Contribution ID: **278** Type: **Parallel**

Weakly Bound Neutron-Rich Nuclei and Cosmic Phenomena

Friday, 1 June 2018 18:10 (20 minutes)

Understanding the limits of existence of nuclei is an open problem in fundamental science. Lack of understanding of the nucleon-nucleon interaction in nuclei with unusual neutron to proton ratio is one of the main reasons. Thus it is an urgent problem to find out the missing link of unified theory by studying single particle and bulk properties of the nuclei with large neutron proton asymmetry. The shell gaps at magic numbers are the characteristics of a mean nuclear field. The unambiguous information on detailed components of the ground-state wave-function along with quantum numbers of the valence neutron of the nuclei can be obtained from the measurement of threshold strength along with the γ-ray spectra following Coulomb breakup. The shape of this threshold strength is a finger-print of the quantum numbers of the nucleon. We investigated the ground-state properties of neutron-rich Na, Mg, Al nuclei around $N \sim 20$ using this method at GSI, Darmstadt. Very clear evidences have been observed for melting and merging of long cherished magic shell gaps at $N = 20, 28$. The nuclei around the drip-line are short-lived but surprisingly, evanescent rare isotopes imprint their existence in stellar explosive scenarios (r-process etc.). Due to their fleeting existence, indirect measurements are often the only possible access to the information which is a valuable input to the model for star evaluation process. Some valuable bulk properties of the neutron-rich nuclei play a key role in understanding cosmic phenomena. I shall discuss in this presentation our achievements related to the above mentioned facts.

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Collaboration name

S306 - LAND FRS collaboration

Funding source

Alexander Von Humboldt fellowship grants, DAE Govt. Of India

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Session Classification: Nuclear Forces and Structure, NN Correlations, and Medium Effects

Track Classification: NFS