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Proton Inelastic Scattering to the 1^+ States in the M1-Resonance Energy Region in ^{58}Ni and ^{60}Ni

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In last few years, several experimental investigations were carried out in search of the existence of the M1 giant resonance. Recently, in a series of seventeen nuclei ranging from ^{51}V to ^{140}Ce, broad structures have been observed at very forward angles by inelastic scattering of 200 MeV protons[1]. The broad structures at energies between 8 and 10 MeV, nearly mass independent, follow an L=0 angular distribution, and have been interpreted as the M1 resonances. On the other hand, the results in high resolution electron inelastic scattering[2] indicate that the level structure in the 8 ~ 10 MeV excitation energy region is complex and fragmented and that the bulk of the strength observed is of M2 character. The (γ,γ') experiment[3] has also revealed only a few narrow M1 states in this energy region. This paper presents $^{58}Ni(p,p')^{58}Ni$ and $^{60}Ni(p,p')^{60}Ni$ reactions leading to the 1^+ states in the resonance energy region. The purpose is to see fragmented structure near 9 MeV excitation energy region by a high resolution experiment.

The experiment was carried out with polarized protons of 65 MeV. The scattered protons were momentum analyzed with the spectrograph RAIDEN. The energy resolution was about 20 keV. The angular distributions of the 10.22 MeV, 1^+ state in ^{48}Ca which is believed to be state with the main component of $\nu(f_{7/2}^{-1}f_{5/2})$ configuration were also observed as a standard shape and are shown in Fig. 1. The curves are DWBA74[4] calculations for the 1^+ state in ^{48}Ca using M3Y effective interactin and the wave function by McGrory and Wildenthal[5]. The 10.66 MeV state in ^{58}Ni and the 11.86 MeV state in ^{60}Ni are considered as the $(f_{7/2}^{-1}f_{5/2})$ isovector 1^+ states. The shapes of the angular distributions of the cross sections and the analyzing powers for more than 100 states in the energy region of 7-11 MeV were compared with those for the well known 1^+ states described above. From the comparison, we selected and classified the states with similarity in the shapes of the angular distributions of

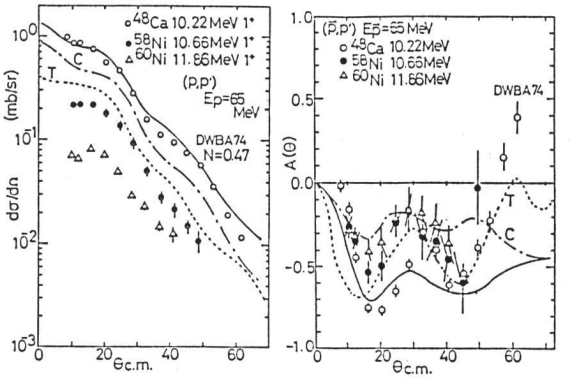

Fig. 1. Angular distributions of cross sections and analyzing powers leading to the 10.22 MeV state in ^{48}Ca, the 10.66 MeV state in ^{58}Ni and the 10.86 MeV state in ^{60}Ni. The solid curves are DWBA calculations for the 10.22 MeV state.

