IN-BEAM SPECTROSCOPY OF NUCLEI PRODUCED IN THE ^{98}Mo(^{16}O, xn) REACTION*

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The ^{98}Mo(^{16}O$,xn$) reaction has been used to study the level structure of the semi-magic nuclei $^{110}_{50}$Sn, $^{111}_{50}$Sn and $^{112}_{50}$Sn. The OSIRIS-II array equipped with 10 HPGe detectors with anticompton shields was used in conjunction with an 48-element BGO multiplicity filter. The experiments performed with projectile energy $E_{^{16}\mathrm{O}} = 60$–80 MeV brought results on relative excitation functions, γ-ray angular distributions, as well as on γ–γ and $\gamma - t_{\mathrm{RF}}$ coincidences. The measurements include also γ-ray multiplicity and total energy data as well as the investigations of radioactive decays. The selected results on the properties of excited states in the studied nuclei are reported. In particular, the evidence for a neutron-core coupling in ^{111}Sn, and the extension of the intruder and negative parity bands in ^{110}Sn and ^{112}Sn nuclei are presented.

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1. Introduction

Spectroscopic studies have been performed in the region of the neutron deficient Sn nuclei with the aim to gather more information on the intruder bands and their systematical behavior as well as to resolve some ambiguities concerning the level schemes construction. Near the shell closure one can expect strong interference of single-particle and collective effects leading *e.g.* to shape coexistence. One particular possibility for shape coexistence is associated with the occurrence of intruder states. In the odd nuclei intruder single-particle states originate in most cases from the next higher shell. In even nuclei intruder states are associated with the excitation of one or two particles into the next shell [1]. Proton particle-hole excitations across the $Z = 50$ gap are responsible for low-lying deformed states, which result in collective rotational bands. The rotational bands have been interpreted as being built on a two-particle two-hole ($2p$–$2h$) configuration. The low spin states in ^{110}Sn have previously been investigated in the decay of the ground state of ^{110}Sb [2] as well in a number of reaction studies [3]. The existence of an $I^{\pi} = 6^{+}$, $T_{1/2} = 5.6$ ns isomer decaying by the 280 keV, 985 keV and 1212 keV γ cascade to the ground state was well established. Rotational bands have been observed in $^{116-118}$Sn even-mass nuclei down to the 0^{+} band head [4] (which is located at an energy of about 2 MeV), whereas, in ^{110}Sn [3,5] and ^{112}Sn [5] no intruder band members below spin 10 have been observed prior to this work.

2. Experiment

The experiment was performed at the Heavy Ion Laboratory of the Warsaw University with the OSIRIS-II detector array. A beam of ^{16}O bombarded a ^{98}Mo (5.6 mg/cm^2) target, leading to the compound nucleus ^{114}Sn. This reaction was investigated at four beam energies: 60, 70, 75 and 80 MeV. In all experiments OSIRIS-II was equipped with 10 HPGe Compton suppressed spectrometers combined with an 48-element BGO multiplicity filter. The HPGe's were surrounding the filter, about 17 cm from the target and the BGO crystals served as collimators for the Ge detectors. Events were accepted by the data acquisition system if at least two coincident γ rays were detected in the Ge detectors. A total amount of 8×10^7 $\gamma\gamma$-coincidence events was recorded in the coincidence experiment. The compound nucleus ^{114}Sn was favouring the evaporation of neutrons, hence the main reaction products were ^{110}Sn ($4n$), ^{111}Sn ($3n$) and ^{112}Sn ($2n$).

