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HIGH EXCITATION ENERGY MODES IN ^{118}Sn POPULATED BY THE ^{120}Sn(p,t)^{118}Sn REACTION AT 35 MeV*

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The ^{120}Sn$(p,t)^{118}$Sn reaction was investigated at 35 MeV incident energy. The ^{118}Sn excitation energy spectrum was reconstructed up to about 16 MeV. Preliminary results show the presence of a broad resonance at high excitation energy, compatible with the predicted population of the Giant Pairing Vibration (GPV).

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1. Introduction

A Giant Pairing Vibration (GPV) is a collective mode based on the coherent superposition of 2-particles (or 2-holes) excitations [1, 2]. GPVs are expected in analogy to the Giant Resonances as a consequence of the basic quantum symmetry between particles and holes. This collective mode is one of the most evident manifestation of particle–particle correlations beyond mean field. Therefore, its discovery could provide precious information on the pairing interaction, determining a significant progress for the description of the nuclear structure. The GPV is predicted as a $L = 0$ transition mode

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in a pair-transfer reaction from an A nucleus to an $A \pm 2$ nucleus. It should manifest itself as a large resonance (FWHM — 1–2 MeV) in the excitation energy spectrum around $70\,A^{1/3}$ MeV, with a strong collective nature due to the coherently contribution of numerous nucleons, in particular in heavy nuclei such as Sn or Pb isotopes [1–4].

Two-neutron transfer reactions are considered to be effective tools to populate the pairing vibrations. However, many unsuccessful attempts have been undertaken in the past to discover the GPV by using the (p,t) reaction on Sn and Pb nuclei [2, 5, 6]. Indeed, a balance between opposite experimental conditions should be reached to increase the probability to populate and observe the GPV. On the one side, the proton incident energy should be high enough to populate modes at high excitation energies, typically at around 13 MeV. On the other side, a too high incident energy does not favor the $L = 0$ transfer matching. Moreover, the use of a magnetic spectrometer is crucial to precisely measure the tritons emitted at small angles, significantly reducing the background in the data. Recently, the existence of the GPV was investigated using the $K = 600$ QDD spectrometer in the (p,t) reaction at incident energies of 50 MeV and 60 MeV for the scattering angles 0° and 7° [7]. However, also in this case, no clear signature for the GPV was found, keeping the question of its existence without any conclusive experimental confirmation. In this paper, we report on our preliminary results concerning the search for the GPV in the $^{120}\text{Sn}(p,t)^{118}\text{Sn}$ reaction at 35 MeV.

2. Experimental set-up and data reduction

The experiment was performed at the Catania LNS–INFN laboratory using a proton beam accelerated by the Superconducting Cyclotron and a 2.8 mg/cm^2 thick ^{120}Sn target. The tritons produced in the reaction were momentum analyzed by the MAGNEX magnetic spectrometer [8, 9] and detected by its Focal Plane Detector (FPD) [10, 11]. In particular, we used six different magnetic field settings to explore the ^{118}Sn excitation energy spectrum up to about 16 MeV, and four different angular settings of optical axis to measure the angular distributions between 8° and 24° in the laboratory reference frame. The MAGNEX FPD is a gas-filled hybrid detector consisting of a drift chamber divided in five sections, with five proportional counters, four of which are position sensitive, and a wall of 57 stopping silicon detectors at the back. The horizontal and vertical coordinates and angles of each incident particle are measured, as well as the energy loss in the gas region and the residual energy released in the silicon detectors.

The first step in the data analysis consists in selecting the isotope of interest among all the detected reaction products [12]. Tritons are clearly identified in the energy-loss *versus* dispersive position (X_{foc}) plot reported in Fig. 1. Then, for each selected triton, the equation of motion is solved using the high order algorithms of trajectory reconstruction, described in Ref. [13]. In this way, the kinetic energy and the scattering angle in the laboratory frame are reconstructed, starting from the final phase space parameters measured at the FPD (X_{foc}, Y_{foc}, θ_{foc}, ϕ_{foc}) [13, 14]. Finally, the kinetic energy is transformed in Q-value or, equivalently, in excitation energy $E_x = Q–Q_0$, where Q_0 represents the ground state to ground state reaction Q-value.

