Neutron-Transfer Reactions with Neutron-Rich Radioactive Nuclear Beams

J.A. Cizewski[(1)], D.W. Bardayan[(2)], J.C. Blackmon[(2)], R. Hatarik[(1)], M.S. Johnson[(3,6)], K.L. Jones[(1)], R.L. Kozub[(4)], S.D. Pain[(1)], M.S. Smith[(2)], J.S. Thomas[(1,5)]

[(1)]*Department of Physics and Astronomy, Rutgers University, New Brunswick, NJ 08901 USA*
[(2)]*Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831USA*
[(3)] *Oak Ridge Associated University, Oak Ridge, TN 37831-6374USA*
[(4)]*Department of Physics, Tennessee Technological University, Cookeville, TN 38505USA*
[(5)]*Physics Department, University of Surrey, Guildford GU2 7XH, Surrey, UK*
[(6)]*N-Division, Lawrence Livermore National Laboratory, Livermore, CA 94550 USA*

The properties of atomic nuclei with closed shells, "magic numbers" of neutrons or protons, have long provided the benchmarks for models of nuclear structure. The single-particle properties of nuclei near closed shells have been established by nuclear reactions in which a proton or neutron is transferred from a closed-shell nucleus, for example by the neutron transfer (d,p) reaction. Modern nuclear structure models (e.g., [1]) and the observed abundances of elements formed in r-process nucleosynthesis suggest that the shell structure that characterizes nuclei near the valley of stability is changed in very neutron-rich nuclei far from stability.

We have begun a program to study the (d,p) reactions with neutron-rich radioactive nuclear beams at the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory. The first measurements[2,3] focused on the (d,p) reaction with beams of the N=50 isotones ^{82}Ge and ^{84}Se. These are the first neutron-transfer reaction measurements on nuclei along the r-process nucleosynthesis path. We are poised to measure the (d,p) reaction with ^{130,132}Sn beams, following a successful benchmark[4] of the techniques with a stable ^{124}Sn beam. These measurements will be facilitated by a new array of position-sensitive silicon strip detectors ORRUBA, currently under development. We have also demonstrated the feasibility to measure gamma rays in coincidence with (d,p) reaction protons in inverse kinematics reactions to enhance the excitation energy resolution of neutron-transfer reaction studies.

This contribution would present an overview of the current and proposed efforts at HRIBF to study neutron-transfer reactions with neutron-rich radioactive nuclear beams near the N=50 and 82 closed shells.

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