Study of the Ground State Properties of Neutron-rich ^{29,30,31}Na Isotopes through Coulomb Breakup

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For several decades the "*island of inversion*" around N~20 has been the subject of interest of many experimental and theoretical investigations. In 1975, Thibault *et al.* [1] through a classic experiment, established that the ground state of ^{31}Na (N=20) is deformed. This deformation cannot be explained by occupation of valence nucleon in normal *sd shell* and it is necessary to consider the valance nucleon occupation from next *pf* shell. Recent experimental result for ^{30}Na (with N=19) by V. Tripathi et. al. [2] has reported the intruder effect from next *pf* shell in the ground state. Coulomb excitation of ^{30}Na [3] by S. Ettenauer et. al. has suggested the ground state as 2^+ but inconclusive. Coulomb break up is a direct probe to explore the ground state configuration of loosely bound nuclei [4,5]. This probe is highly sensitive to the tail part of the wave function of the valence nucleon. Aim of this experiment (S306) is to probe the ground state configuration of ^{29,30,31}Na through Coulomb break up. Experiment S306 was performed on September, 2010 using LAND-FRS set up at GSI, Darmstadt. After fragmentation of ^{40}Ar beam with energy 530 MeV/u, delivered by SIS-18 on 8 gm/cm^2 thick ^{9}Be primary target, several exotic nuclei were populated. Na isotopes with A/Z ratio 2.60 -2.85 were separated at FRS and transferred to Cave C where complete kinematic measurements were performed after Coulomb break-up using secondary target ^{208}Pb (2gm/cm^2). The cocktail incoming beam of the exotic nuclei is shown in figure 1. The reaction run for secondary target ^{12}C (935 mg/cm^2) was also taken to subtract the nuclear contribution in ^{208}Pb target.

After the secondary target the reaction product(s) and fragment(s) were tracked using the tracker programme developed at SINP. Fig. 2 shows the outgoing mass distribution after secondary reaction target for incoming ^{29}Na beam. Four momentums of all the decay product(s) were measured using the LAND, SST, GFI, TFW and Crystal Ball detectors. After measuring all these, the excitation energy of the projectile is reconstructed from invariant mass analysis method.

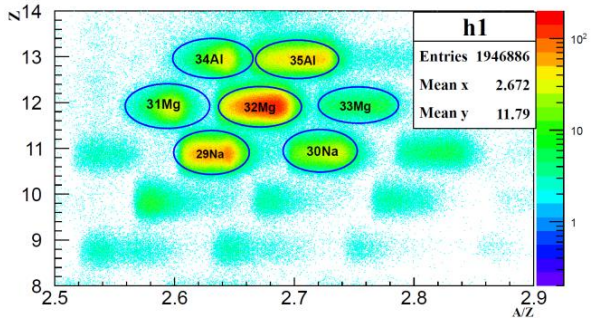

Fig 1: Cocktail incoming PID plot

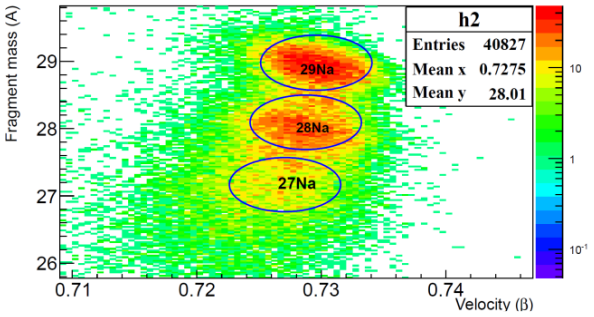

Fig 2: Outgoing mass distribution for incoming ^{29}Na

From the shape differential Coulomb dissociation cross-section with excitation energy and considering the effect of core excitation, it is expected that the valence nucleon of ^{30}Na (gr. state) majorly occupies the low '*l*' orbital. The detailed investigation is going on to understand the ground state configurations of these exotic nuclei.

References

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