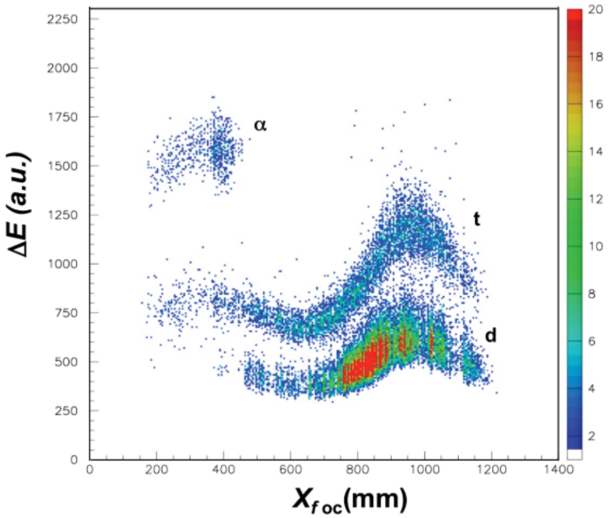

Fig. 1. Energy loss as a function of the reconstructed X_{foc} position on the focal plane.

3. Preliminary results

The ^{118}Sn excitation energy spectrum reconstructed in the angular region $8^\circ \le \theta_{\mathrm{lab}} \le 12^\circ$ is shown in Fig. 2.

The data collected at various spectrometer field settings are displayed in different colors and are normalized each other by arbitrary scaling factors. The background due to other reaction channels is extremely low and only a residual component of deuterons, not completely eliminated from the selected tritons, generates the two narrow peaks between 9 and 10 MeV.

Figure 3 shows a zoom of the ^{118}Sn excitation energy spectrum at high energies, where the presence of a bump over the background is clearly visible. This is located in the energy region where the GPV is expected, and where Mouginot *et al.* [7] found a possible signal of a bump in the same ^{120}Sn$(p,t)^{118}$Sn reaction at 50 MeV bombarding energy.

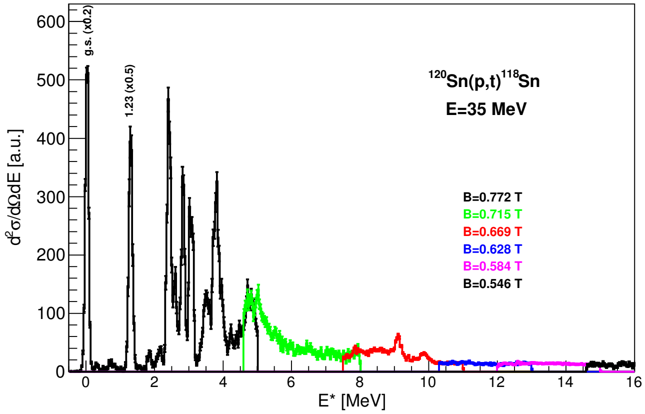

Fig. 2. Excitation energy spectrum of ^{118}Sn integrated over the angular range $8° \leq \theta_{\mathrm{lab}} \leq 12°$. The error bars indicate statistical uncertainties.

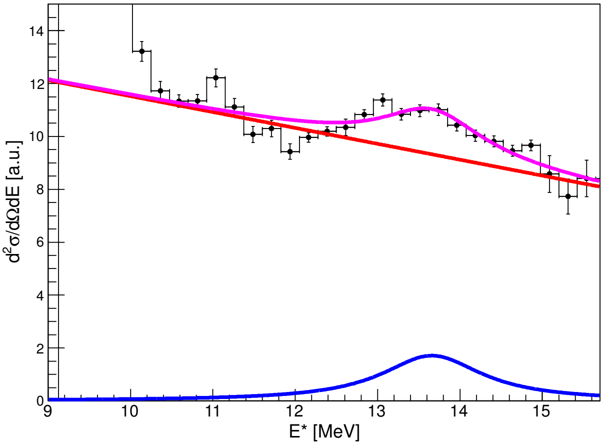

Fig. 3. Zoom of the ^{118}Sn excitation energy spectrum at high energies. The global fit function (top/purple line) and the separated Lorentzian (bottom/blue line) and background (middle/red line) components are reported (see the text for details).

In order to study the observed structure, the spectrum was fitted in the 10 MeV$< E^* <$ 16 MeV region using a Lorentzian function plus a linear background. The result of the best-fit procedure is shown in Fig. 3 where the global fit function and the separated Lorentzian and background components are drawn. The Lorentzian parameters extracted from the fit are: $E_0 = 13.6 \pm 0.1$ MeV and $\Gamma = 1.5 \pm 0.4$ MeV. These values are compatible with those expected for the GPV. Further analysis is in progress to extract also the angular distributions to better understand the real nature of this resonance.

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