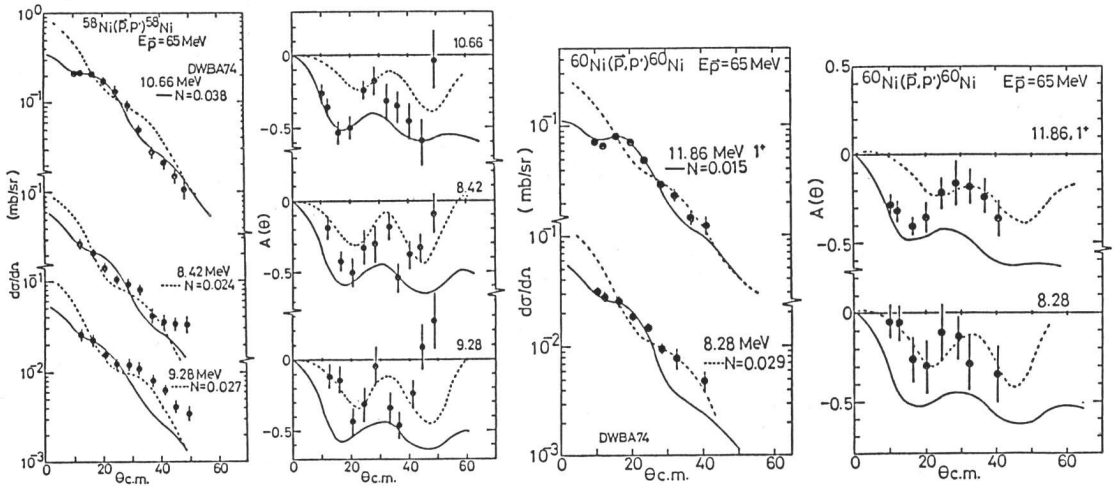

Fig. 2. Angular distributions of cross sections and analyzing powers leading to the 10.66 MeV, 8.42 MeV and 9.28 MeV states in ^{58}Ni and the 11.86 MeV and 8.28 MeV states in ^{60}Ni. The solid and dashed curves are DWBA calculations with $(f_{7/2}^{-1}f_{5/2})$ isovector and isoscalar wave functions, respectively.

cross sections and the analyzing powers. The angular distributions are shown in Fig. 2. The angular distributions of both cross sections and analyzing powers leading to the 8.42 and 9.28 MeV states in ^{58}Ni and the 8.28 MeV state in ^{60}Ni are similar to those of the 10.66 MeV state in ^{58}Ni and the 11.86 MeV state in ^{60}Ni. The curves in Fig. 2 show the DWBA74 calculations using M3Y effective interaction. The solid and dashed curves show the $(f_{7/2}^{-1}f_{5/2})$ isovector and isoscalar wave functions, respectively. The calculations show that the 8.42 and 9.28 MeV states in ^{58}Ni and the 8.28 MeV state in ^{60}Ni may be the $(f_{7/2}^{-1}f_{5/2})$ isoscalar 1^+ states. Fig. 3 shows the relative strength of the 1^+ states to the 10.22 MeV state in ^{48}Ca.

We could observe only a few narrow states considered to be the $(f_{7/2}^{-1}f_{5/2})$ isoscalar 1^+ state in the excitation energy region of 7-11 MeV in ^{58}Ni and ^{60}Ni. The results show that the weakly excited 1^+ states may be concealed by natural parity states at the measured angles ($\theta > 10°$).

Some of the authors have recently measured ^{58}Ni(p,p')^{58}Ni reaction at 5° using 80 MeV protons and polarization spectrograph (DUMAS), and have observed the broad resonance in the excitation energy region of 8-9 MeV.

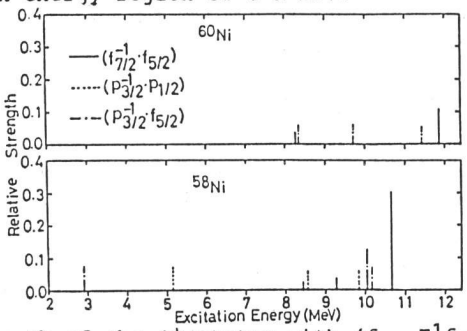

Fig. 3. Relative strength of the 1^+ states with $(f_{7/2}^{-1}f_{5/2})$ configuration and other configurations in ^{58}Ni and ^{60}Ni to the 10.22 MeV, 1^+ state in ^{48}Ca.

References

1) C. Djalali et al. Nucl. Phys. A388 (1982) 1.
2) D. Meuer et al., Nucl. Phys. A349 (1980) 309.
3) K. Ackermann et al., Nucl. Phys. A371 (1981) 1.
4) R. Schaeffer and J. Raynal (unpublished).
5) J.B. McGrory and B.H. Wildenthal, Phys. Lett. 103B (1981) 173.