RCNP EXPERIMENT E501

PROPOSAL FOR EXPERIMENT AT RCNP

7 Febrary 2016

TITLE:
Stellar half-life of ^{63}Ni and its impact to the *s*-process

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RUNNING TIME: Installation time without beam 10 days
Development of device 2.5 days

BEAM LINE: Ring : WS course

BEAM REQUIREMENTS:
Type of particle unpolarized deutetron
Beam energy 200 MeV
Beam intensity 100 pA - 10 nA
Other requirements beam spot ($\leq$1 mm $\times$ 1 mm)
halo-free, small emittance

BUDGET: Experimental expenses (detector frame et al.) 150,000 yen

TITLE:
Stellar half-life of ^{63}Ni and its impact to the s-process

SPOKESPERSON: Bao-Hua Sun and Hidetoshi Akimune

SUMMARY OF THE PROPOSAL

Among the elements in the region between iron and strontium, most of the copper abundance observed today in the solar system distribution was produced by the s-process in massive stars. ^{63}Ni ($T_{1/2}$ = 101.2 years) is a branching point and also a bottleneck in the weak s-process flow. At a temperature above about 300 MK, the effective decay rate could be enhanced significantly by up to two orders of magnitude.

We propose to determine the stellar effective half-life of ^{63}Ni by the ^{63}Cu(d,^{2}He)^{63}Ni charge-exchange reaction using the 200 MeV deuteron beam. The ^{2}He, the two protons in the $^{1}S_0$ state, will be momentum analyzed within the full acceptance of the Large Acceptance Spectrometer (LAS) in WS course and then detected with a focal-plane detector system allowing for particle identification and track reconstruction in horizontal and vertical directions. A resolution of about 200 keV (FWHM) ^{2}He spectra will allow us to determine the GT transition strengths from the low-lying states in ^{63}Ni with a reasonable precision. With these data, the stellar half-life of ^{63}Cu relevant for the s-process can be deduced for the first time, and this will induce propagation effects on the nucleosynthesis yields after core He and shell C burning, e.g., the enhancement of the weak s-process efficiency for heavier species along the neutron capture path up to $A \approx 70$.

Based on the previous (d, ^{2}He) experiments at KVI, RCNP and RIKEN and also a Monta-Carlo simulation for the LAS and detection system, we would like to study the β-transition strength for ^{63}Cu(d, ^{2}He) using a 200 MeV deuteron beam. Considering the need of an improved energy resolution of LAS and the uncertainty in transition strength calculations, we would like to request 2.5 days to perform the beam ion-optical investigation and the signal-to-noise ratio estimation using the ^{63}Cu.