Approaching ^{78}Ni along the N=50 line utilizing deep inelastic reactions*

M. P. Carpenter [1], R. V. F. Janssens[1], S. Zhu[1], B. Fornal[2], R. Broda[2], A. Galindo-Uribarri[3], N. Hoetling[4], A. Ibanez[5], T. L. Khoo[1], F. G. Kondev[6], T. Lauritsen[1], C. J. Lister[1], E. Padilla-Rodal[3,7], D. Seweryniak[1], J. P. Ureggo-Blanco[7], X. Wang[1,8]

[1] *Physics Division, Argonne National Laboratory, Argonne, IL 60439*
[2] *Niewodniczanki Institute of Nuclear Physics, PL-31342, Cracow, Poland*
[3] *Oak Ridge National Laboratory, Oak Ridge, TN 37831*
[4] *University of Maryland, College Park, MD 20742*
[5] *Instituto de Fisica, UNAM*
[6] *Nuclear Engineering Division, Argonne National Laboratory, Argonne, IL 60439*
[7] *University of Tennessee, Knoxville, TN 37996*
[8] *University of Notre Dame, Notre Dame IN 46556*

The study of doubly and semi magic nuclei have historically proven to be important in establishing for example the parameter strengths for the shell model. Until recently, these parameters were set by nuclei lying near the line of beta-stability, however, with the coming online of a number of first and second generation radioactive beam facilities, studies of exotic neutron rich nuclei at and near closed shells have begun. What has motivated many of these measurements from a nuclear structure standpoint is the fact that rearrangements of single-particle energies are observed for neutron rich isotopes. Such changes in the single-particle energies have been attributed to the attractive strength of the spin-isospin part of the effective nuclear interaction. As a result, one has observed the disappearance of certain magic numbers and the emergence of new closed shells. Our collaboration has been actively studying neutron rich nuclei in the Ca-Ti region in order to examine such a phenomenon. Specifically, we have been investigating Ti and Cr isotopes with N> 28. Recent shell model calculations using the GXPF1 Hamiltonian had suggested a new closed shell for N=32 and Z≤24 and the emergence of a shell gap at N=34 for Z≤22 [1]. Our recent results from Gammasphere using both the ^{48}Ca + ^{208}Pb and ^{48}Ca + ^{238}U reactions has confirmed the N=32 gap for ^{54}Ti (Z=22) [2] and shown that no such gap has developed at N=34 for Z=22 (^{56}Ti) [3].

With the success of our Gammasphere experiments utilizing a ^{48}Ca beam, we have extended our measurements into the region around N=50 and Z=28 (^{78}Ni). Neutron rich nuclei in this region are of particular interest due to their role in the r-process, and in particular, their contribution to the peak in the solar elemental abundance near A=80. While much is known with regards to the N=50 isotones starting at ^{86}Kr and proceeding up towards ^{100}Sn, much less is known about the isotones approaching and including ^{78}Ni with much of this knowledge coming from decay work and thus limited to low-spin levels. In order to access high-spin states in the N=50 isobars ^{84}Se and ^{82}Ge, a deep-inelastic reaction was utilized using an ^{82}Se beam at bombarding energies of 510 and 630 MeV incident on thick targets of either ^{208}Pb or ^{238}U. Gamma-rays were detected by the Gammasphere array consisting of 101 Compton-suppressed HPGe counters.

Recently, levels in ^{84}Se have been reported up to a tentative spin of 7^+ in several recent measurements [4-6]. From our measurement, we have extended the yrast structure of ^{84}Se up to a tentative spin of 12^+ and added a number of new non-yrast levels to the known level structure. For ^{82}Ge, besides the first excited 2^+ level at 1348 keV, a level at 2286 keV has recently been reported from ^{83}Ga β^- n decay [7]. We confirm this level in our data and have added two additional levels to the known level structure of ^{82}Ge. Our new experimental results will be presented along with shell model calculations which attempt to reproduce the observed level structure in both these neutron rich N=50 isobars.

[1] J.I. Prisciandaro et al., Phys. Lett. B **510**, 17 (2001).
[2] R.V.F. Janssens *et al.*, Phys. Lett. B **546**, 55 (2002).
[3] B. Fornal *et al.*, Phys. Rev. C 70, 064304 (2004).
[4] Y. H. Zhang *et al*., Phys. Rev. C **70**, 024301 (2004).
[5] A. Prevost *et al*., Eur. Phys. J. A 22, 391 (2004).
[6] E. F. Jones *et al*., Phys. Rev. C **73**, 017301 (2006).
[7] O. Perru *et al*., Phys. Atom. Nucl. **66**, 1421 (2003).

*This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under contracts W31-109-ENG-38 and DE-AC05-00OR22725.