RCNP Experiment E

Research Proposal to the

Research Center for Nuclear Physics, Osaka University (B-PAC Jan 2020)

Development of the Charge-Exchange Oslo Method and application towards constraining reaction rates for nucleosynthesis of cosmochronometer ^{92}Nb

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RUNNING TIME:

Installation and testing without beam:		~2 weeks
Optimization and Calibration with beam on target:		1 day
Data runs on ^{90}Zr target		3 days
Data runs on ^{92}Zr target		3 days
BEAM LINE:		Ring/WS Course
BEAM REQUIREMENTS:	Type of particle	$^{3}He^{2+}$
	Beam energy	420 MeV
	Beam intensity	$\leq$ 10 pnA
	Other requirements	Resolution $\leq$ 50 keV Dispersion-matched beam transport transport

BUDGET: We request support for setting up the SGD array at the target station of the Grand Raiden Spectrometer. We will provide the 4-mg/cm^2 ^{90,92}Zr targets.

SAFETY CONTROLLED ITEMS: None

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Summary

It is proposed to measure the ^{90,92}Zr(^{3}He,t+γ) reactions at 420 MeV to develop the Charge-Exchange Oslo (CE-Oslo) method and to extract reaction rates for the nucleosynthesis of cosmochronometer ^{92}Nb. This high precision study will lay a solid foundation for using the CE-Oslo method in future (p,n+γ) experiments in inverse kinematics with rare isotopes and make it possible to simultaneously extract nuclear level densities (NLDs), γ-ray strength functions (γSFs), β-decay strengths and (β-delayed) neutron decay probabilities (P_n) on neutron-rich unstable nuclei, which are important for several nucleosynthesis processes, including the r, i, γ, and ν processes. This high resolution uniquely available for (^{3}He,t) experiments at RCNP, in combination with the γ-coincidence measurements by using the SGD Array will make it possible to extract level densities in two independent manners: by using the Oslo technique on the correlation spectrum of γ-energy versus excitation energy and by using a combination of the fine-structure analysis and auto-correlation function analysis on the high-resolution singles spectrum. The latter technique has been applied in the past for ^{90}Zr and this component of the experiment serve as the benchmark of the CE-Oslo method. From the measurement on ^{92}Zr, we will be able to extract level densities and γ-ray strength functions of relevance of the γ-process in type Ia supernovae and Gamow-Teller strength distributions of relevance for the ν-process in core-collapse supernovae. These astrophysical phenomena are the possible sites for the production of long-lived ^{92}Nb, which can serve as a cosmochronometer.