Study of the shell evolution at $N = 20$ in neutron-rich region through nucleon transfer reaction

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We have studied neutron single particle states in ^{33}Si ($N = 19$) through the d(^{32}Si,^{33}Si*) neutron pick up reaction aiming at understanding the mechanism of shell evolution along $N = 20$.

The impressive finding of the large deformation in neutron-rich nuclei around ^{32}Mg became an opportunity for considering the importance of understanding the mechanism of shell evolution along $N = 20$ [1]. A lot of theoretical attempts have been made to explain this phenomenon [2, 3]. Some theoretical attempt suggested that the neutron single particle states has important role for this phenomenon. Therefore, we have studied the mechanism of shell evolution along $N = 20$ focusing on the neutron single particle state.

The γ-ray tagged method has been employed to obtain the information about single particle states. The final states of ^{33}Si are identified by measuring the de-excitation γ-rays in coincidence with the outgoing reaction residue. The spin parity of the final state is assigned based on the angular distribution of differential cross section of outgoing ^{33}Si. The spectroscopic factors of these states are determined from comparison of the cross section with theoretical calculation.

The experiment has been performed at RCNP as one of the CAGRA EN campaign experiments in May of 2015. The ^{32}Si nuclei were produced by the RCNP EN course as a secondary beam using fragmentation reaction of ^{40}Ar at 51.5 AMeV. The ^{32}Si beam bombarded the thick solid deuterium target (32 mg/cm^2) at 18.5 AMeV. This solid deuterium target was produced by using solid hydrogen target system developed by ESPRI group [4]. The de-excitation γ-rays were measured by germanium detector array CAGRA and two clover germanium detectors. CAGRA which consists of 14 clover germanium detectors covered with BGO compton suppression shields was placed around the deuterium target to measure the short lived γ-ray. The other two clover germanium detectors were placed at the downstream of the target to detect the delayed γ-ray. Outgoing ^{33}Si was identified by a Si telescope and the scattering angle was extracted by PPACs placed upstream and downstream of the target.

The present result on the γ-ray energy spectrum is shown in Fig.1 -(b) and (c). Fig.1-(a) is a level scheme of ^{33}Si. We could observe the 1434 keV and 1010 keV γ-peaks which correspond to $7/2^-$ and $1/2^+$ states by using Si isotope PID gate. Data analysis is now under progress.

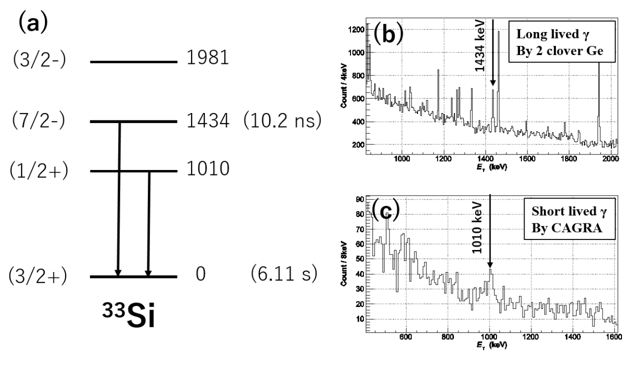

Figure 1: (a) Level scheme of ^{33}Si. (b) γ-ray energy spectrum measured by two clover Ge(for long lived γ). 1434 keV γ peak was observed. (c) γ-ray energy spectrum measured by CAGRA(for short lived γ). 1010 keV γ peak was observed.

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