EXPLORING NUCLEAR SHELL EVOLUTION WITH NUCLEON TRANSFER REACTIONS

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Nuclear reactions in which a single nucleon is transferred onto a radioactive projectile give a unique insight into the evolution of single-particle orbitals away from stability. In particular, a simple transfer such as (d,p), combined with the high resolution of gamma-ray spectroscopy is now proven to be especially powerful. A unique feature of reactions like (d,p) is that the added neutron will probe orbitals that are not occupied in the projectile.

We have recently extended our studies of the neutron shell closure at N=20 in nuclei approaching the “island of inversion”. Our initial studies using TIARA with beams of ^{24}Ne and ^{26}Ne at GANIL/SPIRAL have been extended to exploit reaccelerated beams of ^{25}Na, ^{24}Na and ^{28}Mg at ISAC/TRIUMF.

A new technique, exploited for the first time in our experiment to study (d,p) with ^{25}Na, took full advantage of the gamma-ray energy resolution to distinguish closely spaced states in ^{26}Na: the high beam intensity, > 10^7 pps, allowed differential cross sections to be extracted with gating on individual gamma-ray peaks. Low-lying negative parity states were isolated and observed for the first time, revealing an increased role of the $1p_{3/2}$ neutron orbital compared to the less exotic isotone ^{28}Al.

Our experiments to study ^{25}Na and ^{29}Mg have yielded additional results providing key input to the shell model. For ^{25}Na and ^{29}Mg we have made the first measurements of spectroscopic strength for the negative parity states, plus certain positive parity states.

Future developments include deploying TIARA at Texas A&M and MUGAST at GANIL.