HIGH- AND LOW-SPIN STRUCTURES IN THE PROTON-PARTICLE NEUTRON-PARTICLE ^{210}BI NUCLEUS

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Nuclei around doubly-closed shells play a crucial role in studying both a) the couplings between valence nucleons which provide information on the effective nucleon-nucleon interaction and, b) couplings of the valence nucleons with collective phonons, which may be used as a unique test of various effective interactions like Skyrme, Gogny etc., used in mean-field based models. From a broader perspective, understanding the coupling of a single particle to vibrational motion in nuclei is of primary importance, as this coupling is responsible for the quenching of spectroscopic factors [1]; it is also the key process at the origin of the damping of giant resonances [2].

The vibrational phonons are best known from the spectroscopic studies of doubly-magic nuclei in which they appear, in general, as the lowest excited states exhibiting a high degree of collectivity. For example, in ^{208}Pb, the lowest excitation (at 2615 keV) is the 3^- octupole vibration with a large transition strength of 34 W.u.

We investigated the yrast structure of ^{210}Bi up to an excitation energy of 6 MeV and low-spin structure up to the neutron-capture state at 4.6 MeV by using two approaches: a) a thick-target γ coincidence measurement of ^{208}Pb+^{208}Pb (at 1446 MeV) deep-inelastic reaction products with a multidetector germanium array GAMMASPHERE at Argonne National Laboratory, USA, and, b) neutron capture experiment ^{209}Bi(n,γ)^{210}Bi performed at ILL Grenoble at the PF1B cold-neutron facility in which γ-γ coincidences were measured with the EXILL germanium array.

In deep-inelastic processes occurring during the ^{208}Pb+^{208}Pb collisions, relatively high spin states were populated in ^{210}Bi with rather high intensity. We analyzed the spectra of prompt and delayed γ-rays by requiring coincidences with the known ^{210}Bi yrast transitions. This investigation confirmed known thus far level scheme and resulted in adding new prompt lines. A series of higher-lying γ rays observed in delayed spectra indicates the presence of unknown isomeric state. As the result of this part of the analysis, we were able to establish spins and parities of identified yrast states and extend the spectroscopic information to excitation energy of ~6 MeV and spin of approx. 20. The yrast states with spin greater than 14 have to involve coupling of the valence proton and neutron to the core excitations (phonons).

Low-spin structure of ^{210}Bi was investigated in a cold-neutron capture experiment ^{209}Bi(n,γ)^{210}Bi performed at ILL Grenoble. Due to low neutron energy (~5 meV) only the state at neutron binding energy in ^{210}Bi (~4.6 MeV) was populated. Its decay proceeded through many branches feeding lower lying states. An array of 16 Ge detectors of EXILL array was used for coincident measurements of the γ rays. It is the first time when such large array was employed for ^{209}Bi(n,γ)^{210}Bi reactions studies so the decay scheme could be revised and significantly extended. The analysis of the angular correlations of γ rays provided information about transitions multipolarities and helped with the spin-parity assignments. The structure arising from the excitations of valence protons and neutrons was compared to the shell-model calculations. Some of the observed states must come from the coupling of the valence particles excitations with the first excited state in ^{208}Pb, that is 3^- octupole vibration.

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