Study of the Evolution of Shell Structure of *Z<50* Neutron-rich Nuclei near the *N=82* Closed Shell Using the ^{96}Zr + ^{124}Sn Reaction at 576 MeV with the GASP Array

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The neutron-rich region approaching *N = 82* and *Z = 50* is interesting for nuclear structure and nuclear astrophysics, as a test field of both the shell closures far from stability and the r-process path in nucleosynthesis. This region is difficult to access with fusion-evaporation reactions with stable nuclear beams and novel techniques must be implemented. During the last decades, experimental studies of neutron rich nuclei received a boost with the use of quasi-elastic and deep inelastic reactions in specialized experimental arrays, such as the large acceptance PRISMA [1] magnetic spectrometer used in conjunction with the gamma-ray detector array CLARA [2].

The clear identification of the target-like and projectile-like products, in thin target PRISMA-CLARA experiments, suffers of a lack of yield production that sometimes makes difficult the study and characterization of medium and high spin states of the products. The use of the high efficiency gamma-ray spectrometers GASP, in a thick target experiment, permits to add and complement previous experiments to obtain pivotal information for a more complete characterization of the nuclear states.

Here we report on an experimental study of the yrast- and near-yrast states of neutron-rich isotopes with Z < 50. The main aims of the experiment were to

1. study the structure of neutron-rich Pd isotopes as N = 82 is approached.
2. perform a search for magnetic bands south-west of the ^{132}Sn isotope.
3. complement the high-spin spectroscopy of A ≈ 100 neutron-rich nuclei, studied in a related Prisma/Clara experiment at LNL.

Nuclei in the region were populated using a multi-nucleon transfer reaction initiated by a beam of 6 MeV/u ^{96}Zr ions, with an energy of 576 MeV, incident on a thick target of ^{124}Sn. The incident beam was provided by the Tandem-XTU accelerator, and post-accelerated to his nominal beam energy using the LINAC ALPI accelerator at Legnaro National Laboratory. A beam intensity of 1.5 enA on target was used. The target had a layer of ^{124}Sn, with a thickness of 8 mg·cm^{-2}, supported on 40 mg·cm^{-2} of ^{208}Pb. Gamma-rays were detected using the GASP muti-detector array in the so-called configuration II, composed of 40 high-purity Ge detectors surrounded by anti-Compton BGO shields. A total of 39 Ge detectors were used during the experiment. Events with two or more coincident gamma rays were recorded. Energy and efficiency calibrations were performed using standard sources of ^{60}Co, ^{152}Eu, ^{133}Ba, and ^{88}Y. The data have been sorted into γ-γ and γ-γ-γ matrices. The matrices were analyzed using the UPAK [3], GASPware [4] and Radware [5] spectrum analysis codes.

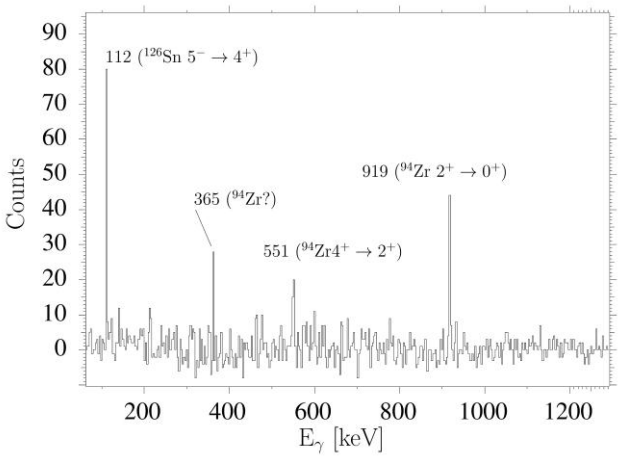

Fig. 1. Double-gated spectra of gamma-ray transitions belonging to ^{124}Sn and ^{94}Zr. The gates were made on the 1131 keV and 970 keV gamma-ray transitions of ^{124}Sn. The transition at 365 keV belongs, presumably, to ^{96}Zr.

Binary reactions produce projectile-like and target-like products simultaneously, this is clearly seen in Fig. 1., where a double gate was set, using the γ-γ-γ cube, on two γ-ray transitions of the ^{126}Sn isotope, the 114 keV (2^+ to 0^+) and the 908 keV (4^+ to 2^+) transitions. The gamma-ray spectrum in Fig. 1., shows gamma rays belonging to ^{126}Sn (^{124}Sn+2n) and to the reaction partner ^{94}Zr (^{96}Zr-2n). The simultaneous production of target-like and projectile-like isotopes in the reaction can be used to identify and characterize gamma-ray decay transitions in neutron-rich nuclei, by gating in known transitions in the not-so rich neutron partners. This studies complement previous experimental results using the Prisma-Clara array [6]. Currently, the data analysis is being performed [7].

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