

PROPOSAL FOR EXPERIMENT AT RCNP

July 27, 2015

TITLE:

α -clustering at the surface of $^{112-124}\text{Sn}$ nuclei investigated in (p,p α) quasi-free knockout reactions

SPOKESPERSON:

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EXPERIMENTAL GROUP:

Full Name	Institution	Title or Position
Thomas Aumann	TU Darmstadt	P
Heiko Scheit	TU Darmstadt	R
Stefanos Paschalis	TU Darmstadt	PD
Diego Semmler	TU Darmstadt	PhD
Philipp Schrock	TU Darmstadt	PhD
Dmytro Symochko	TU Darmstadt	PD
Stefan Typel	GSI	R
Tomohiro Uesaka	RIKEN Nishina Center	CS
Zaihong Yang	RIKEN Nishina Center	PD
Masaki Sasano	RIKEN Nishina Center	R
Juzo Zenihiro	RIKEN Nishina Center	R
Hideaki Otsu	RIKEN Nishina Center	R
Masanori Dozono	RIKEN Nishina Center	PD
Valerii Panin	RIKEN Nishina Center	PD
Sergey Chebotaryov	RIKEN Nishina Center/Kyungpook University	IPA/D1
Motonobu Takaki	Center for Nuclear Study, University of Tokyo	D2
Shinsuke Ota	Center for Nuclear Study, University of Tokyo	A
Hiroshi Tokieda	Center for Nuclear Study, University of Tokyo	D3
Shoichiro Kawase	Center for Nuclear Study, University of Tokyo	D3
Cheng Soo Lee	Center for Nuclear Study, University of Tokyo	D1
Yuki Kubota	Center for Nuclear Study, University of Tokyo	D1
Atsushi Tamii	RCNP, Osaka University	AP
Yohei Matsuda	RCNP, Osaka University	PD
Takashi Hashimoto	RCNP, Osaka University	A
Chihiro Iwamoto	RCNP, Osaka University	PD
Takeshi Ito	RCNP, Osaka University	D2
Masaki Miura	RCNP, Osaka University	M1
Leung Tsz Tang	RCNP, Osaka University	PD
Takashi Nakamura	Tokyo Institute of Technology	P
Takahiro Kawabata	Department of Physics, Kyoto University	AP
Miho Tsumura	Department of Physics, Kyoto University	M2
Satoshi Adachi	Department of Physics, Kyoto University	D3
Tatsuya Furuno	Department of Physics, Kyoto University	M2
Motoki Murata	Department of Physics, Kyoto University	M1
Yuki Ishii	Department of Physics, Kyoto University	M1
Tetsuo Noro	Department of Physics, Kyushu University	P
Satoshi Sakaguchi	Department of Physics, Kyushu University	A
Yukie Maeda	Department of Applied Physics, University of Miyazaki	A

RUNNING TIME:	Installation time without beam	7 days
	Detector Setup	1 day
	Data runs	6 days
	Total	7 days

BEAM LINE: Ring : WS course

BEAM REQUIREMENTS:	Type of particle	p
	Beam energy	392 MeV
	Beam intensity	≤ 500 nA
	Any other requirements	halo-free, $\Delta E \leq 200$ keV

BUDGET:	Experimental expenses	800,000 yen for travel expenses
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Proposal for an experiment at the RCNP Cyclotron Facility

Submitted to RCNP for the B-PAC evaluation in August 2015

α -clustering at the surface of $^{112-124}\text{Sn}$ nuclei investigated in (p,p α) quasi-free knockout reactions

Principle investigators:

Experiment: T. Aumann (TU Darmstadt)
Z. Yang (RIKEN)

Theory: S. Typel (GSI)

Summary of experiment

We propose an experiment to study the effect of α -clustering at the surface of heavy nuclei. We plan to measure the cross section for proton induced quasi-free α knockout on Sn isotopes, which is directly related to the probability of preformed α clusters at the nuclear surface. This effect has been predicted by generalized relativistic mean field calculations, which allow explicitly for clustering degrees of freedom, to occur in low-density nuclear matter and at the surface of heavy nuclei. The existence of α correlations is important not only for the equation of state of dilute matter in core-collapse supernovae, but also for the neutron-skin thickness and its relation to the density dependence of the symmetry energy. In addition, the preformation of α clusters as a prerequisite for α decay would be naturally explained. Since the probability of α correlations at the nuclear surface is predicted to depend also on the N/Z ratio, we propose to investigate the Sn isotopic chain in order to test the theoretical prediction. We plan experiments with enriched targets of ^{112}Sn , ^{116}Sn , ^{120}Sn , and ^{124}Sn . The (p,p α) cross section will be measured in quasi-free kinematics by detecting the scattered protons with Grand Raiden, and the knocked out alpha particles with the large-acceptance spectrometer LAS. For ^{112}Sn , several spectrometer settings will be measured in order to reconstruct the intrinsic momentum distribution of the alpha particles in the nucleus. The proton beam energy will be 392 MeV and a current of 300 nA is considered for the rate estimate. In total, we request 7 days of beam time. The feasibility of the experimental method has been confirmed in the test experiment carried out in June of 2015.