Parity-transfer (^{16}O, ^{16}F) reaction for study of pionic 0^- mode

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The spin-dipole (SD) 0^- excitation is an important topic in the study of spin-isospin responses in nuclei. Because the 0^- excitation carries the same quantum number as a pion, its strength distribution is expected to reflect pion-like correlations in nuclei such as tensor correlations[1)]. Despite this importance, experimental information on 0^- states is very limited because of a lack of experimental tools that are suitable for 0^- studies.

In a previous report[2)], we proposed a new probe, a parity-transfer (^{16}O, ^{16}F(0^-)) reaction for 0^- studies. The parity-transfer reaction uses $0^+ \to 0^-$ transition in the projectile to probe 0^- states in a target nucleus. This reaction has unique sensitivity to unnatural parity states, which is an advantage over other reactions used so far.

For the first parity-transfer measurement, we plan to perform a ^{12}C(^{16}O, ^{16}F(0^-))^{12}B experiment at the RIKEN RIBF facility by using a SHARAQ spectrometer. Figure 1 shows the schematic of the experimental setup. A primary ^{16}O beam of 250 MeV/A is transported onto a ^{12}C target. The outgoing ^{16}F are unbound to $^{15}\mathrm{O} + p$. Thus, we perform the coincidence measurements of the decayed $^{15}\mathrm{O} + p$ pairs. These particles are momentum analyzed using the SHARAQ spectrometer. The analyzed ^{15}O are detected with the focal plane detectors of SHARAQ (two cathode readout drift chambers (CRDCs)), while the protons are detected at the low-momentum side of the first dipole magnet. The 0^- state of ^{16}F is identified by reconstructing the invariant mass of the $^{15}\mathrm{O} + p$ pairs.

For this measurement, we have been developing a proton tracking detector system, which consists of two multi-wire drift chambers (MWDCs) and one plastic scintillator (See Fig. 1). Table 1 shows the specifications of the MWDCs. Each MWDC has an effective area of 480 mm^W × 240 mm^H to cover the acceptance for the protons emitted from ^{16}F. The readout electronics and data acquisition (DAQ) system are the same as those described in Ref.[3)].

The performance of the MWDC was tested in the SHARAQ04 experiment. A proton beam with an energy and intensity of 250 MeV and 1 kHz, respectively, was incident on the MWDC. The position resolution was estimated from the residual of $x_X - x_{X'}$. Here, x_X ($x_{X'}$) is a hit position in the X (X') layer. We also estimated the tracking efficiency, which was defined as the ratio of the number of events with the residual within 3σ to the number of beams measured by using the scintillator at the upstream of the MWDC. The resulting position resolution and tracking efficiency were 270 μm (FWHM) and 96%, respectively, when we applied a voltage of -1.6 kV on the potential wires and cathode planes. This performance is sufficient for the (^{16}O, ^{16}F(0^-)) measurement.

The experiment is scheduled to be conducted in 2014.

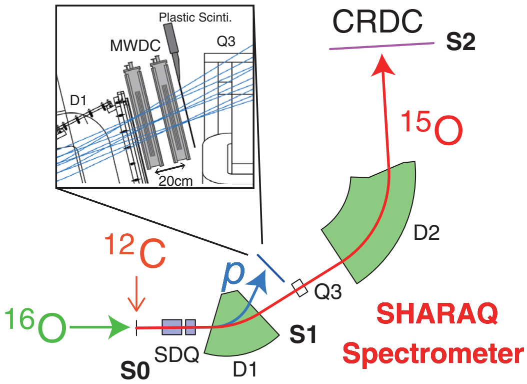

Fig. 1. Schematic of the experimental setup.

Table 1. Specifications of the MWDCs. The X' (Y') plane is offset by half cell from the X (Y) plane.

Configuration	X - X' - Y - Y'
Effective area	480 mm^W × 240 mm^H
Cell size	12 mm^W × 10 mm^t
Numbers of channels	120
Anode wire	Au-W, 20 μm$^\phi$
Potential wire	Cu-W, 80 μm$^\phi$
Cathode plane	Al-Mylar, 2 μm^t
Counter gas	P10 : Ar - CH_4 (90 - 10), 1 atm
Gas window	Al-Mylar, 25 μm^t

References
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