STUDY OF THE $^{13}B(d,p)^{14}B$ REACTION IN INVERSE KINEMATICS WITH HELIOS

S. Bedoor[1], A. H. Wuosmaa[1], J. C. Lighthall[1,2], M. Alcorta[2], B. B. Back[2], P. F. Bertone[2], B. A. Brown[3], C. M. Deibel[4], S. T. Marley[1,2], K. E. Rehm[2], A. M. Rogers[2], J. P. Schiffer[2], D. V. Shetty[1]

[1] *Physics department, Western Michigan University, Kalamazoo MI 49008-5200 USA*

[2] *Physics Division, Argonne National Laboratory, Argonne, IL 60439 USA*

[3] *Department of Physics and Astronomy, Michigan State University, East, East Lansing, Michigan 48824 USA*

[4] *Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803 USA*

We have studied the $^{13}B(d,p)^{14}B$ reaction in inverse kinematics using HELIOS at the ATLAS facility at Argonne National Laboratory at 15.7 MeV/nucleon. Angular-momentum transfers and spectroscopic factors were deduced for the four lowest states in ^{14}B. The low-lying negative-parity states in ^{14}B are formed by the coupling of a single sd-shell neutron with a $0p_{3/2}$ proton hole. As such, it is an ideal candidate to provide information on the trends of the energies of the $1s_{1/2}$ and $0d_{5/2}$ single-particle orbitals at the extreme values of N/Z. The neutron single-particle structure is expected to resemble that of the next heaviest N=9 isotone ^{15}C, whose ground state wave function is well described by a $1s_{1/2}$ neutron coupled to an N=8 neutron core. In ^{14}B, a doublet of $(2,1)^-$ states are expected to be predominantly made up of $\pi(0p_{3/2})^{-1}\nu(1s_{1/2})$ configurations, and coupling of the proton hole to a $d_{5/2}$ neutron produces four negative-parity states with $J^{\pi}=(1,2,3,4)^-$. The $0d_{5/2}$-$1s_{1/2}$ splitting in ^{14}B is expected to be small, producing mixing between the $(1,2)^-$ $l=0$ and 2 configurations. Precise knowledge of the dominant orbital angular momenta, the degree of configuration mixing, and the spectroscopic factors for neutron transfer populating the low-lying negative parity states provides data with which we can test predictions of the shell model for this nucleus, and examine the trends of the single-particle energies at this extreme value of N/Z.

To examine these properties of ^{14}B, we obtained data for the $^{13}B(d,p)^{14}B$ reaction in inverse kinematics using an unstable beam of ^{13}B produced using the In-Flight method [1] at the ATLAS facility at Argonne National Laboratory. Protons from the $^{13}B(d,p)^{14}B$ reaction were detected and analyzed using the HELIOS device [2] at ATLAS, a large solenoid spectrometer specially designed to study transfer and other reactions in inverse kinematics. Bound and unbound states in ^{14}B were distinguished by detecting and identifying the recoiling ^{13}B and ^{14}B nuclei in a set of silicon ΔE-E telescopes at forward angles. Excitation-energy spectra and angular distributions for transitions to low-lying narrow states in ^{14}B will be presented, and the deduced spectroscopic factors for neutron transfer will be compared to the predictions of the shell model. This work was supported by the U. S. Department of Energy, Office of Nuclear Physics, under Contracts DE-FG02-04ER41320 and DE-AC02-06CH11357.

References

[1] B. Harss et al, Rev. of Sci. Instrum. **71**, 380 (2000).

[2] A. H. Wuosmaa et al., Nucl. Instrum. and Meth. in Phys. Res. A **580**, 1290 (2007), J. C. Lighthall et al., Nucl. Instrum. and Meth. in Phys. Res. A. **622**, 97 (2010).