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Low-spin excitations in the 206Tl and 205Pb nuclei studied by thermal neutron capture reactions

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Nuclei from the regions of doubly-closed shells may be considered an excellent ground for studying both a) the couplings between valence nucleons - this provides information on the effective nucleon-nucleon interaction and, b) couplings of the valence nucleons with core excitations, what may be used as a unique test of various effective interactions (Skyrme, Gogny, etc.) employed in mean-field based models.

206Tl, having only one-proton-hole and one-neutron-hole with respect to the 208Pb core, was populated in a thermal neutron capture reaction 205Tl(n,gamma)206Tl at Institut Laue-Langevin in Grenoble (France). To reach the low-spin structure of this nucleus, the gamma decay from the capture state was studied using the HPGe multidetector FIPPS facility. Gamma rays from the capture state, which in 206Tl is placed at 6.5 MeV, were detected by an array of 8 Ge clovers. The results of the double and triple gamma-coincidence analysis will be presented: 21 low-spin excited states were observed in 206Tl, 8 of them were newly established. As the detectors of FIPPS were placed in one ring in octagonal geometry, double-coincidence data could be sorted into the matrices corresponding to different average angles between the crystals. The analysis of gamma-ray angular correlations provided information about transitions multipolarities, which significantly helped with spin-parity assignments.

After extracting the information about spin and parity of the excited states in 206Tl, the level structure of this nucleus was compared to the results of shell-model calculations. The large number of low-spin states populated in neutron capture reactions on 205Tl, arising from one proton-hole and one neutron-hole excitations, can be used as a very good testing ground for the old and newly developed shell-model interactions in the south-west quadrant of the nuclear chart with respect to 208Pb. It will allow to benchmark the two-body matrix elements of the residual interaction in this important region of the nuclear chart.

In turn, the 205Pb nucleus has three neutron-holes with respect to the 208Pb core, which makes it even more demanding testing field for the shell-model calculations. In longer perspective the studies of its structure would also stimulate the works on the shell-model description with a term coming from three-body forces in the region of heavier masses nuclei.

The decay of the capture state in 205Pb populated at ILL in 204Pb(n,gamma)205Pb reaction was investigated using FIPPS array coupled to the 7 HPGe clovers from IFIN Bucharest. The preliminary results of double and triple gamma-coincidence analysis will be presented: the new findings on the 205Pb low-spin structure include 7 excited states and 85 gamma transitions.

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