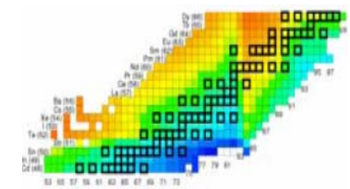
Systematic Study of α-Optical Potentials for p-Process

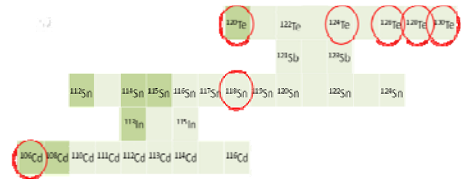


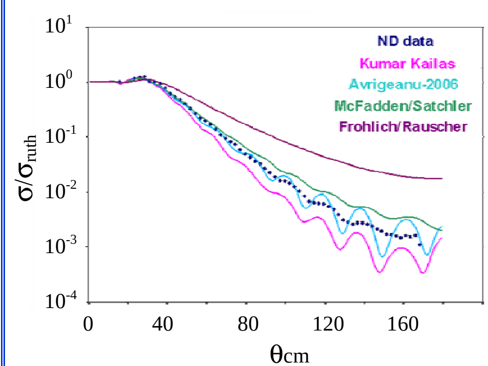
The p-process is the major astrophysical process responsible for the production of proton-rich elements beyond iron [1]. It proceeds via a sequence of photodisintegration reactions, (γ,n), (γ,p), and (γ,α) on heavy elements at temperatures of 2-3x10^9 K. Such high temperature and high photon-flux conditions can exist in astrophysical environments like core-collapse supernova explosions and neutron star mergers.

Abundance calculations for the p-process involve more than 20,000 nuclear reactions of almost 2000 nuclei. These reaction rates are typically calculated with the statistical Hauser Feshbach (HF) model. The (γ,α) rates are critical for the production of heavy p-nuclei while the HF model performs poorly in calculating these rates due to the uncertainty of the alpha optical potentials applied [2]. To test the reliability of the HF calculations and provide a systematic understanding of the alpha optical potential at energies of astrophysical interest, a series of precision alpha scattering measurements were carried out at the Notre Dame FN tandem accelerator. Specifically, ^{106}Cd, ^{118}Sn, and ^{120,124,126,128,130}Te were studied at energies both below and above the Coulomb barrier: 17, 19, 22, 24.5, and 27 MeV.

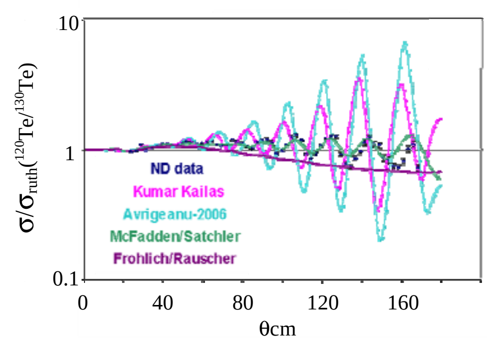
The extended energy range helps probe the energy dependence of the potential parameters and guide the extrapolation down to the astrophysical energy range. The systematic study of almost all stable Te isotopes helps determine the isotopic dependence of the potential and therefore extend the application to the unstable p-rich nuclei away from the stability valley. Additional measurements with ^{106}Cd and ^{118}Sn can provide a test on the charge dependence. Further detailed analysis is in process.

[1] M. Arnould and S. Goriely, Phys. Rep. **384**, 1 (2007)
[2] Gy. Gyürky, et. al., Phys. Rev. C 74, 025805 (2006)





Typical experimental cross sections (normalized to Rutherford cross sections) are compared to the calculations of various alpha optical potential models)



The ratio of the normalized experimental cross section of ^{120}Te(α,α) to that of ^{130}Te(α,α) is compared to the predictions from various alpha optical potential models in order to test the mass dependence.

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