei through novel spectroscopic tool

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Understanding the limits of existence of the quantum many body systems is an open and urgent problem in the fundamental of science. Both theoretical and experimental investigations are pursued to understand the unusual properties of the quantum many body system, the atomic nuclei, at the limit of its existence. Melting of the shell gap at magic number of the exotic nuclei is one of the important observations [1]. RIB facility provide us excellent opportunity to explore this outstanding problems. Coulomb breakup is a sensitive spectroscopic tool to probe the ground state properties [2]. Due to large spatial extension, enhanced threshold strength can be observed. The shape and magnitude of this threshold strength of the nuclei is a direct fingerprint of the quantum numbers of valence nucleon and its occupation probability for that particular quantum state. The ground state properties of psd shell nuclei have been explored through kinematics complete measurement. Recently, using this method, an experiment (S306) has been performed to explore the ground state properties of a number of exotic sd–pf shell neutron-rich nuclei around (N~20) using LAND-ALADIN-FRS setup at energy 400-430 MeV/u. The shape of the differential CD cross section suggests that the predominant ground-state configurations are 28Na(1+)xns,d, 29Na(3/2+)xns,d for 29Na(3/2+), 30Na(2+) [3,5] isotopes, respectively. First time, very clear evidence of reduced shell gap between p3/2 and f7/2 shell has been observed through the data analysis of Coulomb breakup of 35Al (N=22). This results clearly indicate the breakdown of magic number N=28. It is evident from present experimental data of Coulomb dissociation of 31Na(N=20), 33Mg (N=21) [4,6], the ground state configuration is dominated by (~ 80 %) core excited states. This is direct evidence of sufficiently reduced shell gap at N=20 for 31Na and 33Mg [4,6]. I would like to present these exciting experimental results and discuss about the limitations of the present measurements. I would like to discuss how, one may overcome these limitation using future advanced instrumentation.

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