Mass number dependence of the forward-angle cross section for pion single-charge-exchange reactions

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Observed forward-angle cross section for the pion SCX reactions (π^+, π^0) leading to the isobaric analogue states exhibits a prominent mass-number dependence (A-dependence) $(d\sigma/d\Omega)/(N-Z) \propto A^{\alpha(E)}$ as seen in Fig. (a). The plane-wave impulse calculation leads to $\alpha(E)$ =0 (*no* A-dependence) for the spinless nuclei, and the strong A-dependence comes from the pion distortion or from the higher-order effects. In the present work, we have carried out the DWIA calculation with the first-order optical potential of the $t\rho$ type. The nuclear isovector densities $\delta\rho(r) = \rho_p - \rho_n$ are calculated by the relativistic Hartree model. As seen in Fig. (a), the strong A-dependence $(d\sigma/d\Omega)/(N-Z) \propto A^{\alpha(E)}$ and the monotonical decrease of $|\alpha(E)|$ with the increase of the incident pion energy are well reproduced by the DWIA calculation.The first-order theory overestimate the SCX cross section which is common above the delta resonance region [2]. To see the dependence on the pion-nucleus optical potential U, we have multiplied factors s_R and s_I to the real and the imaginary part as $s_R Re(U) + s_I Im(U)$ and have varied s_R and s_I at 500MeV. As seen in Fig. (b) and (c), $\alpha(E)$ is highly *sensitive* to imaginary part of U while is quite *insensitive* to its real part (s_R).

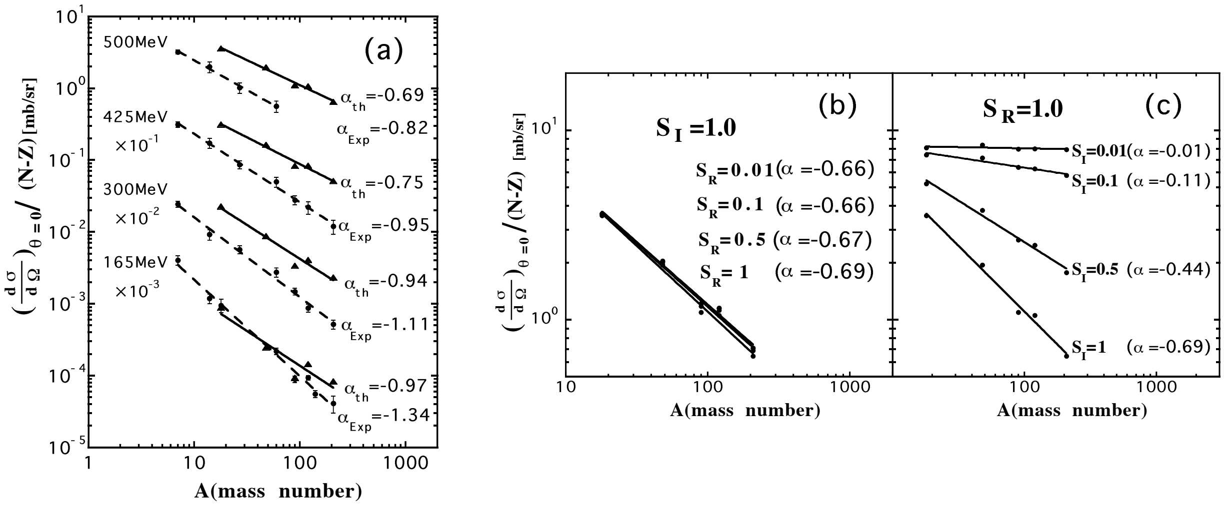

Figure: (a) Results of the DWIA calculation for the pion SCX reactions leading to the IAS. (b) and (c) are the results at 500 MeV with $(0 \leq s_R \leq 1, s_I = 1)$ and $(0 \leq s_I \leq 1, s_R = 1)$, respectively. The dotted lines represent the fit to experimental data taken from Ref. [1].

References

[1] S. R. Rokni *et al.*, Phys. Lett. **B202** (1988) 25.
[2] E. Oset, D. Strottman, H. Toki, and J. Navarro, Phys. Rev. C **48** (1993) 2395.