

PROPOSAL FOR EXPERIMENT AT RCNP

July 23, 2018

TITLE:

From α clustering to α decay : Quasi-Free ($p, p\alpha$) reactions with Nd and Sm isotopes

SPOKESPERSON:

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RUNNING TIME:	Installation time without beam	7 days
	Fine Beam Tuning	0.5 day
	Startup and Calibration	1.5 day
	Data runs	7.5 days
	Total	9.5 days

BEAM LINE: Ring : WS course

BEAM REQUIREMENTS:	Type of particle:	proton
	Beam energy:	392 MeV
	Beam intensity:	≤ 300 nA
	Other requirements:	halo-free, $\Delta E \leq 300$ KeV

BUDGET REQUEST: 1,500,000 yen to purchase the isotopically enriched targets

Proposal for an experiment at the RCNP Cyclotron Facility

Submitted to RCNP for the B-PAC evaluation in August 2018

From α clustering to α decay: quasi-free (p,p α) reactions with Nd and Sm isotopes

Spokesperson:

Zaihong Yang (RCNP)

Summary of experiment

We propose to study α -clustering at the surface of Nd and Sm isotopes by using quasi-free (p,p α) reaction. By measuring the scattered proton and alpha in coincidence with Grand Raiden and the large-acceptance spectrometer (LAS), the cross section for the quasi-free (p,p α) reaction will be determined, which is directly related to the strength of α -clustering at the nuclear surface of heavy nuclei.

The main goals of the present proposal:

(A) To clarify the systematic Q_α dependence of α -clustering strength from negative to positive Q_α values (with real α emitters included).

(B) To investigate the deformation effect on α -clustering strength.

The present proposal is extension of our previous $^{112-124}\text{Sn}(p,p\alpha)$ experiment at RCNP (E461, Aumann&Yang), which was successfully carried out in Feb/2018. **Significant α clustering at the surface of heavy nuclei was well demonstrated. The results of E461 will unravel the dependence of α -clustering strength on the Q_α value, but only negative Q_α values were covered in E461.** Therefore, in the present proposal $^{142-150}\text{Nd}$ are selected to investigate the Q_α dependence of α -clustering strength in a much wider Q_α range, **from negative (^{142}Nd) to weakly bound (^{150}Nd), to positive ($^{148,146}\text{Nd}$), and to real alpha emitter(^{144}Nd).** This measurement will also **provide direct evidence for existence of alpha cluster ("alpha cluster preformation") in real alpha emitting nuclei** which is generally regarded as a prerequisite for alpha decay. The systematic measurements on Sm isotopes, with gradual increase of deformation, will help to **clarify the effect of deformation on the α -clustering strength.** Detailed understanding of "alpha cluster preformation" will further help to decompose the effects of "alpha cluster preformation" and "quantum penetrating" and reach a deep understanding of alpha decay. And A detailed knowledge of alpha decay may also help to open a new door to study the properties of super-heavy elements (SHE) such as Nh through their consecutive alpha decay.