E378

RCNP EXPERIMENT E3**

PROPOSAL FOR EXPERIMENT AT RCNP

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TITLE:

High-resolution study of Gamow-Teller transitions in deformed and spherical heavy nuclei

SPOKESPERSONs:

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RUNNING TIME:

^{94}Zr, ^{114}Sn, ^{124}Sn, ^{165}Ho target nuclei	4.0 days
Measurements for calibration and reference targets	0.5 days
Beam preparation, dispersion matching, sieve slit runs	1.5 days

BEAM LINE:

Ring : WS course, high resolution mode

BEAM REQUIREMENTS:

Type of particle	^{3}He
Beam energy	420 MeV
Beam intensity (max.)	25 nA
Energy resolution	$\Delta E \leq 100$ keV, small emittance

BUDGET:

Enriched targets ^{94}Zr, ^{165}Ho:	600k yen

SCHEDULE:

We request the beam time in December, 2011 or end of April, 2012.

1 Summary of Experiment

- **Summary of proposal and experiment:**

Our aim is to study β^--type Gamow-Teller (GT^-) transitions starting from ^{94}Zr, ^{114}Sn, ^{124}Sn, ^{165}Ho target nuclei in the high energy-resolution (^{3}He, t) experiments. Nuclei ^{94}Zr, ^{114}Sn, and ^{124}Sn are the typical spherical nuclei. In earlier charge-exchange reactions, such as (p, n) or (^{3}He, t), they mainly paid attention to the IAS, which is sharp, and the resonance structure around the excitation energy of 10 MeV, which is called the Gamow-Teller Resonance (GTR).

However, with the increase of the resolution in the (^{3}He, t) measurement using the dispersion matching techniques, highly fragmented structures were observed in the low-lying region below the proton separation energy S_p. Above this energy, the decay widths start to smear the spectrum. It was found that the fragmented structures are very specific for different nuclei, representing individuality of each nucleus. We have already found some part of such unique features in the measurement of GT strength starting from the $Z = 40$ zirconium isotopes (^{90}Zr and ^{92}Zr) and also $Z = 50$ tin isotopes (^{118}Sn and ^{120}Sn). We extend the measurements on ^{94}Zr, ^{114}Sn, and ^{124}Sn target nuclei.

Deformed nuclei in the rare earth region, such as ^{165}Ho and ^{165}Er have well developed structure of rotational-bands. In the deformed nuclei, the z component K of the total angular momentum J becomes the good quantum number and the selection rules $\Delta K = 0$, and ± 1 should be considered for the GT transitions caused by the $\sigma\tau$ operator. If the nucleus is largely deformed, the selection rules related to the asymptotic quantum numbers of the Nilsson orbit $[N\, n_z\, \Lambda]$ also become important in addition to the K^π selection rules. It should be noted that these three asymptotic quantum numbers are related to the "spacial shape" of nuclei and the $\sigma\tau$ operator for the GT transition cannot mediate the transitions between the states with different set of asymptotic quantum numbers, if they are the "good quantum numbers". Here we propose to measure the strengths of GT transitions starting from the ground state (g.s) of ^{165}Ho with $7/2^-[5\,2\,3]$ to the members of rotational bands in ^{165}Er to examine the validity of selection rules related to K^π and asymptotic quantum numbers.

- **Properties of (^{3}He, t) measurements:**

It is known that (^{3}He, t) experiments at forward angles including 0° and a beam energy of 140 MeV/nucleon are a unique tool to study GT^- transition strength. Because of the simplicity of reaction mechanism, and also the dominance of the $\sigma\tau$ interaction at 0°, the B(GT) values that are proportional to the square of the transition matrix element can be derived accurately [1].

In such (^{3}He, t) measurements, a high energy resolution of less than 30 keV is important in order to separate GT (and Fermi) states and also to determine the widths of states. Also important is the good angular resolution and the capability of reconstructing the scattering angle. The ion-optical conditions *dispersion matching* and *angular dispersion matching* are to be realized between the spectrometer and the WS beam line to achieve a high energy-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.

- **Apparatus and beam properties:**

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 ≈ 20 nA of good quality single-turn extracted 420 MeV ^{3}He beam. In order to realize various matching conditions, including the dispersion matching condition, full capabilities of the WS course will be utilized.

- **Beam time request:**

Measurement for ^{94}Zr, ^{114}Sn, ^{124}Sn, ^{165}Ho targets : 4.0 days
Measurements for calibration and reference targets
(for example, mylar, $^{\mathrm{nat}}$Mg, ^{90}Zr, ^{118}Sn) : 0.5 days
Beam preparation, dispersion matching, sieve slit runs : 1.5 days

- **Schedule:**

We request the beam time in December, 2011 or in the end of April, 2012.