Eur. Phys. J. A **2**, 323–324 (1998)

THE EUROPEAN PHYSICAL JOURNAL A

Short note

Intruder bands in ^{113}Sn

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Received: 28 April 1998
Communicated by B. Herskind

Abstract. The level structure of ^{113}Sn has been investigated. The data were obtained by in-beam γ-ray spectroscopy using the reaction ^{100}Mo(^{18}O,5n)^{113}Sn at 70 MeV performed at the OSIRIS gamma array in the Institut für Kernphysik FN Tandem accelerator. We report in this short note the observation of two intruder type rotational bands in this nucleus.

PACS. 21.10.Hw Spin, parity and isobaric spin – 25.70.Gh Compound nucleus – 27.60.+j $90 \leq A \leq 149$

The occurrence of deformed states in Sn nuclei is due to particle-hole excitations of the Z=50 Sn core to the deformation driving orbitals which intrude from above the shell gap [1]. The low excitation energy of the intruder states is a consequence of the attractive proton-neutron force which results in a binding energy gain for such configurations relative to the normal neutron quasi-particle excitations. In recent years the study of intruder bands in the Sn region has resulted in a wealth of experimental data. Some of the features relate to the gradual decrease in collectivity at high spins, interpreted as due to a smooth band termination [2]. In the odd mass Sn nuclei intruder bands have been reported in ^{109,111,115}Sn [3–5]. In this paper we report the observation of two intruder rotational bands in ^{113}Sn, of same spin and parity.

High spin states in ^{113}Sn were populated using the reaction ^{100}Mo(^{18}O,5n)^{113}Sn at a beam energy of 70 MeV. The target consisted of a 1.5 mg/cm^2 thick ^{100}Mo backed onto a 10 mg/cm^2 thick Au backing. Although the beam energy was optimized to study ^{114}Sn [6], ^{113}Sn was produced with appreciable cross-section. We performed the experiment with the OSIRIS spectrometer at the IKP FN Tandem accelerator in Köln (Germany). The analysis procedure is similar to the one described in the work of Schimmer et al. [6]. The level scheme of ^{113}Sn from the present work is depicted in figure 1. Spin assignments were done with the directional correlation of oriented states method, as well as by a systematic comparison with the neighboring odd-Sn nuclei. Not shown in the level scheme are known spherical states feeding the $I^\pi = 15/2^-$ energy level at 1.9 MeV.

The previous work of Hashimoto et al. [7] and Käubler et al. [8] have established the high spin states in ^{113}Sn upto the $(27/2^-)$ level at 4.7 MeV. We have extended this band to a tentative spin of $(43/2^-)$. In addition we have found evidence for another band (band 2) of same spin and parity beginning at an excitation energy of 3.4 MeV and extending to 7.2 MeV and a spin of $(39/2^-)$.

In the previous work states arising due to the coupling of the $h_{11/2}$ neutron to the core Sn spherical states have been identified and described within the framework of shell model calculations [7,8]. Deformed negative parity bands in the odd Sn nuclei arise due to the coupling of the valence neutron to the deformed 2p-2h bands of the core even-even Sn nuclei. Band 1 corresponds to the coupling of the deformed 2p-2h band in ^{112}Sn to the $\nu h_{11/2}$ orbital. Recent lifetime measurements for band 1 support the deformed picture [9]. In addition, the excitation energies of the $19/2^-$ state in ^{113}Sn and that of the deformed 4^+ state of ^{112}Sn are very similar [1]. Interestingly, the transition energies in band 1 are very similar to the transition energies in the negative parity yrast band of ^{115}Sn (Fig. 1) [5]. This suggests the similarity of the configuration for the negative parity yrast bands in the two nuclei.

As in ^{109,111,115}Sn [3–5] only the favored signature partner of this band has been observed. This may be due to the large signature splitting when the low Ω states of the $h_{11/2}$ orbital are occupied. Band 2 decays into the spherical $15/2^-$ energy level at 2 MeV, and to several states of band 1 . This band extends to a spin of $(39/2^-)$. Interestingly the $(27/2^-)$ states of the two bands are only 37 keV apart, implying a weak interaction between the two bands. It was difficult to extract the relative B(E2)'s due to doublets or contaminating γ-transitions. On examination of the transition energies in the two bands, they appear to have different moments of inertia. The different moments of inertia of band 1 and band 2 suggest that they may correspond to different core deformations, and

