

## PROPOSAL FOR EXPERIMENT AT RCNP

23 July 2018

**TITLE:**

Search for the  $\alpha$ -condensed state in  $^{24}\text{Mg}$  by measuring the  $^{12}\text{C} + ^{12}\text{C}$  scattering

**SPOKESPERSON:**

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**RUNNING TIME:** Installation time without beam 7.0 days  
 Setup and beam tuning time 1.0 days  
 Data runs 5.0 days

**BEAM LINE:** EN course

**BEAM REQUIREMENTS:**

Type of particle	$^{12}\text{C}$
Beam energy	50 MeV
Beam intensity	$\leq 1 \text{ pA}$
Energy resolution	$\leq 100 \text{ keV}$

**BUDGET:** Experimental expenses 1,000,000 yen

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**SPOKESPERSON:** Kawabata Takahiro

### SUMMARY OF THE PROPOSAL

Alpha particle clustering is an important phenomenon in nuclear physics for light nuclei. On the basis of the Ikeda diagram, the  $\alpha$  cluster structure is expected to emerge near the  $\alpha$ -decay threshold energy. For example, it was suggested that the 7.65-MeV  $0_2^+$  state in  $^{12}\text{C}$ , which locates at an excitation energy higher than the  $3\alpha$ -decay threshold by 0.39 MeV, has an  $3\alpha$  cluster structure. It was suggested that this  $0_2^+$  state is theoretically described by introducing a novel concept of the nuclear structure, *i.e.*, this state is an  $\alpha$ -condensed state where three  $\alpha$  particles are weakly interacting and are condensed into the lowest  $s$  orbit. The next natural question addressed is whether such an  $\alpha$ -condensed state universally exists in the heavier self-conjugate  $N = 4n$  nuclei or not.

Since the  $\alpha$ -condensed states are expected to decay by emitting multiple low-energy  $\alpha$  particles, it might be possible to identify the  $\alpha$ -condensed states by measuring those decay particles emitted from excited states near the  $n\alpha$ -decay thresholds in the self-conjugate  $N = 4n$  nuclei.

Thus, we propose to measure the low-energy  $\alpha$  particles emitted from the  $^{12}\text{C} + ^{12}\text{C}$  scattering at  $E_{\text{c.m.}} = 17.5\text{--}22.5$  MeV using the active target time projection chamber (AT-TPC) and to search for the  $\alpha$ -condensed state in  $^{24}\text{Mg}$ .