Beta Decay Studies at the NSCL

P.F. Mantica

National Superconducting Cyclotron Laboratory and Department of Chemistry,
Michigan State University, East Lansing, Michigan, USA

The results of recent measurements of beta-delayed gamma rays from neutron-rich nuclides produced by projectile fragmentation at the National Superconducting Cyclotron Laboratory at Michigan State University will be summarized. The use of fast fragmentation for production of the radioisotopes of interest allows for unambiguous assignment of $A$, $Z$, and $Q$ based on standard energy-loss and time-of-flight techniques, coupled with information on beam rigidity and total energy. The correlation of fragment implantation and beta events in a double-sided silicon microstrip detector permits event-by-event assignment of beta activities [1]. Twelve detectors from the NSCL Segmented Germanium Array [2] monitor delayed gamma rays. Experiments have been completed to examine the systematic behavior of low-energy states near the neutron shell closures at $N=20, 28, 50$, and $82$. The pathway into the island of inversion around $N=20$ for the Na isotopes was investigated, and low-energy states in $^{29}$Na [3] that lie outside the sd shell-model space were identified. Measurements of the low-energy states of even- and odd-$A$ nuclides above $^{48}$Ca$_{28}$ have provided evidence for a subshell closure at $N=32$ for the Cr, Ti, and Ca isotopes; however, expectations for a new shell closure at $N=34$ for the Ti isotopes were not corroborated [4]. The systematic variation in the first $2^+$ and $4^+$ states of the even-even Ni isotopes is now known to $^{76}$Ni, just two neutrons removed from the $N=50$ shell closure [5]. The spectroscopy for determining the level energies in the Ni isotopes was not limited to delayed gamma rays, but involved isomeric gamma-ray detection as well; a “free” by-product of the event-by-event correlations methods employed for the beta-decay studies. Lastly, the low-energy level structures for a number of nuclides “southwest” of $^{132}$Sn$_{82}$ have been determined for the first time. New data on excited states in $^{125-127}$Cd, $^{121-125}$Ag, and $^{120}$Pd from beta-delayed as well as isomeric gamma-ray studies provide a means for evaluating the “goodness” of the $N=82$ shell closure for these very neutron-rich nuclei [6].

This work is supported in part by the National Science Foundation grant PHY-01-10253. The experimental beta decay program at the NSCL has involved researchers from the following institutions: Argonne National Laboratory, Florida State University, Michigan State University, Oak Ridge National Laboratory, University of Maryland, University of Tennessee, and Vanderbilt University.

References