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EXPLORING THE COLLECTIVE SPIN–ISOSPIN LONGITUDINAL RESPONSE OF NUCLEI WITH COHERENT PION PRODUCTION IN (^{3}He, tπ^+) *

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The SATURNE charge-exchange program explored the spin-isospin response of nuclei in the Δ region [1]. New results on coherent pion production are presented. They give a precise measure of the spin longitudinal component of this response. This component is particularly interesting since theoretical models predict that attractive residual Δ-hole correlations in the longitudinal channel (pion exchange) softens the response.

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(^{3}He,tπ^+) was studied at 2 GeV on ^{12}C, ^{40}Ca and ^{208}Pb, using the SPES4pi coincidence set up [2, 3]. The missing mass resolution was good enough to separate the contribution of the first excited state of ^{12}C at 4.4 MeV from the ground state contribution which corresponds to coherent

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production. Fig. 1 shows results on ^{12}C. The excitation energy resolution is 5.1 MeV. The continuous curve represents a fit by two Gaussian curves centered on the ground state and on the first excited state at 4.4 MeV, plus a constant background. The background contribution in the hatched area ($\pm 3\sigma$) is 14% of the peak. The angular correlations and energy transfer spectra were obtained by applying a narrower gate which further reduced this contamination to 7%.

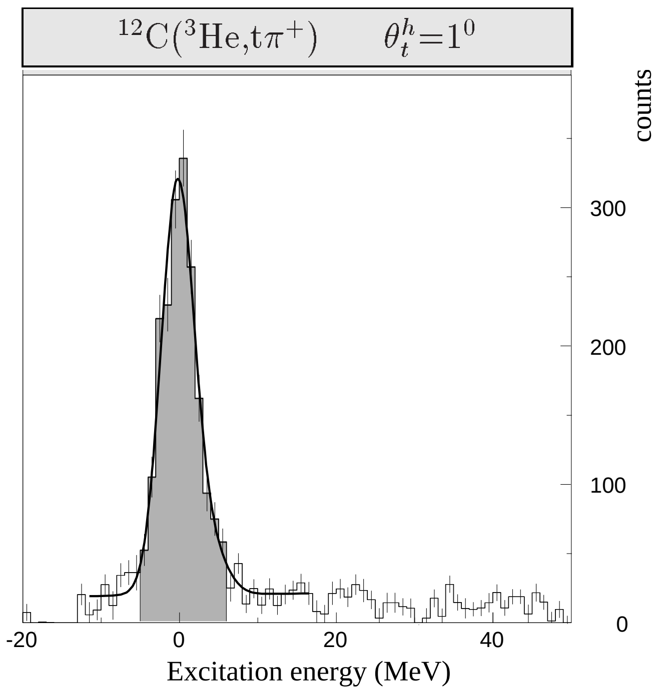

Fig. 1.

Obviously, in ^{12}C one can isolate the coherent pion production. This is also true for ^{40}Ca (the resolution was 4.7 MeV). For ^{208}Pb, due to target thickness, the 6.8 MeV resolution was not sufficient to separate the ground state from the excited states which start at 2.61 MeV. But the coherent pions dominate the excitation energy spectrum. In this experiment, the coherent production is absolutely dominant.

The angular distribution of the coherent pions is strongly peaked in the direction of the momentum transfer. This characteristic shape demonstrates that the spin longitudinal component contributes practically alone in this process. Fig. 2 shows examples of coherent pion angular correlation for two slices in energy transfer $\boldsymbol{\omega}$, chosen on each side of the maximum of the $\boldsymbol{\omega}$

spectrum. It demonstrates that in charge exchange reactions, coherent pion production selects the spin longitudinal component of the interaction.

As expected from the effect of kinematics on the target form factor, the width decreases when the energy transfer increases, or when the triton angle increases. And it decreases with the target size, which again, follows from the target form factor.

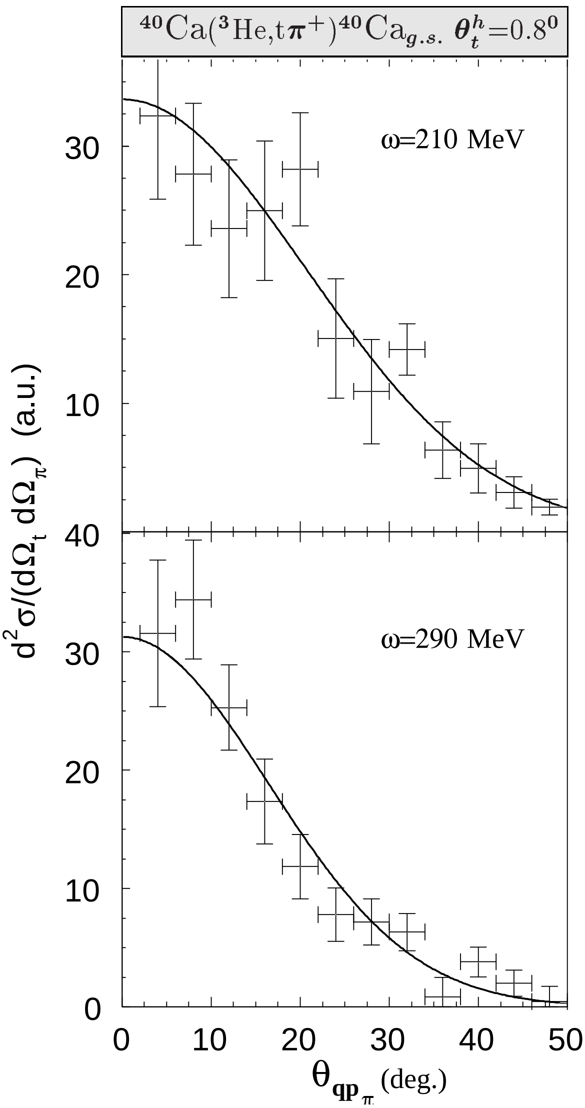

Fig. 2.

Therefore, the energy transfer spectrum displays the spin longitudinal response without distortions. Fig. 3 shows this energy transfer spectrum for ^{40}Ca.

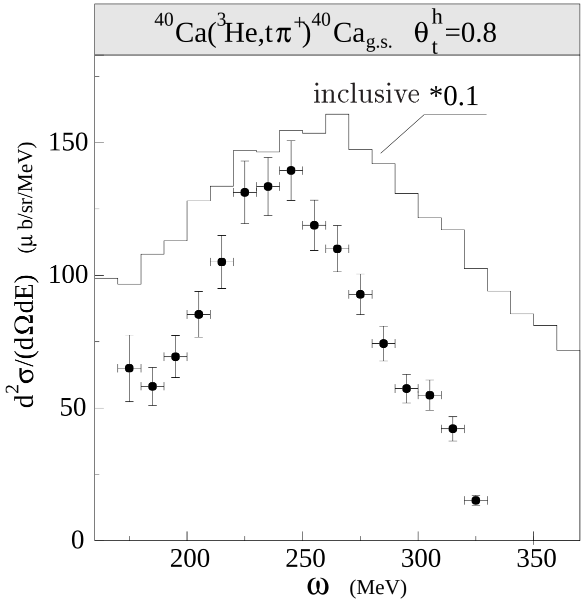

Fig. 3.

The coherent pion production represents an important fraction of the inclusive cross section (around 5% in ^{12}C at 1° triton angle). The maximum of the coherent pion peak is shifted down in energy transfer relative to the maximum of the inclusive cross section, which means a large shift relative to the quasi-free Δ production (around 90 MeV). Theoretical predictions [4–6] exist.

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