β-NMR measurement of ^{41}S

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The erosion of $N = 28$ shell gap has been suggested from several spectroscopic experimental data.[1–4] In particular, the ^{43}S nucleus is of considerable interest because shape coexistence is expected to occur, which is key to understanding the evolution of shell gaps far from stability. The isomeric state of ^{43}S at 320 keV is suggested to have a shape close to spherical with a spin-parity of $7/2^-$,[5,6] but both the spin-parity and deformed parameter of the ground state have not been determined directly. To investigate the mechanics leading to such an anomalous nuclear structure, we aim to measure the ground-state nuclear moment of ^{41,43}S. First, μ of ^{41}S was measured using the β-ray detected nuclear magnetic resonance (β-NMR) method,[7] combined with a technique to produce spin-polarized RI beams.[8]

The experiment was carried out at the RIPS facility at RIBF. The RI beam of ^{41}S was produced by the fragmentation of a primary beam of ^{48}Ca at an energy of $E = 63$ MeV/nucleon on a primary target of ^{9}Be with a thickness of 0.52 mm. The typical intensity of the ^{48}Ca beam at the target was 200 pnA. To realize the spin polarization in ^{41}S, an emission angle of $\theta_F > 1^\circ$ and a momentum window of $p_F = p_0 \times (1.015 \pm 0.025)$ were selected, where p_0 represents the central momentum of the fragment ^{41}S. Under this condition, the particle identification of the secondary beam was performed on an event-by-event basis with information regarding time of flight (TOF) and energy loss (ΔE) as shown in Fig. 1. The beam was pulsed with durations of beam-on and beam-off periods of 2.9 s and 2.9 s, equally.

The ^{41}S beam was then transported to the final focal plane and implanted into a stopper crystal of CaS with which $AP = -0.14\%$ was observed previously,[9] where A and P denote the asymmetry parameter for the β-ray emission and the degree of polarization of ^{41}S, respectively. The CaS stopper was mounted between the poles of a dipole magnet that produces an external magnetic field of $B_0 = 0.5$ T. β rays emitted from the stopper were detected using plastic scintillator telescopes located above and below the stopper. An oscillating radio-frequency field B_1 was applied perpendicular to B_0 using a pair of coils. The frequency of B_1 was swept over a certain region, and spin reversal occurred when the region included the Larmor frequency. The spin reversal was detected through the change of the up/down ratio R of the β-ray counts at the two telescopes. Because the range within which the g-factor of ^{41}S is predicted theoretically is quite wide, a fast switching system for changing the tank-circuit frequency[10] was used. In this experiment, the g-factor search was conducted in the region where $0.2 < g < 0.8$. The results of the NMR measurements are under analysis.

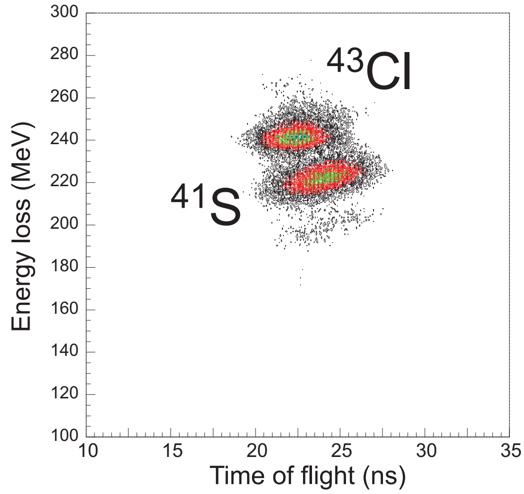

Fig. 1. Particle identification of ^{41}S. The horizontal and vertical axes represent TOF between the plastic scintillators at F2 and F3, and ΔE taken at the silicon detector at F2, respectively.

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