ABSTRACT

THESIS: Experimental studies of $^{65}\text{Cu} (\alpha, p)$ $^{68}\text{Zn}$ and $^{85}\text{Rb} (\alpha, p)$ $^{88}\text{Sr}$ reactions for Nuclear Astrophysics

STUDENT: Samuel Teye

DEGREE: Master of Science

COLLEGE: Sciences and Humanities

DATE: December 2017

PAGES: 64

In the study of the field of Nuclear Astrophysics, we have sought to answer questions about the origin of elements, how they were formed in the Universe and why they exist in their abundances. Nuclear fusion and nuclear reactions provide energy for stars to live and evolve. During this process, elements are produced and synthesized. Nuclear reaction rates provide an essential ingredient and it is critical for the understanding of the synthesis of elements in the solar system and the Universe. The production of heavier elements can occur during supernova explosions. Alpha particle induced reactions on elements heavier than the Iron group nuclei may quickly produce heavier elements in a short time in the order of seconds. The s- and r- processes of neutron capture are currently well understood. However, a third process, known as the p- process may provide more understanding for the proton rich elements which cannot be explained by the neutron capture processes. This study presents the experimental measurements of the $(\alpha, p)$ reaction cross sections on $^{65}\text{Cu}$ and $^{85}\text{Rb}$. The experimental cross sections may be compared with the theoretical predictions. This comparison gives a scale factor which may then be used to scale the predicted cross sections at lower energies, below the Coulomb threshold, where experiments become practically impossible. These scaled theoretical cross sections may be used to calculate the astrophysical S-factor, which can go into the calculation of reaction rates at particle energies relevant to the temperature at the time of supernova explosions. The experiment was conducted at the Nuclear Facility at the University of Notre Dame in South Bend, Indiana. The energy of the incident alpha particle ranges between $E_\alpha = 8.5 - 11$ MeV. An array of charged particle detectors placed at angles between $\theta_{\text{lab}} = 25^\circ - 160^\circ$ was used so that data can
be accumulated at various angles for a given incident energy, all at one time using a Data Acquisition Software. Data at a different energy is obtained by simply changing the energy of the incident alpha particle. Experimental set up and data analysis will be reported and compared to the Hauser-Feshbach theoretical calculations using the NON-SMOKER simulations.