STUDY OF GIANT RESONANCE REGION BY INELASTIC SCATTERING OF POLARIZED PROTONS

S. Kailas, P.P. Singh, A.D. Bacher, C.C. Foster, D.L. Friesel, P. Schwandt, and J. Wiggins
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

Inelastic scattering of charged particles from nuclei has been the most popular method to excite the giant resonances (GR) and understand their excitation mechanism. Utilizing this technique, the existence of the giant quadrupole resonance[1] (GQR) and giant monopole resonance[2] (GMR) has been well established. It is clear that the use of various projectiles at different bombarding energies followed by comparisons of their inelastic spectra will be very helpful to establish the relative strengths of various multipoles in the GR region. Further, calculations show that simultaneous measurement of analyzing power angular distributions and differential cross sections will be a better method, not only to establish the presence of various L values, but also to determine more reliably the strengths of the various multipoles excited in the GR region. In the ongoing program[3] at the IUCF to study the GR through inelastic scattering of intermediate energy protons, we have measured the differential cross section and analyzing power for the GR excited in the $^{92}Zr(p,p')$ reaction at E_p = 104 MeV. The scattered protons were detected

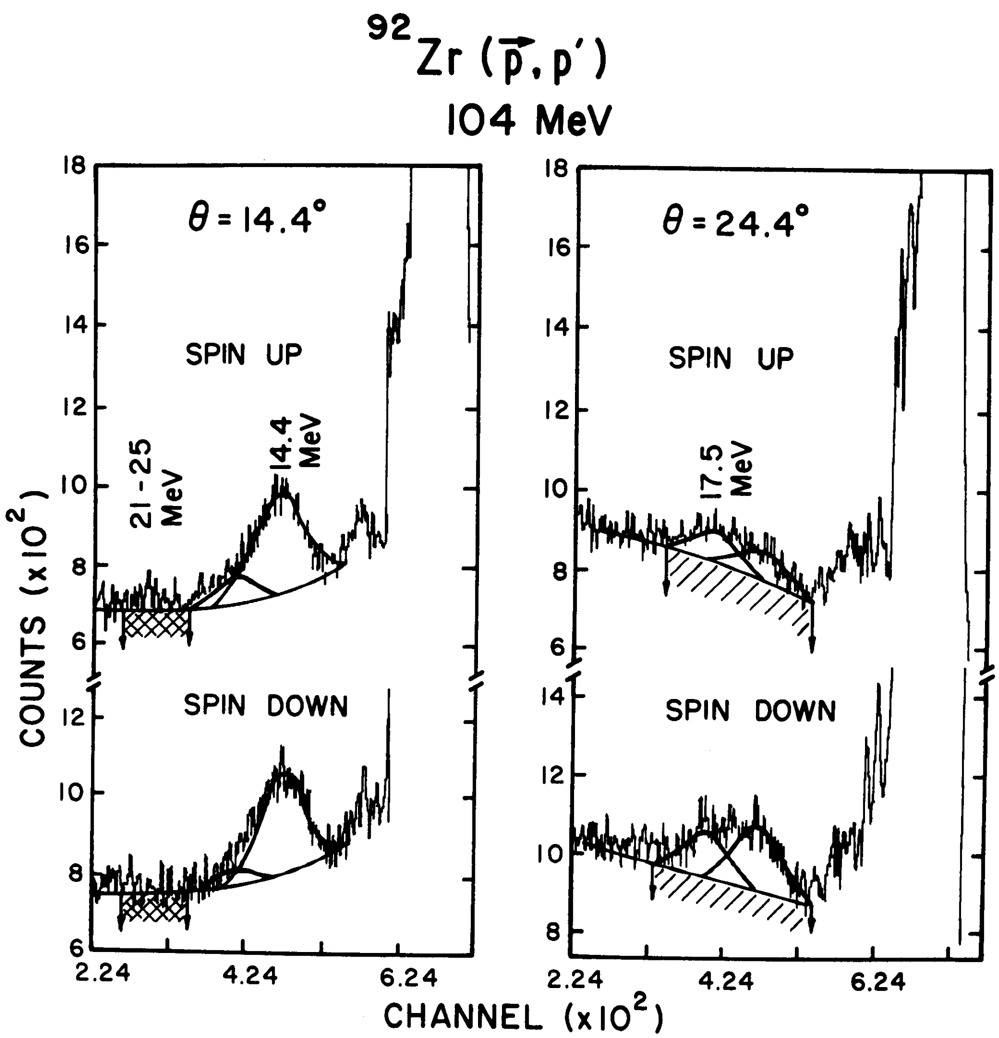

Figure 1. Energy spectra for inelastic proton scattering on ^{92}Zr. The two Gaussian fits, GQR and GMR+GDR, to the GR region, the background subtracted from under the GR and the continuum above the GR are indicated in the figure.

