E444

RCNP EXPERIMENT E

PROPOSAL FOR EXPERIMENT AT RCNP

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TITLE:

Search for new resonant states in ^{10}C and ^{11}C as a possible solution to the cosmological lithium problem

SPOKESPERSONS:

Full Name	Kawabata Takahiro
Institution	Department of Physics, Kyoto University
Title or Position	Associate Professor
Address	Kitashirakawa Oiwake, Sakyo, Kyoto 606-8502
Phone number	+81-75-753-3832
FAX number	+81-75-753-3887
E-mail	kawabata@scphys.kyoto-u.ac.jp

Full Name	Fujiwara Mamoru
Institution	Quantum Beam Science Directorate, Japan Atomic Energy Agency
Title or Position	Guest Researcher
Address	Tokai, Ibaraki 319-1195
Phone number	+81-6-6877-5111
FAX number	+81-6-6879-8899
E-mail	fujiwara@rcnp.osaka-u.ac.jp

EXPERIMENTAL GROUP:

Full Name	Institution	Title or Position
S. Adachi	Department of Physics, Kyoto University	D3
T. Furuno	Department of Physics, Kyoto University	D1
M. Tsumura	Department of Physics, Kyoto University	D1
M. Murata	Department of Physics, Kyoto University	M2
Y. Ishii	Department of Physics, Kyoto University	M2
H. Akimune	Department of Physics, Konan University	Professor
Y. Matsuda	Department of Physics, Konan University	PD
T. Nakahara	Department of Physics, Konan University	M1
N. Hattori	Department of Physics, Konan University	B4
K. Hatanaka	RCNP, Osaka University	Professor
A. Tamii	RCNP, Osaka University	Associate Professor
C. Iwamoto	RCNP, Osaka University	PD
T. Ito	RCNP, Osaka University	D3
M. Miura	RCNP, Osaka University	M2
M. Itoh	Cyclotron Radioisotope Center, Tohoku University	Assistant Professor
Y. Maeda	Department of Engineering, Miyazaki University	Assistant Professor

RUNNING TIME:

Installation time without beam	2.0 days
Setup of detectors	0.5 days
Beam tuning for the dispersive transport	1.5 days
Data runs using the ^{10}B and ^{11}B targets	2.0 days
Background runs using the Mylar ^{nat}C target	0.5 days
Total	2.0 days + 4.5 days

BEAM LINE: Ring : WS course

BEAM REQUIREMENTS:	Type of particle	$^{3}He^{2+}$
	Beam energy	420 MeV
	Beam intensity	$\leq$ 10 pnA
		Energy resolution $\leq$ 100 keV
BUDGET:	Experimental expenses	800,000 yen

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SPOKESPERSONS: Kawabata Takahiro and Fujiwara Mamoru

SUMMARY OF THE PROPOSAL

The primordial abundances of the light elements produced in the process of Big Bang nucleosynthesis (BBN) provide important and useful information to understand what happen in the early universe. Accurate estimation of the primordial abundances is crucial to test the cosmological theories by comparing the predicted values with the observations.

A comparison between the theoretical predictions of the primordial abundances and the observations is in good agreement with those for the helium and deuterium. However, there remains a serious problem: The ^{7}Li abundance does not agree with any theoretical BBN calculations. This discrepancy is known as the cosmological lithium problem, and has been of great interest in recent years.

It was pointed out that if the destruction rate of the ^{7}Li or its mirror nucleus ^{7}Be is enhanced, the ^{7}Li abundance can be reduced in the BBN calculation. If a unknown resonant nuclear reaction channel involving ^{7}Li or ^{7}Be exists, the ^{7}Li abundance will be greatly reduced. Then, the lithium problem will be solved. The most promising resonant reactions to exhaust ^{7}Be are $^{7}\mathrm{Be} + {}^{3}\mathrm{He} \rightarrow {}^{10}\mathrm{C}$ and $^{7}\mathrm{Be} + {}^{4}\mathrm{He} \rightarrow {}^{11}\mathrm{C}$. It is, therefore, desired to search for missing resonant states in ^{10}C and ^{11}C near the $^{7}\mathrm{Be} + {}^{3}\mathrm{He}$ and $^{7}\mathrm{Be} + {}^{4}\mathrm{He}$ reaction thresholds

Very recently, the proposed resonant states were searched for by measuring the ^{10}B(^{3}He,t)^{10}C and ^{11}B(^{3}He,t)^{11}C reactions at $E_{^{3}\mathrm{He}} = 35$ MeV, and no new states were observed in the region of interest. However, this conclusion is not reliable and should be carefully reexamined. It is generally difficult to measure the (^{3}He,t) reaction at low beam energies because the continuous background from the multi-step "break-up and pick-up" processes overlaps the region of interest. Therefore, a new measurement at a higher beam energy should be done to solve this problem.

We propose to search for the missing $^{7}\mathrm{Be} + {}^{3}\mathrm{He}$ and $^{7}\mathrm{Be} + {}^{4}\mathrm{He}$ resonant states by performing the high resolution measurement of the (^{3}He,t) reaction at $E_{^{3}\mathrm{He}} = 420$ MeV.