Pygmy and Giant Dipole Resonances in $^{130-132}$Sn

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We report on first results from the experiment aimed on dipole strength measurements in the region of ^{132}Sn. The motivation and experimental technique were already presented in the last year status report [1]. In brief, such a studies are motivated by the theoretical predictions of much different distributions of the multipole strength in exotic nuclei compared to the stable ones, which in turn provides a source of information on the isospin dependence of the effective nuclear interactions [2] and brings pronounced consequences for astrophysical models of the r-process nucleosynthesis [3]. One of the most exciting prediction concerns a new mode of collective excitation of medium and heavy neutron-rich nuclei at energies below the GDR region. This so called Pygmy or Soft Dipole mode (PDR), being interpreted as an oscillation of the neutron skin against the core of the nucleus, is at the moment lively discussed [4, 5, 6].

Measurements of the dipole strength in ^{132}Sn and about 20 other isotopes of similar A/Z ratio have been performed with the LAND-FRS facility. The secondary, radioactive beam was produced via in-flight fission of primary ^{238}U beam at 550 MeV/u. Isotopes of interest were selected with the FRS and identified on event-by-event basis. After delivering to Cave B they were electromagnetically excited in a secondary 0.5 g/cm^2 Pb target. Energy differential cross section spectra were obtained by means of the invariant mass analysis. To allow for the reconstruction of the invariant mass momenta of all the decay products (neutron(s), γ-rays and a heavy fragment remaining after dissociation in the target) were measured.

Left panels in the figure 1 show the measured cross sections in ^{130}Sn and ^{132}Sn. In the corresponding right panels the photoneutron cross section spectra deduced by means of the semiclassical method of virtual photons are presented. The enhancement of the cross section at energies close to 10 MeV is evident in both isotopes.

In order to extract quantitative information a function being sum of a lorentzian (to account for the GDR) and a gaussian (to account for the enhancement at low energy) was adopted to describe the shape of the photoneutron cross section. This function was then translated into energy differential cross section (by means of virtual photon method) and folded with the detector response obtained from an elaborated Monte Carlo simulation. Finaly parameters of both components were found by means of a χ^2 minimization against the experimental data. The solid red line in the figure indicates the fitted function. The lorentzian and gaussian contributions are showed separated as green dash-dotted and blue dashed lines respectively.

The low energy peak is found at $10.1^{+1.1}_{-0.3}$ MeV in ^{130}Sn and at 9.8±0.7 MeV in case of ^{132}Sn. The integrated cross sections attributed to those peaks amount to 130^{+60}_{-50} and 75^{+60}_{-55} mb·MeV accordingly, what exhausts 7% and 4% of the respective values of the Thomas-Reiche-Kuhn sum rule ($S_{TRK} = 60\frac{NZ}{A}$ mb·MeV). Such amount of strength is certainly too large to be interpreted in terms of single particle transitions but is consitent with the picture of the collective excitation.

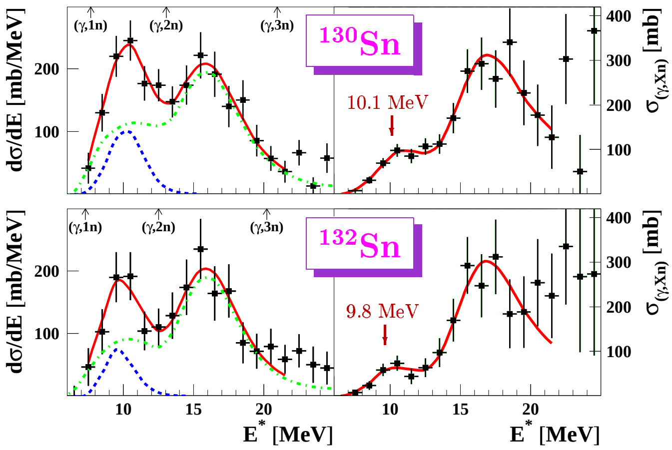

Figure 1: Experimental cross sections.

Maxima of the GDR peaks are located at 15.9±0.5 MeV in ^{130}Sn and at $16.1^{+0.9}_{-0.6}$ MeV in ^{132}Sn. In both cases the width was found to be 4.7 MeV with uncertainty of the order of 2 MeV.

The cross section integrated in an interval ranging from the neutron separation threshold up to 25 MeV amounts to 126% of the S_{TRK} in case of ^{130}Sn and 107% in case of ^{132}Sn.

A more complete report of the experimental findings obtained so far is being prepared for a publication in one of the scientific journals. At the same time the analysis of remaining data collected for neutron rich isotopes of In, Sb and Te is in progress and will be reported elsewhere.

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