COHERENT PION PRODUCTION AS VIRTUAL PION SCATTERING

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We explore coherent pion production in (^{3}He, ^{3}Hπ^+) reaction as effective virtual pion scattering, in calculations of cross sections to the ground state and low-lying excitations of the target nucleus. Our coupled channel model developed in [1] includes a source term emulating a virtual pion beam and an optical potential for the interaction of the pion in the medium. We demonstrate that the lowering of the peak in the energy-transfer spectra is entirely determined by the re-scattering of the pion. The calculations are compared with the data on coherent pion production from ^{12}C and ^{40}Ca targets, where the target nuclei were left either in the ground state or in the first excited state.

1 Outlines of the Model

In our approach, the wave function of the outgoing created pion satisfies the inhomogenious coupled channels Klein-Gordon equation.

$$\left(\frac{1}{r^2}\frac{d}{dr}r^2\frac{d}{dr} - \frac{l_\beta(l_\beta+1)}{r^2} - U^{l_\beta I_\beta}_{l_\beta I_\beta J}(r) + k^2_\beta\right) \times R^{l' I' J'}_{l_\beta I_\beta J}(r) - \sum_\alpha U^{l_\alpha I_\alpha}_{l_\beta I_\beta J}(r)$$

$$\times R^{l' I' J'}_{l_\alpha I_\alpha J}(r) = \rho^{l' I' J'}_{l_\beta I_\beta J}(r), \qquad (1)$$

where $R^{l' I' J'}_{l_\alpha I_\alpha J}(r)$ is the radial wave function of the outgoing pion in exit channel α with the set of quantum numbers $l_\alpha I_\alpha J$. Here I is the spin of a final nuclear state, l is the angular momentum of the outgoing pion, and J is the total angular momentum in the channel α. The set of primed quantum numbers l', I', J' refers to the virtual object transferred from ^{3}He to the target nucleus as a result of a charge exchange reaction. $U^{l_\beta I_\beta}_{l_\beta I_\beta J}(r)$ is the diagonal optical potential responsible for elastic pion nucleus scattering. $U^{l_\alpha I_\alpha}_{l_\beta I_\beta J}(r)$ is the off diagonal potential responsible for the excitation of intermediate states of the target nucleus during pion re-scattering. It is constructed from the

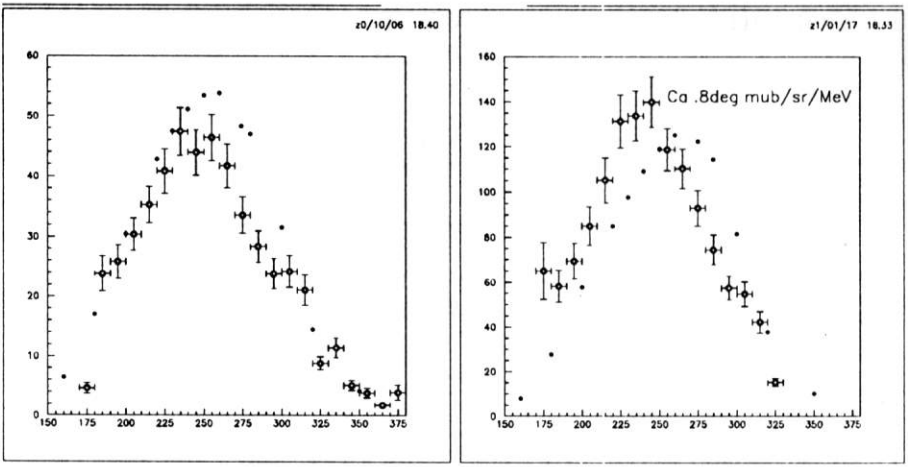

Figure 1: The cross sections of coherent pion production in $\mu b/Sr/MeV$ from ^{12}C (left picture) and from ^{40}Ca (right picture) as a function of transferred energy ω in MeV. Black dots represent the calculated cross section.

pion nucleon elastic scattering amplitude obtained from the phase-shifts and weighted with the one-body transition densities obtained from the shell model calculations for ^{12}C and ^{40}Ca[2].

The source term in r.h.s. of Eq (1) is constructed using the amplitude $T_{NN\to NN\pi}$ of pion production in NN-collisions, and the distorted waves of ^{3}He and ^{3}H. The calculations were performed for finite triton angle. For the moment, we use the simplest model of pion production via Δ_{33} - resonance[3].

2 Comparison with data

In Fig.1, we compared the results of the calculations of coherent pions spectra with the data[4]. The calculations reproduce the magnitude of the cross section rather well for both targets. However, the shape of the calculated spectra is slightly different, especially for ^{40}Ca.

References

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