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1.28 Hexadecapole Moments of the Medium-Weight Transitional Nuclei by 65 MeV Polarized Proton Inelastic Scattering

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The structure of nuclei, from Ge to Sr, with neutrons in the 1g9/2 shell has been a subject of extensive investigations in recent years, and many interesting transitional behaviors have been revealed; especially the importance of the hexadecapole degree of freedom in the understanding of the structure of the nuclei in this region has been suggested in a number of experiments[1-3]. In our recent experiment[3], we showed that the cross section $\sigma(\Theta)$ and analyzing power $A(\Theta)$ for the inelastic scattering of polarized protons to the first 4^+ states in the even Se isotopes are particularly sensitive to the sign of the deformation parameters β_4 and the coupled-channels analyses (CC) clealy support positive β_4 for ^{74,76,78}Se while negative β_4 for ^{80,82}Se, thus indicating a hexadecapole shape transition between the ^{78}Se and the ^{80}Se.

In the present experiment, we extended the measurements to neighboring even−even nuclei covering nealy whole region of nuclei with 28−50 neutrons, and deduced systematically the quadrupole and the hexadecapole moments in this region. The experiments were performed at RCNP with 65 MeV polarized protons. Inelastically scattered protons from enriched targets of ^{62,64}Ni, ^{64,66,68,70}Zn, ^{70,72,74}Ge and ^{84,86}Sr were momentum analyzed with the broad range magnetic spectrograph RAIDEN, the overall energy resolution being 20-30 keV.

The observed $\sigma(\Theta)$ and $A(\Theta)$ for the 4^+ states in $^{64-70}$Zn are shown in Fig.1. The CC predictions of the distributions with the code ECIS are also shown in this figure where the ground, the first 2^+, and the first 4^+ states are coupled in the assumpton of the symmetric rotational model. CC analyses with the second harmonic vibrational model were also done, resulting nearly the same predictions of both the distributions and the β values as those with the symmetric rotational model. As seen in the figure, hexadecapole shape transition occurs also in the Zn isotopes as in the case of Se isotopes. With the deduced deformation parameters β_2 and β_4, we obtained the quadrupole and hexadecapole moments from the the deformed optical potential with the method of Mackintosh[4]. The values of the moments[5] thus obtained are shown in Fig.2 together with the previous data of Se isotopes.

The observed hexadecapole moments vary systematically with neutron numbers. A crude estimate[6] of the hexadecapole moments in terms of the orbits near the Fermi surface predicts large positive moments in the beginning of the shell,decreasing with increasing nucleon number to large negative moments in the ending of the shell, qualitatively in agreement with the present experimental results near the shell closure,N=28 and 50. However in the middle of the shell near N=42, the moments have rather large positive values ,indicating large departure of the trend of the Q_4 moments from the above simple estimate, and thus requiring further detailed theoretical investigations. A prediction of the Q_4 moments from a microscopic potential surface calculation by Möller and Nix[7] are in disagreement with the present experimental results generally.

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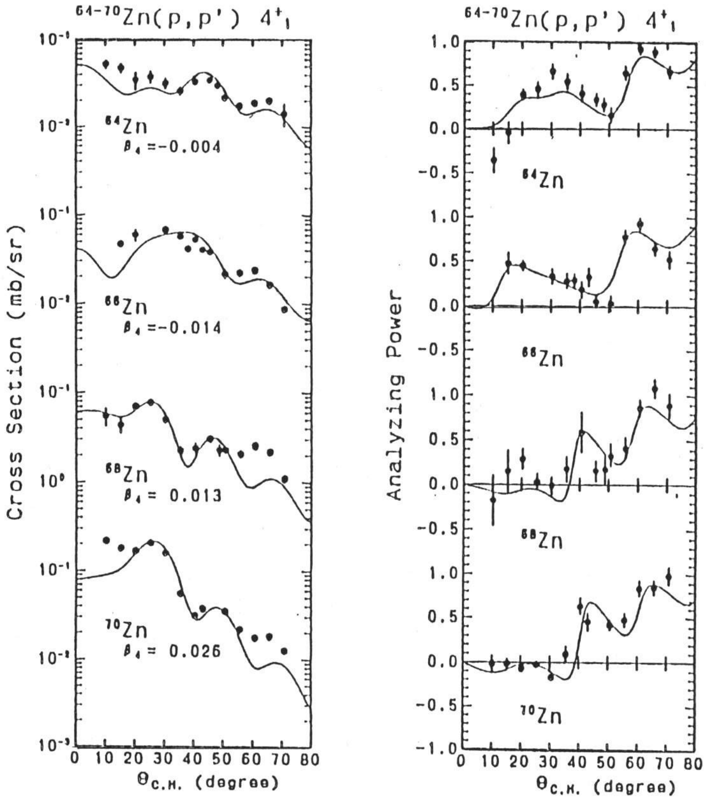

Fig.1. The cross section and analyzing power for the inelastic scattering of polarized protons to the 4^+_1 state in even Zn isotopes. Solid lines are CC predictions with the symmetric rotational model in which the 0^+_g, 2^+_1 and 4^+_1 states are coupled. The CC code ECIS was used for this analysis.

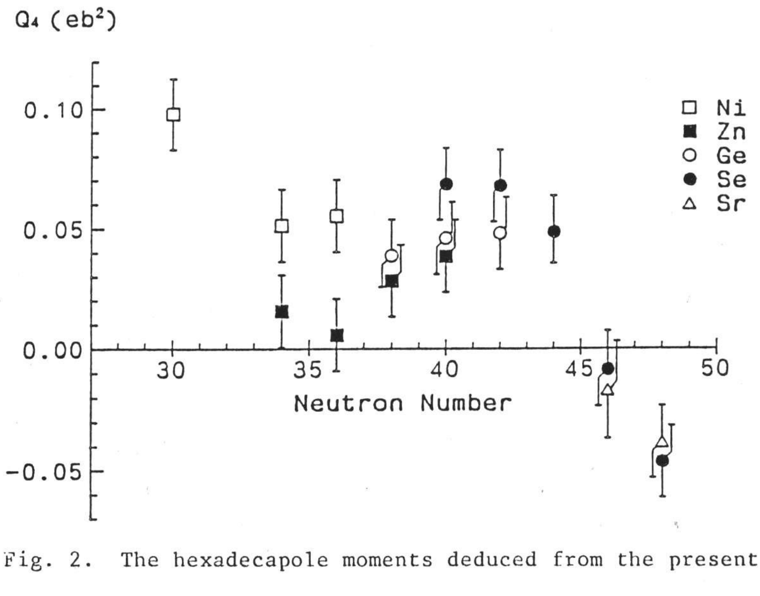

Fig. 2. The hexadecapole moments deduced from the present experiment.