PROPOSAL FOR EXPERIMENT AT RCNP

28/08/2000

TITLE:

High Resolution Study of 0^- states in ^{16}O

SPOKESPERSON:

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RUNNING TIME:

Test running time for experiment	2 days
Data runs	8 days

BEAM LINE: WS (WS beam line + Grand Raiden)

BEAM REQUIREMENTS:

Type of particle	Polarized Protons
Beam energy	392 MeV
Beam intensity	10 nA on target
Energy resolution	$<$ 100 keV (FWHM)
Beam polarization	$>$ 0.7
Injection mode	High Resolution Mode
WS transport mode	Dispersive/Achromatic Modes

BUDGET:

Summary of budget request	1,450,000
Experimental expenses	950,000
Travel plan	500,000

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SUMMARY OF THE PROPOSAL

Isovector $J^\pi = 0^-$, $0^\pm \to 0^\mp$ excitations are of particular interest since they carry the simplest pion-like quantum number. At low momentum transfers, they have been investigated in beta decay and muon capture experiments [1, 2, 3]. Axial-vector and pseudoscalar currents are responsible for these first-forbidden transitions in nuclear weak processes. Gagliardi *et al.* [1] reported an enhancement of the decay rate by more than a factor 3 for the first-forbidden beta decay of the 120 keV, 0^- state in ^{16}N. This enhancement can be explained by considering the meson-exchange effects [4].

The (p, n) and (p, p') reactions are suited to study these transitions for a wide momentum-transfer range [5]. Orihara *et al.* [6] reported the angular distribution for the ^{16}O$(p, n)^{16}$N(0^-, 0.12 MeV) reaction at $T_p = 35$ MeV. The discrepancy between the distorted wave Born approximation (DWBA) calculation and their data in the large momentum transfer region of $q =$ 1.4–2.0 fm^{-1} has been observed, which might be due to the effect of the enhancement of the pion probability in the nucleus [7, 8, 9, 10, 11]. However, in the proton inelastic scattering to the 0^-, $T = 1$ state in ^{16}O at $T_p = 65$ MeV, such an enhancement was not observed [12]. The differences between (p, n) and (p, p') results might indicate the contribution from complicated reaction mechanisms in these low incident energies.

At intermediate energies of $T_p > 100$ MeV, where reaction mechanisms are expected to be simple, there are data only for the 0^-, T=0 transition at $T_p = 135$ [13, 14], 180 [14], 200 MeV [15], 318 MeV [16], and 400 MeV [17]. Most of these measurements were not performed with sufficient energy resolution to isolate the 0^-, $T = 0$ state at $E_x = 10.96$ MeV from its strong neighboring doublet (3^+ and 4^+) which is only about 140 keV away. It should be noted that there is no published experimental data for the 0^-, $T = 1$ state at $E_x = 12.80$ MeV in this energy region.

In this experiment, we measure cross sections and analyzing powers for inelastic excitations of 0^-, T=0 (10.96 MeV) and 0^-, T=1 (12.80 MeV) unnatural-parity states in ^{16}O in 392 MeV inelastic proton scattering from ^{16}O. The results will be studied in a framework of DWIA with shell-model (SM) wave functions. Such a comparison will provide us information on tensor and spin-spin components of effective NN interactions. Furthermore data will be compared with DWIA calculations employing RPA response functions in order to assess the pionic enhancement in a large momentum-transfer region.

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