Multiple Mechanisms in Proton-Induced Nucleon Removal at ~100 MeV/Nucleon

Introduction

- This article report on the first proton-induced single proton-removal reactions and neutron-removal reactions from the neutron-deficient ^{14}O nucleus with large Fermi-surface asymmetry $S_n - S_p = 18.6$ MeV at ~100 MeV/nucleon, which is a widely used energy regime for rare-isotope studies.
- In the article, the measured inclusive cross sections and parallel momentum distributions of the ^{13}N and ^{13}O residues are compared to the latest reactions models, with nuclear structure inputs from many-body shell-model calculations.

Introduction

- Their results provide the first quantitative contributions of multiple reaction mechanisms including: quasifree knockout, inelastic scattering, nucleon transfer processes.

- It is shown that the inelastic scattering and nucleon transfer, which are usually neglected at such energy regime, actually contribute about 50% and 30% to the loosely bound proton and deeply bound neutron removal, respectively.

- These multiple reaction mechanisms should be considered in analyses of inclusive one-nucleon removal cross sections measured at intermediate energies for quantitative investigation of single-particle strengths and correlations in atomic nuclei.

Experiment Part

- Since the light absorptive nuclear targets ^{9}Be or ^{12}C may introduce the complexity that the final state of the target is unknown, this research use a single-nucleon target, the proton, to do the experiment.
- The experiment was performed at the Radioactive Isotope Beam Factory operated by the RIKEN Nishina Center and the Center for Nuclear Study, The University of Tokyo.
- The research group use ^{18}O at 230 MeV/nucleon to bombard on a 14-mm thick ^{9}Be target to produce the ^{14}O beam which will be used in the experiment as the projectile.

Experiment Part

- The ^{14}O secondary beam was purified and identified using the time of flight (TOF) and the energy loss (ΔE) information by the BigRIPS fragment separator.
- Then, the ^{14}O was tracked onto a 2.40(34)-mm thick solid hydrogen target using two multiwire drift chambers.
- The beam energy at the target center was 94 MeV/nucleon with a narrow spread of 0.2 MeV/nucleon. The target density was determined to be 86 mg/cm^3 based on the monitored target-cell temperature.
- The target thickness and its uncertainty were extracted by measuring the momentum change of the unreacted ^{14}O beam with and without the hydrogen target.