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New decay studies near the doubly-magic ^{78}Ni[1]

KRZYSZTOF RYKACZEWSKI, ORNL Physics Division

The nucleus ^{78}Ni, with a closed proton shell at Z=28 and a closed neutron shell at N=50, is the most neutron-rich doubly-magic nucleus identified to date [1,2]. Spectroscopic studies of nuclei around ^{78}Ni are important for understading both the evolution of nuclear structure in neutron rich matter and the rapid neutron capture nucleosynthesis process. Additionaly, the beta-delayed neutron emission from neutron-rich fission products contributes to the total number of neutrons inducing fission in nuclear fuel and should be accounted for when running power reactors. The neutrons filling the large $1g_{9/2}$ shell between N=40 and N=50 impact the spin-orbit splitting of the respective proton orbital pairs, $2p_{3/2}$-$2p_{1/2}$ and $1f_{7/2}$-$1f_{5/2}$. This can trigger a change in the ground-state proton configuration of very neutron rich nuclei above Z=28 [3,4]. Further, the energy difference beetwen the $2d_{5/2}$ and $3s_{1/2}$ neutron orbitals above N=50 is decreasing when approaching the ^{78}Ni region possibly resulting in the appearance of a new subshell closure at N=58. Nuclei in the ^{78}Ni region are produced at the Holifield Radioactive Ion Beam Facility (HRIBF, Oak Ridge National Laboratory) by means of an on-line isotope separation technique using the fission of a ^{238}U target induced by a 50 MeV, 10 microAmp proton beam. The decay studies performed at the HRIBF profitted from the post-acceleration of mass-separated radioactive beams to about 200 MeV. A novel method, the so-called *ranging- out* technique, allowed us to separate the most neutron-rich component of the isobaric cocktail beam [5,6]. New results on the decay of A=76 to A=79 Cu isotopes and of A=83 to A=85 Ga isotopes will be presented. In particular, the measured beta-delayed neutron branching ratios for the Cu isotopes are two to four times larger than previously reported [7]. An energy of 247 keV was established for the $3s_{1/2}$ neutron state above the $2d_{5/2}$ ground- state in the N=51 isotone ^{83}Ge suggesting the existence of low energy E2 isomers in the N=51 ^{81}Zn and ^{79}Ni nuclei. The low-energy $3s_{1/2}$ state may have a spatially extended wave function (halo) in a weakly bound N=53 isotone ^{81}Ni. The extension of the HRIBF studies to even more neutron-rich nuclei at the recently completed Low-energy Radioactive Ion Beam Spectroscopy Station will also be discussed. [1] Ch.Engelmann et al., Zeit. Phys. A 352, 351 (1995) [2] P.T.Hosmer et al., Phys. Rev. Lett. 94, 112501 (2005) [3] T.Otsuka et al., Phys. Rev. Lett. 95, 232502 (2005) [4] J.Dobaczewski et al., Prog. Nucl. Part. Phys. 59,432(2007) [5] C. J. Gross et al., Eur. Phys. Jour. A25, s01, 115 (2005) [6] J. A. Winger et al., Acta Phys. Pol. B39, 525 (2008) [7] B. Pfeiffer et al., Prog. Nucl. Energy 41, 39 (2002)

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