RCNP EXPERIMENT E209

PROPOSAL FOR EXPERIMENT AT RCNP

27/01/2003

TITLE:

Search for the Gamow-Teller Strengths in ^{14}O via the ^{14}N(^{3}He, t)^{14}O reaction

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RUNNING TIME:

Beam tuning time	1.5 days
Set up time of the matching conditions	0.5 days
Data runs	2.0 days
Mesurement time for calibration targets	0.5 days

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

BEAM REQUIREMENTS:

Type of particle	^{3}He
Beam energy	420 MeV
Beam intensity	$10 \sim 20$ nA on target
Energy resolution	$\Delta E \leq 100$ keV, small emittance
Injection mode	High Resolution Mode
WS transport mode	Dispersive/Achromatic Modes

BUDGET:

Support to the two PhD students from Gent
(for their stay of about a month for data analysis).

SCHEDULE: We request the beam time late in the fall, 2003.

SUMMARY OF THE PROPOSAL

We propose the investigation of the Gamow-Teller (GT) excitations in ^{14}O via the (^{3}He, t) charge-exchange (CE) reaction on a ^{14}N target. The study of these excitations represents one of the anomalous features in spin-isospin type transitions. The ground state (g.s) of ^{14}N has isospin $T = 0$ and $J^\pi = 1^+$ and ^{14}O has g.s isospin $T = 0$ and $J^\pi = 0^+$. This means that the quantum numbers involved would permit a GT decay. Nevertheless, the $\log(ft)$ of the g.s→g.s transition is 7.3, wich means that it is strongly supressed and therefore one could guess that higher order effects can become important in this transition.

It was theoretical suggested that this famous suppresion of the GT β-decays ^{14}C ($J^\pi = 0^+$, $T = 1$) → ^{14}N ($J^\pi = 1^+$, $T = 0$) and ^{14}O ($J^\pi = 0^+$, $T = 1$) → ^{14}N (g.s, $J^\pi = 1^+$, $T = 0$) can be explained if a tensor component of the effective interaction is considered. At the same time it was suggested that the main part of the B(GT) strength should be found at higher excitation energies. Therefore, a precise measurement of the B(GT) value for each individual transition to the state up to high excitation energy is crucial to make a guideline for the theoretical calculations. In addition, measurements under the condition of different q transfers are important in order to see the contribution of the tensor and also the different effects of two configurations $\nu p_{1/2} \rightarrow \pi p_{1/2}$ and $\nu p_{3/2} \rightarrow \pi p_{1/2}$ involved in transitions.

This experiment is possible only at RCNP due to the best resolution of the (^{3}He, t) reaction among the CE reactions at intermediate energies. For this study, a 140 MeV/nucleon ^{3}He beam from the RCNP Ring Cyclotron will be used to excite the target nucleus. The outgoing tritons are momentum analyzed by the spectrometer Grand Raiden. In this experiment a high energy resolution of less than 40 keV is very important. Also important is the good angle resolution and the capability of reconstructing the scattering angle. The ion-optical conditions *dispersion matching* and *angular dispersion matching* will be realized between the spectrometer and the WS beam line to achieve a high resolution and good angle resolution, respectively. The over-focus mode of the spectrometer is essential in realizing good angle resolution in vertical direction and also in correcting kinematic aberrations.

The spectrometer Grand Raiden and the standard VDC focal plane detector system will be used for the analysis and detection of outgoing tritons. We request ≈ 10 nA of good quality single-turn extracted 140 MeV/nucleon ^{3}He beam. In order to realize various matching conditions, various capabilities of the WS course will be fully utilized.