Tuesday, June 4th At 3:45pm

Neutron production and capture in s-process stars: Nuclear physics with TIARA, STARLiTeR, and HYPERION

About a half of elements heavier than Fe in the solar system are produced by the s-process nucleosynthesis, a series of neutron capture reaction and β^--decay in stellar environment such as He burning stages of AGB stars and massive stars. It is therefore important to accurately determine the production and capture rates of neutrons in these stars for better constraining the s-process stellar models. The *s*-process occurs under the neutron environment of 10^{7-10} neutrons/cm^3. Neutrons for the *s*-process are believed to be dominantly produced by two key reactions. ^{22}Ne(α,n)^{25}Mg reaction is one of the two reactions and the reaction in the s-process environment is dominated by a few resonance reactions. However, there remain large uncertainties in the reaction rate because the reaction cross sections are too small due to Coulomb barrier ($E\alpha$ = 400-900 keV in the lab system) to determine by direct measurements. In the first half of my talk, I will present our experiment to determine these resonance strengths with the TIARA detector and the MDM spectrometer at a Texas A&M University (TAMU) cyclotron. The experiment was performed by an indirect approach using ^{6}Li(^{22}Ne,^{25}Mg+n/^{26}Mg+γ)*d* α-transfer reaction, in which resonance properties such as neutron decay branching ratios of the produced ^{26}Mg were studied. Our measured branching ratios show past direct measurements possibly overestimated the ^{22}Ne(α,n)^{25}Mg cross sections by a factor of three.

In the second half of my talk, I will present our experiments to determine neutron capture cross sections of unstable nuclei using the Surrogate Reaction method [1]. Neutron capture reactions for the *s*-process involve relatively long-lived nuclei neighboring stability in the nuclear chart. Therefore, the Surrogate Reaction, which creates the same compound nuclei as the neutron capture reaction using a stable beam and target, can be a useful approach. The ^{90,91}Zr(p,d) experiment was performed to constrain ^{89,90}Zr(n,γ) cross sections with the STARLiTER detector at TAMU cyclotron. Theoretical calculations combined with our experiments successfully showed the Surrogate method can constrain the reaction [2]. In the last part of my talk, I will also introduce a possible new approach to indirectly determine neutron capture reaction cross sections of unstable nuclei using radioactive ion beams with the BaF_2 detector array currently under development at TAMU.

[1] S. Ota et al., Phys. Rev. C 92 054603 (2015).

[2] J. Escher et al., Phys. Rev. Lett., 121 052501 (2018).y under development at TAMU.

CYCLOTRON COLLOQUIUM

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Refreshments will be served at 3:30 pm

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