PROPOSAL FOR EXPERIMENT AT RCNP

December 6, 2003

TITLE:

Neutrino Nucleosynthesis of the Exotic, Heavy Doubly Odd-Mass Nuclei ^{138}La and ^{180}Ta

SPOKESPERSON(s):

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THEORETICAL SUPPORT:

Full Name	Institution
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RUNNING TIME:	^{138}Ba and ^{180}Hf data taking runs	2.0 days
	Mesurement time for calibration targets ^{136}Ba, ^{140}Ce, ^{142}Nd and ^{178}Hf	1.0 days
	Usually after a run of $\approx$ 3 days, the cyclotron and the beam line should be retuned. For the retuning	0.5 days
BEAM LINE:	Ring : WS course, high resolution mode	

BEAM REQUIREMENTS:

Type of particle	^{3}He
Beam energy	420 MeV
Beam intensity	10 – 20 nA
Energy resolution	$\Delta E \leq 100$ keV, small emittance

BUDGET: Some of the targets are very critical. Target storage conditions should be improved. 500 kyen

SCHEDULE: We request the beam time late fall or winter, 2003. We have a wish to run the experiment together with the Ni isotope measurements of the Gent group to spare the time for beam tuning and dispersion matching.

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1 Summary of Experiment

- **Proposed experiment:**

Recent calculations suggest charged-current neutrino reactions as a major source for the production of the rare, heavy, doubly-odd mass isotopes ^{138}La and ^{180}Ta in the universe. A large uncertainty of these predictions lies in the use of rather schematic RPA calculations to describe the low-energy GT strength dominating the relevant (ν_e, e^-) cross sections. Therefore, we propose a high-resolution measurement of the GT strength in ^{138}La and ^{180}Ta using the ^{138}Ba(^{3}He, t) and ^{180}Hf(^{3}He, t) reactions, respectively. The astrophysical implications of the results will be analyzed by experts in the field who have joined the collaboration. Beyond clarifying the origin of these rare species, the results may have far-reaching impact by giving insight into the role played by neutrino oscillations during a supernova outburst.

- **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 $10 - 20$ 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. It was also found that a high quality ^{3}He beam with small emittance and momentum spread results in better experimental conditions.

- **Beam time request:**

High-resolution (^{3}He, t) spectra will be measured at 0°. In order to achieve a high resolution, the effect of energy spread in the target should be minimized. The energy spread in the target is mainly caused by the different energy losses of ^{3}He and t particles, and thus sufficiently thin targets of about 1-2 mg/cm^2 have to be used. By realizing the angular dispersion matching and over-focus mode of the spectrometer, we can achieve a good angle resolution. In a ^{58}Ni(^{3}He, t) experiment, it was found that an angle cut of less than 0.5° was very effective in order to distinguish $L=0$ excitations, like GT or Fermi states, from others. For heavier targets, like Ba or Ta, we expect a steeper angular distributions, and thus even a narrower cut may be needed. On the other hand, the information not only on $L=0$ excitations, but also on $L=1$ excitations are expected from the 0° measurement. Therefore, good statistics is very important.

For an extraction of absolute GT strengths a normalization to known GT β decays is necessary. This will be achieved in the (^{3}He, t) reactions on the neighboring isotopes ^{136}Ba, ^{140}Ce and ^{142}Nd, and ^{178}Hf.

We propose to perform the experiment jointly with the Gent group who submitted a similar proposal. Thus, no setup time before the actual measurements and no time consuming initial beam tuning and beam matchings are needed.

The total requested beam time consists of

(1) measurements for the ^{138}Ba and ^{180}Hf target : 2.0 days

(2) B(GT) calibration runs : 1.0 day

(3) for the retuning of the beam : 0.5 days

- **Schedule:**

We request the beam time in the late Fall of 2003, together with the experiment of the Gent group.