Statement of Research Interests and Goals

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For the past 7 years, I have been focusing on research on experimental nuclear physics and astrophysics as a graduate student and a post-doctoral fellow. I have also been working on nuclear structure data evaluation and stellar reaction rate evaluations as part of my post-doctoral research for the past two years. The following sections summarize my research effort in these areas as well as my future goals.

1 Experimental Nuclear Physics and Astrophysics

Computer Simulation of Nuclear Detectors In nuclear physics, computer simulations using the Monte-Carlo method are useful for testing the performance of a detector and for predicting nuclear events, especially, when experimental tests are expensive, or if beam time is not available. They can also serve as a benchmark for experimental results. For my master's thesis project, I made simulations of silicon detectors using the GEANT4 toolkit, including a compact disk-like double-sided strip detector (CD detector) used as an end detector in the SHARC array (Silicon Highly-segmented Array for Reactions and Coulex) in conjunction with the TIGRESS γ-ray spectrometer at TRIUMF.

Nuclear Reactions and γ-ray Spectroscopy I have performed experiments using radioactive beams to study the nuclear states of astrophysical interest in ^{26}Si for my Ph.D. thesis project. One was performed at the National Superconducting Cyclotron Laboratory (NSCL) in Michigan State University using the (p,d) transfer reaction in inverse kinematics with a radioactive ^{27}Si beam, impinged on a polypropylene foil (C_3H_6). The Doppler-broadened de-excitation γ-rays were detected in a highly-segmented Germanium detector array (SeGA) in coincidence with the particle detection. γ-γ coincidence matrix was constructed for extracting transition cascades and levels. Most of the analysis codes were written by me using C++ and ROOT library. Our result confirmed most of the bound states in ^{26}Si and made improvement in calibration of future studies.

A second experiment was performed at the CRIB facility at RIKEN using (p,p) elastic scattering with a radioactive ^{25}Al beam on a thick C_3H_6 foil. By employing the thick target method, compound resonant states up to E_{cm}=3.5 MeV above the proton threshold were scanned with a single beam energy. Elastically scattered protons were detected in three sets of ΔE-E silicon telescopes, which together with the two PPAC (Parallel-Plate-Avalanche-Counter) detectors, provided the scattering geometry for energy conversion in different reference frames and for the energy-loss correction of the proton energy in the target and detectors. Experimental resonant cross-sections were obtained from the proton spectrum and were fit using the R-Matrix differential cross-section formula. Resonant parameters such as resonance energies, spin-parity assignments and widths were extracted from this fit to the resonances that were prominent in the excitation function. Most of the program coding for the data analysis was written by me using C/C++ and Fortran.

Apart from my research projects, I have been also involved in other experiments such as direct measurements with radioactive ion beams at TRIUMF, and indirect measurements with transfer reactions and in-beam γ-ray spectroscopy at Yale University and the University of Tsukuba.

Experimental Nuclear Astrophysics My interest is in stellar reaction rates of key reactions in explosive environments, such as in nova and supernova explosions. These reaction rates provide very important clues for understanding the nucleosynthesis in our galaxy. My PhD thesis project was on the ^{25}Al(p,γ)^{26}Si reaction rate, which strongly influences the production of galactic ^{26}Al at nova temperatures. The goal was to reduce the existing large uncertainty in this rate, which therefore provides more accurate inputs for network calculations of nucleosynthesis in these environments.

2 Nuclear Structure Data Evaluation

I have been working on nuclear structure data evaluation for the data project of the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory (BNL) since 2009. So far, I have completed evaluations on the nuclear structure of nuclei in the mass chains A=33, 35, 37 (partial contribution) and 44. In these evaluations, detailed evaluated level properties and related information are presented, including adopted values of level and γ-ray energies, decay data (energies, intensities and placement of radiations), and other spectroscopic data. I have also developed some computer programs which have been used to facilitate the evaluation process.

3 Stellar Reaction Rate Evaluation

As I am interested in stellar reaction rates, it was a natural step for me to do some evaluations of stellar reaction rates which are closely coupled to our group's experimental program. This effort falls under the umbrella of the astrophysical reaction rate evaluation project at Oak Ridge National Laboratory (ORNL). I have evaluated and updated some important astrophysical reaction rates, such as the ^{23}Mg(p,γ)^{24}Al which serves as a bridge between the NeNa cycle and the MgAl cycle in O-Ne classical novae, the ^{29}P(p,γ)^{30}S which is a key reaction that affects the production and destruction of ^{29}Si and ^{30}Si in nova outbursts, and ^{25}Al(p,γ)^{26}Si.

4 Future Goals

I am very interested in experimental nuclear physics and nuclear astrophysics, particularly in nuclear structure and astrophysical reaction rates. I have been involved in several experiments in such areas to date. There is still a large unknown territory to be explored. One of my goals is to study the nuclear structure of the nuclei in the astrophysically important reactions and their rates using improved experimental techniques and conditions. Another goal of mine is to evaluate and update the nuclear structure of additional mass chains, as well as new stellar reaction rates.