PROPOSAL FOR EXPERIMENT AT RCNP

Feb. 14, 2008

TITLE: Feasibility study of the (d, pp) reaction in inverse kinematics as a possible probe for $B(\mathrm{GT}^+)$ strengths in neutron-rich nuclei

SPOKESPERSON:

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EXPERIMENTAL GROUP:

Name	Institution	Title or Position
D. Ishikawa	RCNP, Osaka Univ.	M1
I. Tanihata	RCNP, Osaka Univ.	P
H.J. Ong	RCNP, Osaka Univ.	A
A. Tamii	RCNP. Osaka Univ.	AP
H. Matsubara	RCNP, Osaka Univ.	D2
K. Suda	RCNP, Osaka Univ.	R
H. Otsu	RIKEN Nishina Center	R
K. Sekiguchi	RIKEN Nishina Center	R
H. Iwasaki	Dept. of Phys., Univ. of Tokyo	A
D. Suzuki	Dept. of Phys., Univ. of Tokyo	D2

RUNNING TIME:

Tuning	24 hrs
Data runs	72 hrs
Total	4 days

BEAM LINE:

Ring: EN (or ENN) course

BEAM REQUIREMENTS:

Type of particle	^{12}C
Beam energy	100 MeV/A
Beam intensity	10 pnA

BUDGET:

Travel expense 1.5 M JPY

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SUMMARY OF THE PROPOSAL

The $(d, {}^2\mathrm{He})$ reaction has been extensively used to extract β_+ Gamow-Teller strength $B(\mathrm{GT}^+)$ making the most of its advantages over the (n, p) reaction; the selectivity in spin-transfer, relatively high energy-resolution and high count-rate. Here the ^{2}He denotes a p-p pair in ${}^1S_0$ state and is experimentally measured by the coincidence detection of two protons with relative energies ϵ_{pp} less than 1 MeV, where the ${}^1S_0$ amplitude is expected to be dominant due to the strong p-p final-state interaction. It is the second simplest (n, p)-type reaction and, although it is a three-body reaction, can be theoretically treated with less ambiguities than other composite-projectile reactions. It is fascinating to apply the $(d, {}^2\mathrm{He})$ reaction to neutron-rich unstable nuclei. The $B(\mathrm{GT}^+)$ of such species will provide precious information for studies of nucleosynthesis in stars, double β-decay nuclear matrix elements, and other various fields.

For unstable nuclei, however, the $(d, {}^2\mathrm{He})$ reaction is not easy to measure. One of the most powerful methods for producing short-lived unstable nuclei is to use the projectile-fragmentation at intermediate energies. Since the produced nuclei form beams with relatively small angular and momentum spreads, direct reactions on such nuclei are usually measured in inverse kinematics. A common and serious problem is the low energy of recoiled ejectiles in small momentum-transfer regions, which are relevant to direct reactions. For the case of $(d, {}^2\mathrm{He})$ reaction at several 100 MeV/A, protons with energies as low as 0.6 MeV have to be measured to keep $\epsilon_{pp} \leq 1$ MeV.

A reasonable compromise is to measure protons with higher energies, 5 MeV for example, in coincidence. Although ϵ_{pp} increases up to 10 MeV in this case thus contributions from higher partial-waves than ${}^1S_0$ increase, it will be still useful to extract $B(\mathrm{GT}^+)$ because, among isovector central parts of the N-N effective interaction, the relative strength of spin-flip part to non-spin-flip one is known to increase as increasing energy and reaches maximum at $\sim$300 MeV/A. The reaction may be extensively utilized at RIKEN/RIBF, which can provide intense RI-beams with such energies. For this purpose, a theoretical treatment properly describing contributions from higher partial-waves must be established. Also the experimental feasibility is not clear; low-energy protons are emitted to large angles thus have to be measured without using a magnetic spectrometer under huge backgrounds, particularly from accidental coincidence of inclusive (d, pX) breakup protons. We thus propose to measure the (d, pp) reaction in inverse kinematics using the 100-MeV/A ^{12}C beam, which is known to have a large spin-flip transition strength to ${}^{12}\mathrm{B}_{\mathrm{gnd}}$ isolated from other excited states, to examine its feasibility for extracting $B(\mathrm{GT}^+)$ strength.