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Measurement of 59Cu(p,alpha)56Ni Reaction Rate to Constrain the Flow of nu p-Process

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In the universe, most matter is mainly composed of light elements like hydrogen and helium, which were synthesised shortly after the Big Bang. Elements beyond iron are produced through neutron capture via the r-process or the s-process. However, these processes can't explain the existence of several neutron-deficient elements, called p-nuclei, especially ^{92,94}Mo and ^{96,98}Ru. The νp-process which happens during the Core-Collapse SuperNovae (CCSNe) explosion and the rp-process in type-I X-ray bursts (XRBs) have been suggested as potential sites to produce these nuclei. In both processes, the ability to synthesise heavy elements depends on the competition between ^{59}Cu(p,γ)^{60}Zn and ^{59}Cu(p,α)^{56}Ni reactions, where the latter hinders the flow to the higher mass region, this is the Ni-Cu cycle. The upper-temperature limit for effective νp-process strongly depends on the ^{59}Cu(p,α)^{56}Ni reaction rate. CCSNe ejects the nucleosynthesis products to the interstellar medium whereas the ashes of XRBs do not become part of the interstellar medium, XRBs are therefore an unlikely source of heavy nuclei. However, the Ni-Cu cycle directly affects the energy generation and, consequently, the shape of the XRB light curves. There is presently no direct experimental information on these reaction rates, at temperatures relevant for CCSNe and XRBs. A first direct measurement of ^{59}Cu(p,α)^{56}Ni reaction cross-section at a higher energy (E$_{c.m.}$ = 6 MeV) was reported recently. This work will report an experiment to directly measure this reaction cross-section at E$_{c.m.}$ = 4.64 MeV, which is relevant to the temperature range for νp-process. Therefore, it is important to measure the ^{59}Cu(p,α)^{56}Ni reaction rate to understand the Ni-Cu cycle in the νp-process and XRBs.

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