Pion spectra for ^{88}Sr$(p,\pi^-)^{89}$Zr reaction

S. Yamamoto, K. Kume and N. Nose-Togawa

Department of Physics, Nara Women's University, Nara 630-8506,Japan

For the near threshold (p,π^-) reaction leading to streched high-spin states, the reaction cross sections and also the asymmetries are explained with the full-range DWBA calculation [1,2]. But the reaction mechanism is still not thoroughly understood. For example, the delta peak seems to be absent in the ground-state transitions for carbon which disagrees with the theoretical prediction [3]. The experiments at delta regions are planned at RCNP for medium heavy nuclei and these experiments are expected to give an insight for the (p,π^-) reaction mechanism.

In this short note, we report the results of theoretical calculation for the reaction spectra of ^{88}Sr$(p,\pi^-)^{89}$Zr reaction. We have assumed the zero-range plane-wave approximation similar to that adopted by Brown et al. [4] which could explain the relative strengths of the near threshold pion spectra for $f_{7/2}$-shell region.

The DWBA calculation shows that the final pp$(^1S_0)$ channel dominates due to the large momentum and angular momentum transfer[5]. The zero-range approximation automatically select the dominant spin singlet channel pp$(^1S_0)$. The distortion effects are incorporated approximately by discarding the inner part from the overlap integral as in Ref.[4]. The 2p-1h amplitudes are calculated with the $1p_{1/2}$-$0g_{9/2}$ shell model assuming the inert ^{88}Sr core. The similar calculations have been done already near threshold by only taking into account the $0g_{9/2}$ components for the wave functions [6] where only positive parity states are predicted. In our calculation, we have considered the $1p_{1/2}$-$0g_{9/2}$ full space and could predict the negative parity states. The effective interaction matrix elements determined by Serduke et al. [7] are used.

The results are shown in Fig. 1 for incident energies T_p=200-300 MeV. We have checked that the PWBA calculations give similar relative strengths with those of DWBA for ^{48}Ca(p,π^-)^{49}Ti at these energies. The vertical solid lines correspond to positive parity states while dotted lines are negative parity states. The results are shown in arbitrary units and only the relative strengths are predicted. Our results can be compared with the experimental data shown in Ref. [6]. As seen, the overall structure of the spectrum are reproduced. For negative parity states, the $1p_{1/2}$ orbit is relevant and these states correspond to rather low-spin states and are weakly populated. The small peak at 3.96 MeV corresponding to the $\frac{13}{2}^-$ states seems to be present in the experimental spectra [6]. Two prominant peaks seen in the spectra are the excitation of the $\frac{21}{2}^+$ (3.71 MeV) and $\frac{25}{2}^+$ (4.10 MeV) states and the $\frac{25}{2}^+$ states are strongly populated at higher energis due to the better momentum and angular momentum matching conditions. The full-range DWBA calculations for the reactions for $1p_{1/2}$-$0g_{9/2}$ nulcei are now under way.

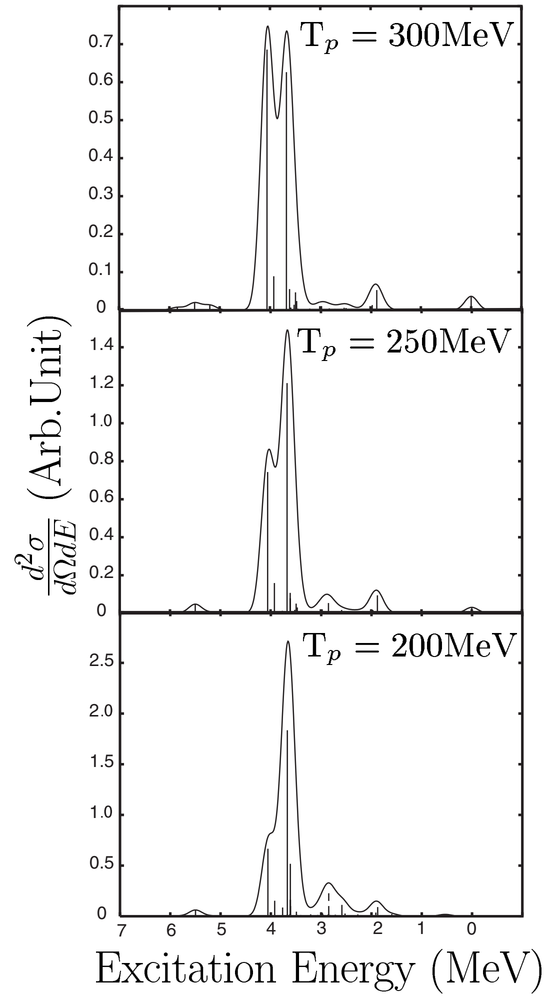

Figure 1: Calculated spectra for $^{88}\mathrm{Sr}(p,\pi^-)^{89}\mathrm{Zr}$ at 30° for various incident energies. The curves are Gaussian averaged with Γ_{FWHM}=0.3 MeV. The prominent peaks at 3.71 MeV and 4.10 MeV corresponds to the final $\frac{21}{2}^+$ and $\frac{25}{2}^+$ states for ^{89}Zr.

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