PROPOSAL FOR EXPERIMENT AT RCNP

4 Mar 2018

TITLE:

Performance test of a time projection chamber to search for the alpha condensed state in ^{24}Mg

SPOKESPERSON:

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EXPERIMENTAL GROUP:

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I. Tanihata	RCNP, Osaka University	Professor
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RUNNING TIME:	Installation time without beam	7 days
	Beam tuning	0.5 days
	Detector setup	0.5 days
	Performance test of TPC with high intensity beam	1 day
	Data runs	1 day
	Total	7 days + 3 days
BEAM REQUIREMENTS:	Type of particle	^{4}He^{2+}
	Beam energy	400 MeV
	Beam intensity	1 pnA
	Energy resolution	$\leq$ 200 keV
		halo-free, small emittance
BUDGET:	Experimental expenses	1,000,000 yen

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SUMMARY OF THE PROPOSAL

Alpha particle clustering is important to discuss nuclear structure. Two protons and two neutrons in nuclei strongly correlate to each other and form an α cluster (^{4}He nucleus). For example, the 0_2^+ state in ^{12}C is considered to have spatially well-developed 3α cluster structure. Recently, this 0_2^+ state in ^{12}C has been of great interest as an α condensed state where the three α clusters are condensed into the lowest $0s$ orbit. It is theoretically suggested that the α condensed states exist in self-conjugate $4n$ nuclei not heavier than ^{40}Ca, however, there is still no experimental information in heavier nuclei than ^{12}C.

We carried out an experiment to search for the α condensed states in ^{24}Mg at Research Center for Nuclear Physics (RCNP), Osaka University in 2010 as E308. Since the α condensed states are expected to decay with emitting several low-energy α particles, we tried to identify the α condensed states by a measurement of decay particles from the excited states in ^{24}Mg. However, the detection solid angle to measure the decay particles was as small as 3% of 4π in the previous experiment, thus we could not measure the α-decay events in sufficient statistics and draw a conclusion on the α condensed states in ^{24}Mg.

We newly plan an experiment to measure decay particles emitted from excited states in coincidence with inelastically scattered α particles using a TPC with very large angular coverage. In this experiment, a 400-MeV α beam is transported to a target ^{24}Mg installed in the sensitive volume of the TPC. The scattered α particles are momentum-analyzed by the Grand Raiden spectrometer to obtain excitation-energy spectra in ^{24}Mg. This experimental method with a combination of the TPC and Grand Raiden is an epoch-making way because it enables us to systematically search for the α condensed states in various self-conjugate $4n$ nuclei as well as in ^{24}Mg.

In this proposal, we propose a test experiment to examine performance of the TPC as a decay-particle detector using a high-intensity beam and feasibility of the new experiment to search for the α condensed states with the TPC and Grand Raiden.