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1.36 Observation of Spin Excitations in the Continuum via Polarization Transfer Measurements for the $^{58}Ni(\vec{p},\vec{p}'X)$ Reaction at 80 MeV

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It is customary thought that the inelastic scattering spectra by protons below $E_p < 100$ MeV are dominated by the non-spinflip transitions since the spin-dependent terms in the nucleon-nucleon interaction are rather small at low energy. Therefore only non-spinflip transitions are, so far, considered in the analysis of the continuum spectra. Spinflip probability S_{NN} of the continuum region was measured in order to see how much spin-dependent strength in the continuum. It is also quite interesting in connection with the M1 giant resonance which has been found recently.

The measurements of the S_{NN} were carried out by using the newly constructed polarization spectrograph DUMAS[1] at RCNP. The effective analyzing power of the polarimeter was about 75-92% depending on the outgoing proton energies.

The results for the $^{58}Ni(\vec{p},\vec{p}'X)$ reaction at 10° is shown in Fig. 1. Both the cross sections and the spinflip probability S_{NN} are illustrated. The S_{NN} are small at low excitation energy in the region of discrete states. The S_{NN} raise to significant values at $E_x \approx 7$ MeV and decreases gradually up to at least 25 MeV. The M1 giant resonance has been reported to be around 8 MeV. A sudden raise of the S_{NN} just corresponds to the M1 giant resonance energy but the value of the S_{NN} is not remarkable at all compared with the highly excited region. Essentially similar feature was also observed in the 20° spectrum. This result is very surprising since the present feature of the S_{NN} is almost identical to that observed by Nanda et al.[2] in the reaction $^{90}Zr(\vec{p},\vec{p}'X)$ at 319 MeV and $\theta_{lab} = 3.5°$ where the ratio of spinflip to non-spinflip components in nucleon-nucleon scattering is much larger compared to the present projectile energy. Our data seem to indicate that higher multipole components such as M2, M3 etc. contribute this large S_{NN} value.

In order to understand the present results one-step DWBA calculations were performed in a same manner as ref. 3 for the excitation energy of $E_x = 14$ MeV where the S_{NN} value is around 0.18. A microscopic form factors were employed. The M3Y forces[4] were used as an effective interaction. The transferred angular momenta considered here were L=1-7 with $\Delta S=0$ and $\Delta S=1$. Possible 1p-1h transitions within four major shells were calculated assuming the bound state shell model wavefunctions with a harmonic oscillator potential. It was also assumed that all the strengths were concentrated at $E_x = 14$ MeV (spectroscopic factors = 1 for all the transitions). The predicted value is $S_{NN} \approx 0.26$ at 10°. It overestimates the experimentally observed value of S_{NN}. One of the reasons of this too strong spinflip strength may be due to the ignorance of the collective enhancements such as the E2 giant resonance ($\Delta S=0$) in the present calculation. The present model is obviously rough and more refined calculations are needed.

Our data clearly show the existence of the strong spin-dependent strength in the continuum region of $E_x = 7$-25 MeV. Further measurements of S_{NN} at larger angles certainly help to clarify not only the spin-response in nuclei but also the continuum reation mechanism.

In summary the spin-flip probability of the highly excited continuum region $E_x = 0$-25 MeV for the $^{58}Ni(\vec{p},\vec{p}'X)$ reaction at $\theta = 10°$ and 20° has been measured at 80 MeV by using the polarization spectrograph DUMAS. The spin-flip probability increases suddenly beyond the excitation energy at about 7 MeV and decreases gradually.

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References

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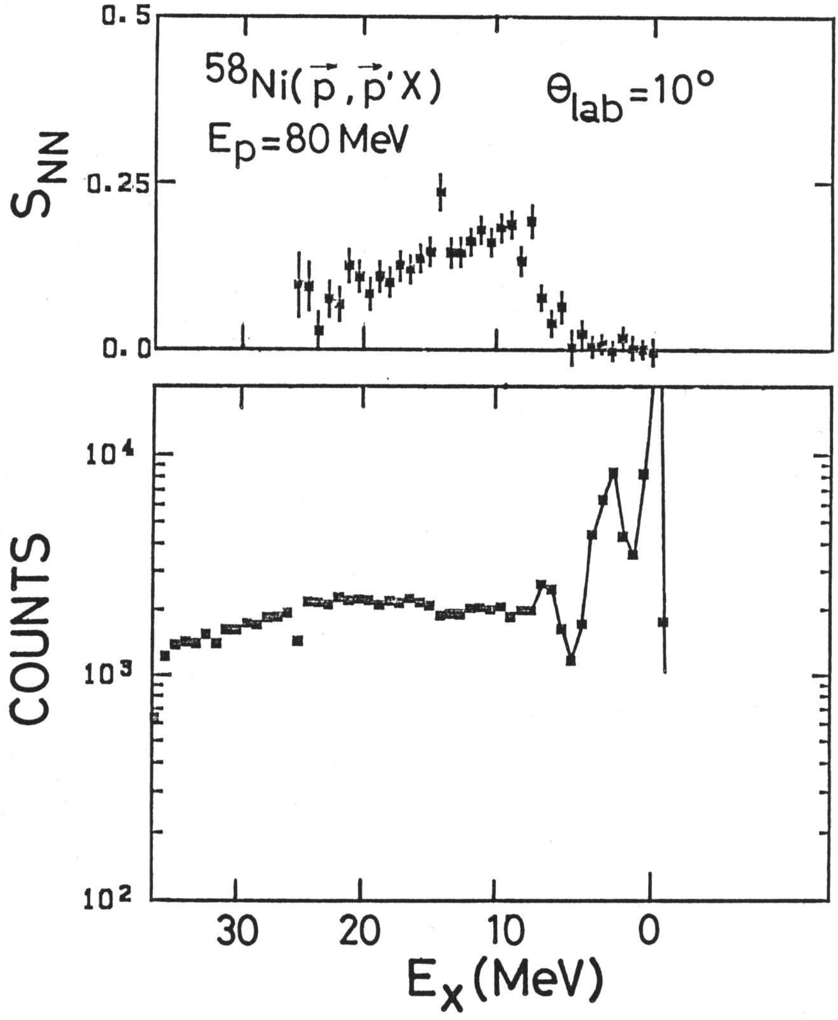

Fig. 1. Spinflip probability S_{NN} and momentum spectrum observed with the polarization spectrograph DUMAS at 10° for the $^{58}Ni(\vec{p},\vec{p}'X)$ reaction at 80 MeV. No background has been subtracted.