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q-Scaling of Continuum Analyzing Powers in the Reaction $^{58}Ni(\vec{p},p'X)$ at 35, 50, 65 and 80 MeV

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A typical energy spectrum induced by medium energy protons contains a structureless continuum region inbetween the low energy evaporation peak and the higher energy discrete peaks. This continuum spectrum has a strong forward peaking angular distribution. A lot of theoretical as well as experimental studies have been devoted to reveal the origin of this continuum spectrum. However the structureless nature of the continuum spectrum prevented us to pin down the reaction mechanism.

Recently we have shown that the analyzing power (A_y) data of the continuum spectrum are very useful to investigate the reaction mechanism[1-4]. Most of our studies of refs.1-4) have been made at E_p = 65 MeV. We extended our measurements to the wide range of the projectile energies 35-80 MeV in order to see the bombarding energy dependence of the continuum analyzing powers in the ^{58}Ni nucleus.

The 35, 50, 65 and 80 MeV polarized proton beams were provided by the RCNP AVF cyclotron. Emitted protons were detected by two counter telescopes which were set at symmetric angles in the left and right sides with respect to the incident beam direction. Each telescope consisted of a ΔE (300 μm Si-detector) and an E(NaI(Tl)) detectors.

Fig. 1 shows the double differential cross sections $d^2\sigma/d\Omega dE$ and analyzing powers A_y as a function of angles θ_{lab} for the region corresponding to the excitation energy of E_x = 12-16 MeV. Cross sections decrease rather monotonously as a function of angles. Analyzing powers are non-zero and show rather large positive values at large angles where one might expect small A_y values because of a dominance of the evaporation process contribution.

The peak angles of A_y changes according to the change of the projectile energies. The A_y data are plotted again in fig. 2 as a function of the transferred momentum $q = |k_p - k_{p'}|$ instead of the angle. Analyzing powers seem to peak at about $q \approx 2$ fm^{-1} independent of the projectile energy. Even second peak seems to be seen in the high-q region. This q-scaling is very unexpected and surprising.

The q-scaling of the continuum A_y values is very suggestive of some nuclear structure effects in the structureless continuum region.

As a first attempt, one step DWBA calculations were performed in a same manner as ref. 3 and results are shown in fig. 1 as dashed lines. Calculations reproduce almost perfectly the $d^2\sigma/d\Omega dE$ angular distribution for all the projectile energies. Calculated analyzing powers do show positive large values at large angles, however they do not reproduce at all the absolute magnitudes and the change of the peak angles of A_y.

It would be very interesting to investigate further the origin of this q-scaling whether it represents some structure effects or nuclear dynamics in the continuum reaction process. Similar q-scaling is also observed in the $^{28}Si(p,p'X)$ reaction.

In summary analyzing powers of the continuum energy spectra for the $^{58}Ni(\vec{p},p'X)$ reaction were measured for the wide range of the projectile energies 35-80 MeV. It is found that the analyzing powers seem to scale with respect to the transferred momentum $q = |k_p - k_{p'}|$ for the low excitation regions $E_x < 20$ MeV of the continuum spectra irrespective to the projectile energies. One step DWBA calculations reproduce the continuum angular distribution ($d^2\sigma(\theta)/d\Omega dE$) but fail to reproduce the q-dependence of the continuum analyzing powers.

References

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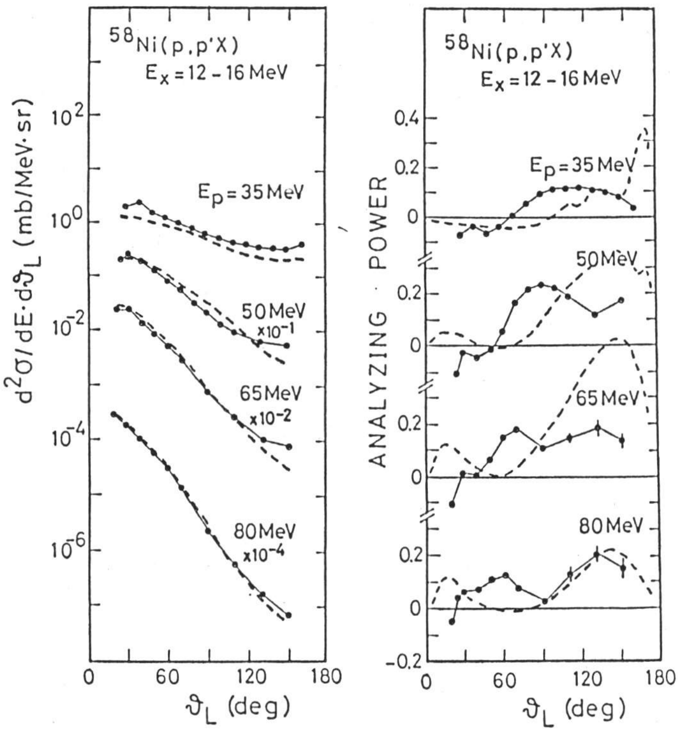

Fig. 1. $d^2\sigma/d\Omega dE$ and A_y vs. θ_{lab} for the continuum region of E_x = 12-16 MeV.

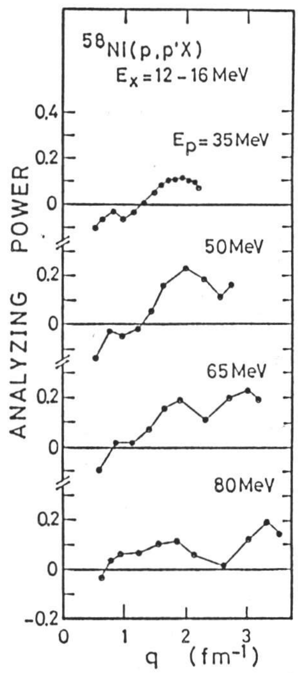

Fig.2. A_y vs.q (momentum transfer)