Neutron Decays from the s-Hole State in ^{15}N

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Nuclear deep-hole states have been studied by measuring pickup and knockout reactions on various nuclei and the excitation energies with total widths have been roughly determined. [1] The interest in the characteristic of fragmentation for s-hole states in light nuclei has recently been aroused through the study of the production of hypernuclei. A theoretical calculation based on the $SU(3)[f](\lambda\mu)$ microscopic cluster model has suggested a suppression of α decays from the deep-hole states in light nuclei. [2] The hole states of ^{15}N and ^{15}O are also related with the nucleon life-time measurement in water Čerenkov detectors. [3]

In order to study the microscopic structures and fragmentation mechanism of deep-hole states, we measured p,d,t and α decays from s-hole states in ^{11}B and ^{15}N populated by ^{12}C, ^{16}O(p,2p) reaction at $E_p = 392$ MeV in the previous experiment. [4] The s-hole states were strongly excited at higher excitation energy regions. The α decay channels were found to be suppressed in comparison with the triton channels although the Q-value of the α channels are larger than the triton ones for both nuclei. This indicated that the fragmentation process could not be explained by the statistical decay process and some effects of the selection rule by the SU(3) spatial symmetry were recognized.

A recent shell model calculation has shown that the s-hole states split into three or more components. [5] In the case of ^{11}B(s-hole), some bump structures were observed in our experimental excitation spectrum, while those were not clear for the ^{15}N(s-hole). The branching ratio of neutron decay in different excitation energy region is one of the key ingredients to study those bump structures as well as it makes the measurement of fragmentation of s-hole states complete.

In the present experiment (E148), we have measured neutron decays from the proton s-hole state in ^{15}N. The outgoing two protons have been measured by the Grand Raiden (GR) and the large acceptance spectrometer (LAS), which are set to satisfy the zero-recoil momentum condition. Decay neutrons have been detected by thirty neutron detectors in coincidence with two protons of the $(p, 2p)$ reaction. Each neutron detector is a 20cm$\phi\times$ 5cm BC-501A liquid scintillator and has been placed at backward angles with the 2 m distance from the target. An iced water target, recently developed, [6] has been employed for the ^{16}O target to avoid the subtraction process of contaminants.

In Fig. 1, singles and coincidence excitation energy spectra in ^{15}N are shown together with a two-dimensional plot for neutron energy versus excitation energy of ^{15}N and the final-state spectrum of ^{14}N obtained from projecting loci onto the ^{14}N excitation-energy axis. Two-body decay dominant region are chosen so that the excitation energy of ^{14}N is less than 8.2 MeV.

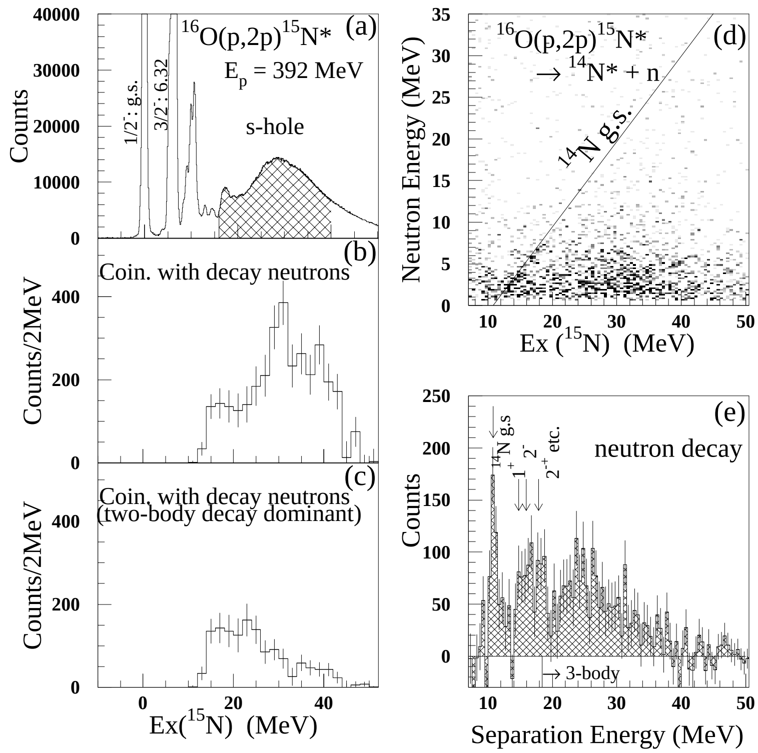

Figure 1: (a) Excitation energy spectrum in ^{15}N excited by the ^{16}O$(p, 2p)^{15}$N reaction at E_p = 392 MeV. (b) Excitation energy spectrum in coincidence with decay neutrons. (c) Coincidence spectrum gated on the two-body decay dominant region. (d) Two-dimensional plot for neutron energy versus excitation energy of ^{15}N. (e) Final-state spectrum of ^{14}N obtained from projecting loci of above figure.

Neutron decays from the s-hole state in ^{15}N account for about a half of total decays. When the 30 MeV bump is separated into two regions (E_x = 20 - 30 MeV and 30 - 40 MeV), we find the decay patterns among the n,p,d,t and α decays are quite different in two regions. Adding the 17 MeV bump, this supports the three bump structures predicted by the shell model calculation if the excitation energy is shifted by 5 MeV. Detailed comparisons with the statistical model and shell model calculations are being carried out to deduce the escape and spreading widths of the s-hole state in ^{15}N.

References

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