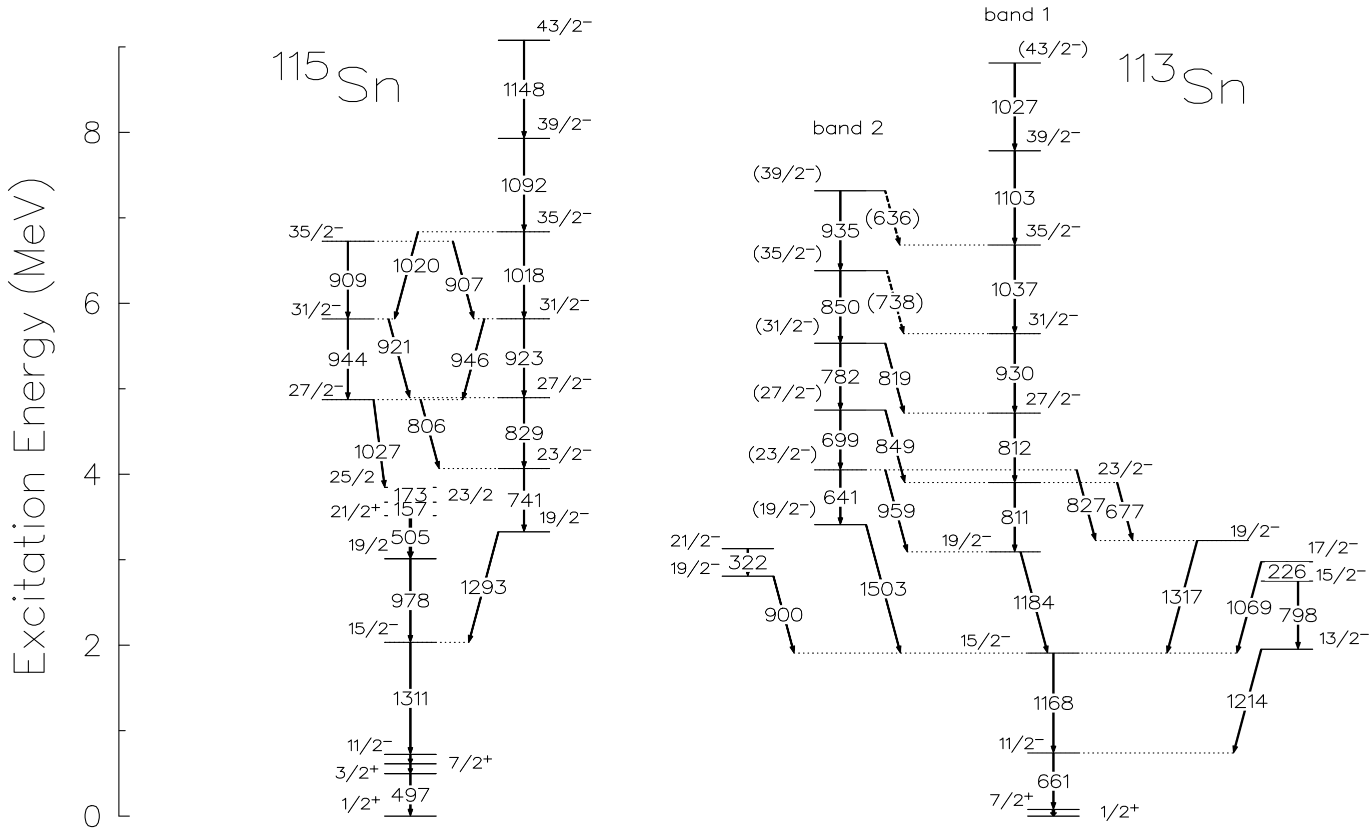

Fig. 1. Partial level scheme of ^{113}Sn from this work. The partial level scheme of ^{115}Sn from [5] is also shown for comparison

thereby differing in the number of the neutrons occupying the $h_{11/2}$ orbital. Bands analogous to band 2 have been observed in ^{115}Sn [5] and ^{115}Sb [10].

We thank the crew of the IKP FN Tandem accelerator staff for excellent operation of the tandem during the experiment. We thank Drs. L. Käubler and A. Gelberg for discussions. One of us (RSC) is grateful to the Alexander von Humboldt Foundation for the award of a research fellowship. This work was supported by the DFG under the contract DF6 Br 799/8-1.

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