EXCITATION OF THE GIANT RESONANCE REGION BY INELASTIC SCATTERING OF POLARIZED PROTONS

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Angular distributions of the differential cross section $\sigma(\theta)$ and analyzing power $A(\theta)$ have been measured for the giant resonance (GR) region excited in ^{92}Zr, ^{120}Sn and ^{208}Pb targets through inelastic scattering of 104 MeV polarized protons. The scattered protons were detected using a ΔE-E counter telescope employing high-purity Germanium detectors. Data for the GR region were obtained in the angular range from 12° to 26° for ^{92}Zr, 13° to 27.5° for ^{120}Sn and 11° to 21° for ^{208}Pb targets. A preliminary account of this work (for ^{92}Zr) has been given earlier.[1]

The $\sigma(\theta)$ and $A(\theta)$ angular distributions for the low-lying states of ^{92}Zr, ^{120}Sn and ^{208}Pb were measured using the QDDM spectrometer in a separate experiment. The optical model was used to fit the elastic scattering angular distributions and the resultant distorting potential parameters were used in DWBA collective model calculations. The Oak-Ridge form of deformed spin-orbit coupling[2] with $\beta_C = \beta_{SO}$ was found to yield satisfactory fits to the data for the low-lying states.

The spectral shape in the GR region has been fitted with two Gaussian curves, one for the giant quadrupole resonance (GQR) and the other for the giant dipole resonance (GDR) + giant monopole resonance (GMR) complex, riding on a smooth underlying continuum. The $\sigma(\theta)$ and $A(\theta)$ values extracted for the GQR and the (GDR + GMR) regions are shown in Figs. 1 and 2, respectively. Since both L=2 and L=4 multipoles are expected to occur in the same region of excitation, the fits to angular distributions for the GQR region have been carried out using a combination of these multipoles. As is evident from Fig. 1, inclusion of L=4 strength in addition to L=2 strength has brought about an overall improvement in the quality of fits to the data. The percentage of the energy-weighted sum rule strengths (%EWSR) obtained for L=2 are listed in Table I. These values are consistent with those obtained from high-energy proton inelastic scattering[3,4] experiments, but are considerably smaller than those obtained from ^{4}He scattering,[5] ^{3}He scattering,[6] and low-energy proton scattering[7] experiments. As the use of conventional, macroscopic collective-model calculations may not be fully justified for the case of high-energy proton scattering, one should carry out a detailed microscopic calculation for the inelastic scattering of high-energy protons in order to understand the differences between the results obtained using these probes and those obtained using the more strongly-absorbed probes such as ^{3}He and ^{4}He.

The data for the (GDR + GMR) region can not be satisfactorily explained by the collective-model calculations involving a mixture of L=0 and L=1 multipoles alone. The inclusion of L=4 improves the

Table I. Percentage of the energy-weighted sum rule strengths

Target	% EWSR				
	L=0	L=1	L=2	L=3	L=4
^{92}Zr	27±12	65	43±6	----	8.9±1.8
^{120}Sn	18±34	100	37±7	4±6	8.5±2.9
^{208}Pb	----	100	35±7	----	22±6

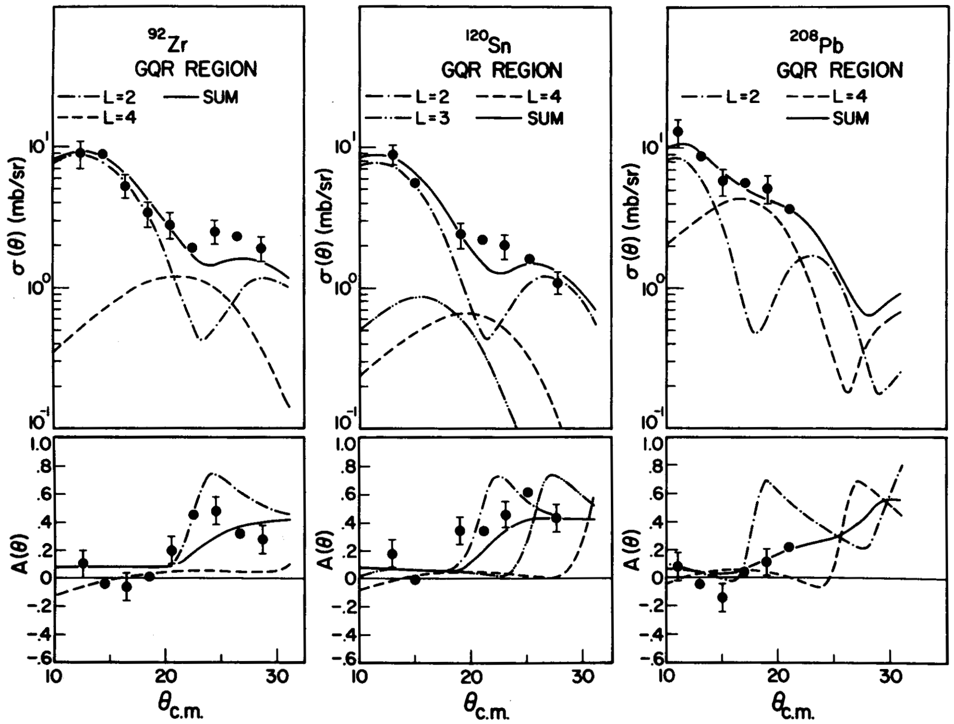

Figure 1. The $\sigma(\theta)$ and $A(\theta)$ angular distributions for the GQR region for ^{92}Zr, ^{120}Sn and ^{208}Pb. The curves are DWBA calculations for L=2 and L=4.