3. Experimental results

Our experiment has confirmed levels reported previously for ^{110}Sn, ^{111}Sn and ^{112}Sn [3, 5, 6], and several new levels were identified. In the level scheme of ^{110}Sn we propose four new side bands (including an M1-transition band). Moreover, the negative parity band was extended. For ^{111}Sn one of the bands was extended. Complete level schemes for ^{110}Sn, ^{111}Sn and ^{112}Sn will be published elsewhere [7]. Here, we present partial level schemes of ^{110}Sn, ^{111}Sn and ^{112}Sn relevant for the discussion of the intruder bands, see Fig. 1. These are positive parity bands in ^{110}Sn and ^{112}Sn, and a negative parity band in ^{111}Sn. The ordering of transitions is based on relative γ-ray intensities and coincidence relationships. The intensity of transitions were determined using the ESCAL8R program [8]. Analysis of these data enabled a detailed level scheme to be established for the lower-spin states in the intruder band (below the 5228 keV state) of ^{110}Sn. The level having an excitation energy of 5018 keV, intepreted as $I^\pi\!=\!10^+$ state was observed

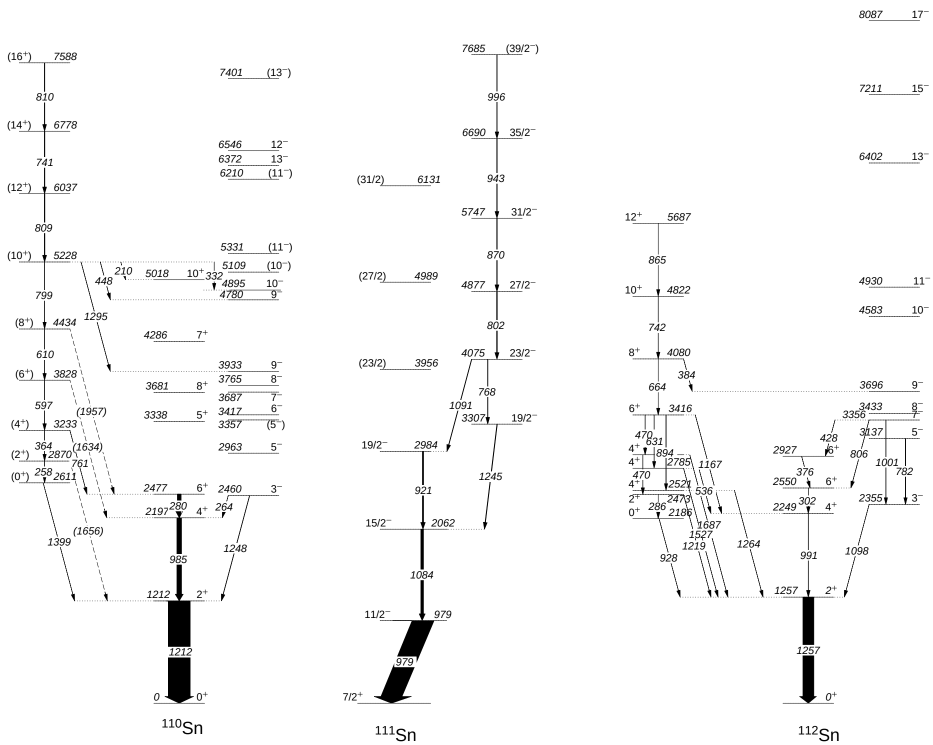

Fig. 1. Partial level schemes limited to the intruder bands: positive parity band in ^{110}Sn and ^{112}Sn, and negative parity band in ^{111}Sn. Gamma-ray energies are given in keV.

for the first time in this work. The new levels proposed for ^{110}Sn are in agreement with the level systematics of corresponding states in neighbouring even-Sn nuclei. The level energies of states in the intruder band increase with decreasing neutron number [9]. The new γ-transitions suggesting the existence of a neutron-core coupling in ^{111}Sn are not included in the presented part of the level scheme. For ^{112}Sn the lower part of the intruder band was extended too (below the 2785 keV state).

In conclusion, we have observed new levels and transitions in the neutron deficient nuclei ^{110}Sn, ^{111}Sn and ^{112}Sn, including the extension of the intruder bands. The second 10^+ state found in ^{110}Sn is consistent with the systematical behaviour of even-Sn isotopes. A short discusion of the experimental results concerning the collective states and band-like structures is presented in the another contribution to this conference [10].

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