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Colloquia: COMEX7

Systematic investigation of $E1$ strength below S_n in the tin isotopic chain using the (d,pγ) reaction

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Summary. — While the general properties of the electric dipole ($E1$) strength below the neutron separation energy are well known, there are still open questions about its underlying structure. In a previous ^{119}Sn(d, pγ) experiment, a grouping of the Pygmy Dipole Resonance was observed depending on the excited 1 particle - 1 hole structures. This prompted similar investigations on the other applicable isotopes, ^{115,117}Sn. Here, first results and a comparison to (γ, γ') data are presented.

1. – The (d,pγ) reaction

1˙1. *Introduction.* – The electric dipole response of a nucleus near its neutron separation energy S_n is often referred to as the Pygmy Dipole Resonance (PDR). However, its origin is still an active topic of debate [1]. The term PDR will thus be used without implying any structural implications in this proceeding. To investigate the microscopic structure of the PDR, a detailed study focusing on the ^{119}Sn(d, pγ) reaction has previously been performed and published [2]. By comparing the (d, pγ) to (γ, γ') data a difference in the response has been observed: a group of states at lower energies consisting of mainly 1 particle - 1 hole states is clearly present in the (d, pγ) data, while higher lying states, largely consisting of more complex structures, are barely detectable. For further investigations of this finding, ^{115,117}Sn(d, pγ) experiments were performed. The choice of these nuclei was further supported by the similar ground-state configuration of the stable even-odd tin isotopes, all of which feature an unpaired neutron in the $3s_{1/2}$ shell. Thus, a similar response to this reaction is to be expected.

1˙2. *Experiments.* – The experiments were performed at the 10 MV FN Tandem Accelerator at the Institute for Nuclear Physics at the University of Cologne. It provided the deuteron beam at 6.8, 7.0 and 8.5 MeV for the experiments on ^{115}Sn, ^{117}Sn and ^{119}Sn, respectively. A thorough description for ^{119}Sn(d, pγ) can be found in [2]. The measurements themselves were performed at the SONIC@HORUS setup [3]. Here, up to twelve silicon detector telescopes, consisting of two single detectors for particle identification, are mounted under backward angles. The detection of γ rays is handled by the 14 HPGe detectors of HORUS. In this combined setup, 168 unique particle-γ detector

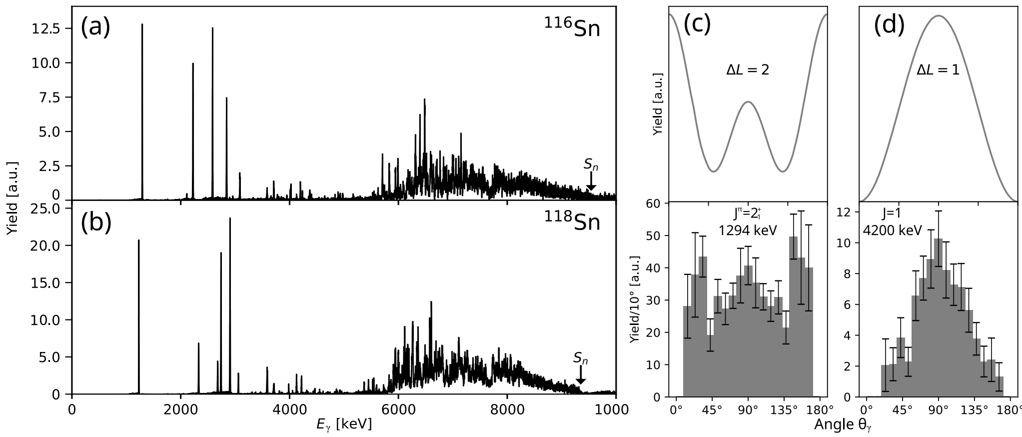

Fig. 1. – Ground-state decay spectra of (a) ^{116}Sn and (b) ^{118}Sn. (c) and (d) show theoretical (top) and measured (bottom) angular distributions of J={1,2} ground-state transitions in ^{116}Sn.

combinations are possible, yielding a good coverage of most angles between 0° and 180°. θ_γ is defined as the angle between the direction of the recoiling nucleus and the emitted γ ray.

1·3. *First results.* – The $(\mathrm{d},\mathrm{p}\gamma)$ reaction channel was selected via particle identification and ground-state γ-transitions were selected. Imposing these restrictions, the analysis of the $(\mathrm{d},\mathrm{p}\gamma)$ experiments yield high quality spectra (cf. fig. 1 (a) and (b)) which were used to identify 188 states in ^{116}Sn. In ^{118}Sn, 200 states have been observed. Using the relative angular distributions of protons and γ rays, spins have been assigned to 34 and 45 states, respectively. For some examples, see fig. 1 (c) and (d).

2. – Comparison

In all three isotopes, ^{116,118,120}Sn, a group of excited states around 6.5 MeV has been observed in the $(\mathrm{d},\mathrm{p}\gamma)$ experiment. When comparing these results for ^{116}Sn to their respective (γ,γ') data, which shows a more uniform distribution [4], a grouping can be seen for the $(\mathrm{d},\mathrm{p}\gamma)$ case. This effect has already been observed in ^{120}Sn, where it has been linked to 1p-1h structures via quasi-particle phonon model calculations, particularly for $(3s_{1/2})^{-1}(3p_{3/2})^1$ contributions. This explanation could also be applicable for the other isotopes, but further theoretical calculations for both ^{116}Sn and ^{118}Sn, as well as (γ,γ') experiments on ^{118}Sn are needed.

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