Experimental Study of the $3^{-}\otimes g_{9/2}^{-1}$ Multiplet in the Proton-Hole Nuclei ^{115}In and ^{113}In

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In the frame of a systematic study of the single- and multiphonon-states in odd nuclei around closed shells, we have studied the proton-hole ^{115}In nucleus through three combined experiments:(d,d') at E_d=22MeV, (p,p'γ) at E_p=15MeV, and (p,2nγ) at E_p=18MeV. The γ-spectroscopy experiments were performed at the Tandem accelerator and OSIRIS Cube spectrometer of the University of Cologne. They provided a complete level scheme up to 3.0 MeV, spin assignments (the (p,2nγ) experiment) and a reliable way to identify the γ-spectroscopy states (the (p,p'γ) experiment) with the ones populated in the (d,d') particle-detection experiment. The (d,d') experiments on ^{115}In and the core nucleus ^{116}Sn were performed at the Tandem accelerator and Q3D magnetic spectrograph of the University of Munich, at 22 MeV beam energy, using targets of 110(15)μg/cm^2 and 98% enrichment. We obtained an energy resolution between 5 and 7 keV, depending on the position in the focal plane. Angular distributions in 10 points between 17.5 and 45 deg. for ^{115}In and 11 points between 22.5 and 55 deg. for ^{116}Sn were measured. Through their specific shape a clear identification of the transferred angular momentum was possible for 30 states in ^{115}In; for known states in ^{116}Sn the spin and isoscalar transition rate G_λ were confirmed, although the latter values amounted systematically only to 70% of the ones existing in the literature.

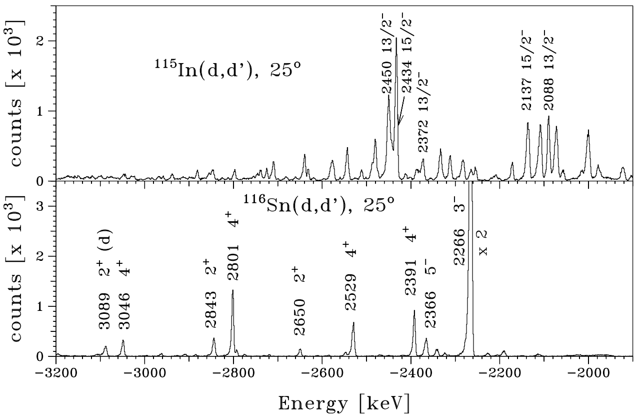

Fig. 1: sample (d,d') spectra on ^{115}In and ^{116}Sn; the region shown is dominated by L=3 states

Fig. 1 shows the higher energy part of the (d,d') spectra for ^{115}In and ^{116}Sn at 25°, which is the position of the first maximum in the L=3 angular distribution. The lower part of spectra, up to 2 MeV, is dominated by L=2 states. The scale of the ^{115}In spectrum has been chosen twice smaller than it should be in order to compare directly the cross sections with the ones in the ^{116}Sn core. Some of the known states in ^{116}Sn and the high spin members of the octupole multiplet in ^{115}In are labeled on the figure.

The octupole strength for each spin in the odd nucleus was found to be shared by at least two states, even for the $13/2^-$ and $15/2^-$ states, expected to have a pure structure. The configurations contributing to the spreading of the strength through mixing are explained [1] by the presence of a 5^- state only 100 keV above the first 3^- in ^{116}Sn.

In order to check the above interpretation, we have studied the only other stable isotope of In, with A=113, together with its ^{114}Sn core, where the first 5^- state is 600 keV above the first 3^-. Fig. 2 shows the higher energy part of the (d,d') spectra on ^{113}In and ^{114}Sn at 22.5°. Due to the very low isotopic abundance of ^{114}Sn (0.7%) the isotopic enrichment of the target material amounted only to 66%; the presence of impurities is clearly seen in the spectrum. The energy resolution (around 10 keV) is due to the thick targets (160(30) μg/cm^2). We have measured angular distributions in 8 points between 17.5° and 45° for ^{113}In and 6 points between 20° and 40° for ^{116}Sn. Around 15 states in ^{113}In show an L=3 or L=(3) angular distribution, the situation looking nearly as complex as in ^{115}In. The information on the spins of the states, some of which are new, is nonetheless scarce.

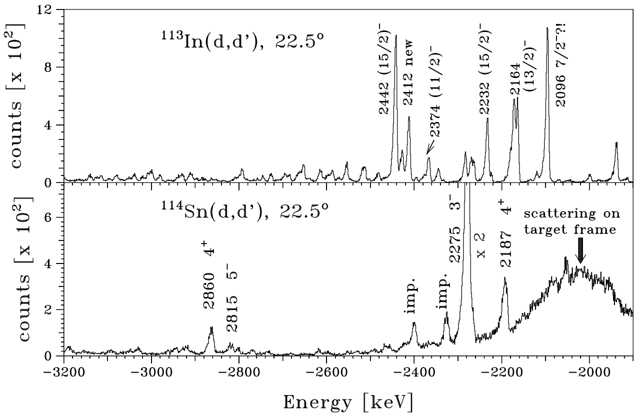

Fig. 2: sample (d,d') spectra on ^{113}In and ^{114}Sn

One needs to complement the (d,d') information on the structure of the states with firm spin assignments from γ-spectroscopy experiments in order to make possible an interpretation of the states seen.

References

[1] M. Eschenauer et al., Journal of Physics G, in print