RCNP EXPERIMENT E208

PROPOSAL FOR EXPERIMENT AT RCNP

27 January 2003

TITLE:
Agenda to E158: Study of Gamow-Teller transition strength by ^{37}Cl(^{3}He, t)^{37}Ar

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RUNNING TIME: Installation time without beam 1 days Beam tuning time 1.5 days
Set up time of the matching conditions 0.5 days
Data runs 2.5 days

BEAM LINE: Ring : WS course

BEAM REQUIREMENTS:
Type of particle ^{3}He
Beam energy 420 MeV
Beam intensity $10 - 30$ nA
energy resolution $\Delta E \leq 100$ keV, small emittance

BUDGET: Production costs for the new Faraday cups 80,000 yen

SCHEDULE: We request the beam time in April, May, 2003

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SPOKESPERSON: Yoshihiro Shimbara, Yoshitaka Fujita

SUMMARY OF THE PROPOSAL

We propose to measure the ^{37}Cl(^{3}He,t)^{37}Ar and ^{35}Cl(^{3}He,t)^{35}Ar reactions at $0-6^\circ$ as an extension of the E158 experiment. This experiment will give realistic Gamow-Teller (GT) strengths B(GT) for the ^{37}Cl $\rightarrow$ ^{37}Ar and ^{35}Cl $\rightarrow$ ^{35}Ar transitions. The results will give an important calibration standard for the study of solar neutrino using ^{37}Cl detector.

Under the assumption of isospin symmetry, the B(GT) of ^{37}Cl $\rightarrow$ ^{37}Ar and ^{37}Ca $\rightarrow$ ^{37}K transitions should be the same. However, the B(GT) distributions empirically determined in the ^{37}Cl$(p,n)^{37}$Ar and ^{37}Ca β decay measurements are not consistent. Although, in charge exchange reactions, the proportionality between B(GT) and cross section is used for the empirical extraction of B(GT) values, it has been discussed that the proportionality is broken for the $j_< j_<$ transitions. This is exactly the case of GT strengths in ^{37}Cl $\rightarrow$ ^{37}Ar and ^{35}Cl $\rightarrow$ ^{35}Ar transitions. A DWBA calculation for the ^{37}Cl(^{3}He, t)^{37}Ar reaction was performed. Two states with different configurations of $(\pi d_{3/2}, \nu d_{3/2}^{-1})$ and $(\pi d_{3/2}, \nu d_{5/2}^{-1})$ were assumed. The calculated angular distributions for these transitions were different. By using this difference of angular distributions, we can classify the GT states and evaluate more accurate the B(GT) values with different unit cross sections. In E158 experiment at RCNP we measured the ^{37}Cl(^{3}He,t)^{37}Ar and ^{35}Cl(^{3}He,t)^{35}Ar reactions at 0° and 4°. Among the same $\Delta J^\pi = 1^+$ states some significant differences of the angular distributions were observed for the states below $E_x = 5$ MeV. Unfortunately, we have data only at 0° and 4°. Our aim of this proposal is to extend the measurements to other scattering angles in order to roughly distinguish the configurations of GT states. This experiment will give more realistic B(GT) values of the ^{37}Cl $\rightarrow$ ^{37}Ar and ^{35}Cl $\rightarrow$ ^{35}Ar transitions. In addition, it makes the charge exchange reaction more reliable as a tool to search for the Gamow-Teller transition strengths.

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 at $0-6^\circ$. In this experiments a high energy resolution of the order of 30 keV is very important. Therefore a chlorine gas target is not suited. In order to achieve a high resolution by using a magnetic spectrometer, a newly developed thin film made by calcium chloride ($CaCl_2$) and polyvinylalcohol (PVA) will be used as targets. In order to improve the energy spread of the beam, the dispersion matching

method will be used. 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.