E425

RCNP EXPERIMENT E

PROPOSAL FOR EXPERIMENT AT RCNP

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TITLE

High energy-resolution study of the (^{3}He, t) reactions on Ge, Sn and Te isotopes at 420 MeV and SD 2^- neutrino responses

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BEAM TIME:

^{74}Ge data taking runs (3 angle settings)	5 shifts
^{122}Sn data taking runs (3 angle settings)	5 shifts
^{126}Te data taking runs (3 angle settings)	5 shifts
Beam tuning and beam preparation time	3 shifts
Total	18 shifts

BEAM LINE: Ring WS course

BEAM REQUIREMENTS:

Type of particle	^{3}He
Beam energy	420 MeV
Beam intensity	20 nA
Energy resolution	ΔE = 30 keV

BUDGET:

Local support for non-RCNP participants	
Enriched targets ^{74}Ge, ^{122}Sn, ^{126}Te	420 K

1. Summary of experiment

Proposed experiment:

We propose to measure spin-dipole (SD) 2^- strength distributions in ^{74}As, ^{122}Sb and ^{126}I nuclei by using the ^{74}Ge(^{3}He,t), ^{122}Sn(^{3}He,t) and ^{126}Te(^{3}He,t) charge exchange reactions (CERs) with the highest possible energy resolution.

The present experiment aims at studying neutrino nuclear responses, which are crucial for extracting neutrino properties of particle and astrophysics interests from double beta decays (DBDs) and supernova neutrino interactions. So far, GT τ^- responses have extensively been studied by high energy-resolution (^{3}He,t) experiments at forward angles at RCNP. The GT response, which is associated with s-wave neutrinos, is involved in the two neutrino DBDs and low-energy solar neutrinos. The SD response, which is associated with p-wave neutrinos, is the major component of the neutrino-less DBDs and the medium energy astro-neutrinos.

Recent studies of the (^{3}He,t) reactions on DBD nuclei have shown that the SD 2^- strengths for low-lying states are well studied by measuring the angular distributions in a wide region of $\theta = 0 - 5$ deg. However, the SD 2^- strengths (B(SD 2) values) in the DBD nuclei are not known experimentally from β^+(EC) rates.

In the present experiment, we measure the angular distributions of the (^{3}He,t) reactions on ^{74}Ge, ^{122}Sn and ^{126}Te, where the B(SD2) values for the ground-state $0^+ \rightarrow 2^-$ transitions are known experimentally from EC rates. We plan to extract experimentally the relation between the CER cross sections and the SD strengths. Then, the relation will be used to get the integral of the effective SD interaction and the SD strength.

The present experiment makes it possible to use the CER to extract the p-wave τ^- response, which is of vital importance for neutrino studies in nuclei. The extracted SD 2^- matrix elements (NMEs) provide experimentally the effective SD axial coupling g_A and the SD strength distribution. They are used to help theoretical model calculations for DBD matrix elements and supernova neutrino interaction rates.

Apparatus and beam properties:

The proposal asks for a 140 MeV/nucleon ^{3}He beam from the RCNP ring cyclotron. The Grand Raiden spectrometer and the standard focal plane detection system will be used for the detection of the outgoing tritons. The momentum and angular dispersion matching technique will be employed to achieve a high momentum and high angular resolution. The over-focus mode of the spectrometer is essential for good angular resolution in vertical direction and, moreover, for correcting kinematic aberrations.

In the present experiment we perform measurements at 3 angles of 0 deg. 2 deg. and 4 deg. in order to identify the SD 2^- strength.

We request $\approx$ 20 nA single-turn extracted ^{3}He beam of good quality. In order to realize various matching conditions, the capabilities of the WS course will be employed.

Target:

Enriched isotopes of ^{74}Ge, ^{122}Sn and ^{126}Te are used as targets. High-resolution (^{3}He,t) measurements demand that the effect of energy spread in the target be minimized. The energy spread in the triton energy is mainly caused by the different energy losses of ^{3}He and t particles in the target. Thus a sufficiently small target thickness is important.

Beam time request:

The requested beam time consists of (1 shift equals 8 hours):

^{74}Ge data taking runs (3 angle settings)	5 shifts
^{122}Sn data taking runs (3 angle settings)	5 shifts
^{126}Te data taking runs (3 angle settings)	5 shifts
Beam tuning and beam preparation time	3 shifts
Total	18 shifts

Schedule:

We request beam time in the period from summer to the end in 2014.