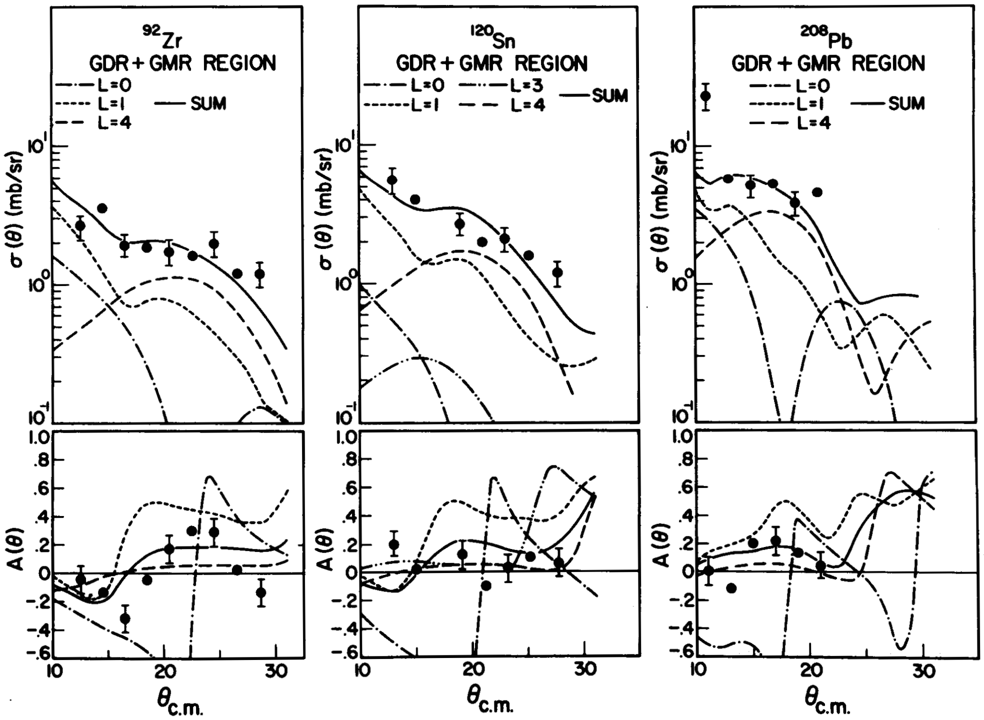

Figure 2. The $\sigma(\theta)$ and $A(\theta)$ angular distributions for the (GRM + GDR) region for ^{92}Zr, ^{120}Sn and ^{208}Pb. The curves are DWBA calculations for L=0, 1, 3 and 4.

quality of fits to the data (see Fig. 2). The %EWSR strengths obtained are given in Table I. Some L=0 strength is indicated in the results for ^{92}Zr and ^{120}Sn, but none is required for ^{208}Pb. On the other hand, we have determined that the inclusion of 50% L=0 in the case of ^{208}Pb does not drastically alter the quality of the fits. It appears that the angular range covered in the present work is not sufficient to allow a reliable extraction of the GMR strength. The L=4 strengths determined from the present work are consistent with those found in Refs. 4 and 8.

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GIANT MULTIPOLE RESONANCES IN THE (^{3}He,t) REACTION AT 200 MEV

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Charge exchange reactions at intermediate energy are particularly interesting because of their selective excitation of isovector giant multipole resonances.[1-3] As a result they provide information complementary to that of inelastic hadron scattering, which populates predominantly isoscalar resonances.

This investigation of the (^{3}He,t) reaction was undertaken to exploit that complementarity by studying the excitation of the giant dipole resonance (GDR) and by looking for higher multipolarity resonances. Because the GDR has been studied extensively in photonuclear reactions, it provides a good calibration point to verify our understanding of hadronic excitation of giant resonances. Since the isoscalar giant quadrupole resonance (GQR) is strongly excited in inelastic hadron scattering, the elusive isovector GQR should be seen in the isovector (^{3}He,t) reaction if it is compact.

The detection of energetic tritons is difficult because of their long range and high magnetic rigidity. A stack of 3 high-purity germanium diodes was used to detect and identify the tritons. Two of these were specially fabricated with thin ion-implanted electrodes on both sides for use in transmission. The first Ge detector was 10 mm thick and provided an excellent measurement of the differential energy loss for particle identification. The remaining two detectors were each 15 mm thick. A plastic scintillator was used