Preparation for the measurement of the $^{12}C(\alpha,\gamma)^{16}O$ reaction at TRIAC*

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The $^{12}C(\alpha,\gamma)^{16}O$ reaction plays an important role in stellar evolution at the stage of helium-burning. Its reaction cross section determines the mass fraction of ^{12}C and ^{16}O , the abundance distribution of the elements between oxygen and iron, and the iron-core mass before the supernova explosion [1]. Therefore, it is quite important to accurately determine the cross section at center-of-mass energy $E_{\rm c.m.} = 0.3$ MeV. The direct measurement of the cross section at $E_{\rm c.m.} = 0.3$ MeV, however, is not possible using current experimental technique, because the cross section is too small, around 10^{-17} barn. Hence, one has to derive the cross section by extrapolating a measured cross section at $E_{\rm c.m.} \geq 1.0$ MeV into the range of stellar temperature. However, the estimated cross section at $E_{\rm c.m.} = 0.3$ MeV still has a large uncertainty mainly due to the poor determination of the ratio of $E2$ cross section to $E1$ one, σ_{E2}/σ_{E1}.

Recently, we have succeeded in determining the σ_{E2}/σ_{E1} with small statistical and systematic uncertainties by using high efficiency anti-Compton NaI(Tl) spectrometers to detect a γ-ray from the reaction with a large S/N ratio, intense pulsed α-beams to discriminate true events from background events due to neutron from $^{13}C(\alpha,n)^{16}O$ reaction with a time-of-flight (TOF) method, and monitoring system of target thickness [2, 3].

In order to provide a stringent constraint to extrapolation down to $E_{\rm c.m.} = 0.3$ MeV additional data is crucial. Hence we are now preparing a new measurement at TRIAC (Tokai Radioactive Ion Accelerator Complex). TRIAC can accelerate heavy ions ($q/A > 1/10$) from 2keV/u to 1.1 MeV/u with 26 MHz Split Coaxial RFQ (SCRFQ) and 52 MHz Interdigital-H (IH) linac. Since the SCRFQ has a radio frequency of 26 MHz, the bunch interval becomes 38.5 ns. On the other hand, the bunch interval is required to be that of 250 ns or more for removing a background events due to neutrons with the TOF method. Therefore we have installed the pre-buncher, coupled to a multilayer chopper, with a variable frequency of 2-4 MHz upstream of the SCRFQ. In this presentation we will report the results of the beam test using α beam and the plan for new experiment on $^{12}C(\alpha,\gamma)^{16}O$ reaction.

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