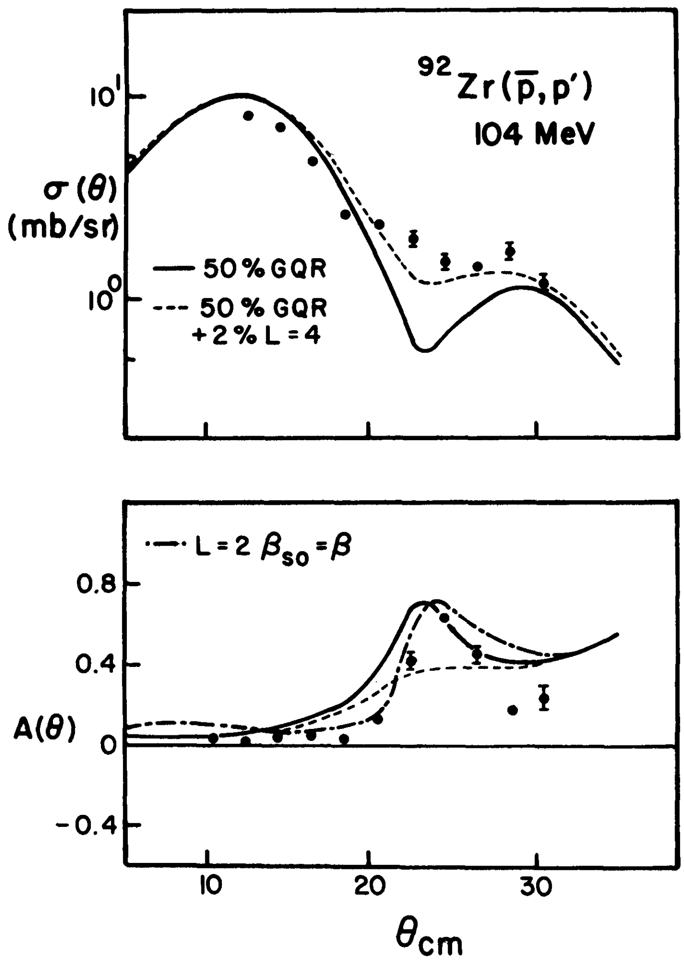

Figure 2a. Differential cross section and analyzing power data for the GQR region. The DWBA calculations for L=2 and L=4 are shown in the figure. An additional L=2 analyzing power calculation using a 50% larger spin-orbit deformation is shown.

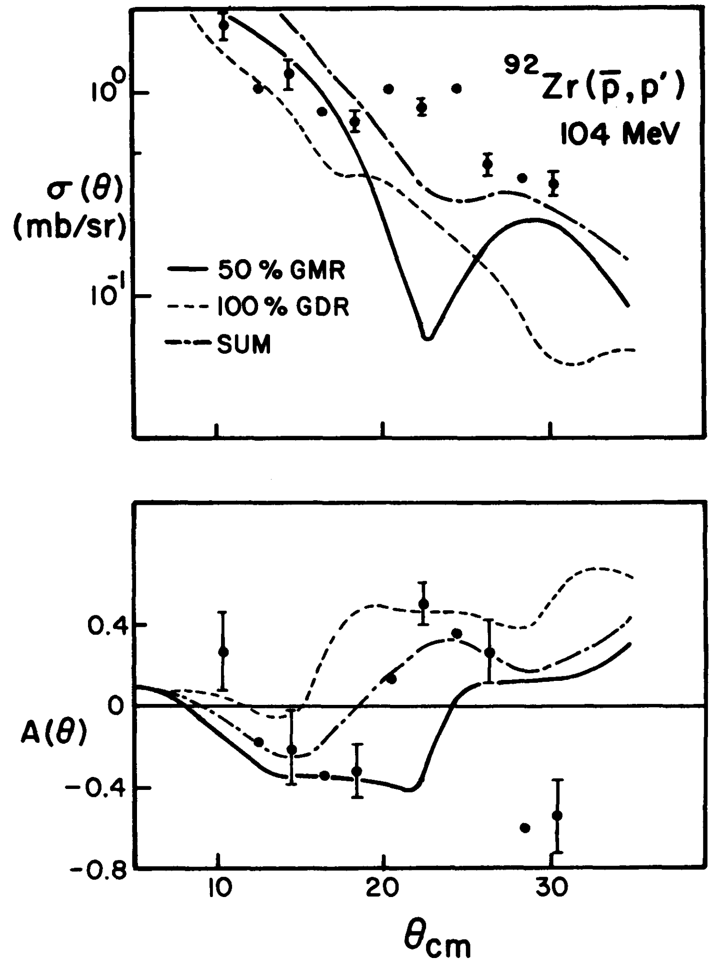

Figure 2b. Differential cross section and analyzing power data for GMR and GDR region. The DWBA predictions for L=0 and 1 are also shown.

using ΔE-E telescopes consisting of intrinsic germanium detectors. The polarization of the incident beam was monitored periodically with a polarimeter placed between the cyclotrons. The data were measured in 2° steps from 10° to 30°. The beam on target was kept in the same place by the use of a split Faraday cup and associated beam steerers. Typical energy spectra measured at $\theta_{cm} \approx 14.4°$ and 24.4° are shown in Fig. 1. The GQR, GMR, GDR, and continuum regions are appropriately indicated in the figure.

In the present work, the GR region has been fitted with two Gaussians (as shown in Fig. 1), one centered around 14 MeV with a width of 4 MeV and the other located at 17.5 MeV with a width of 3.5 MeV, and a smooth underlying background. While the first Gaussian is attributed to the GQR, the second peak is assumed to be a combination of GDR and GMR. Standard DWBA calculations have been carried out to determine the extent to which the sum rules for the various L-values are exhausted in the GR region. In Fig. 2a, the results for the GQR region are given. It is found that a few percent L=4 is required in addition to 50% L=2 to explain the cross section data in the GQR region. However, this combination provides a poorer fit to the measured analyzing powers. The results for the GDR + GMR region are shown in Fig. 2b. They clearly indicate that this region cannot be fully explained with only L=0 and 1 contributions. The behavior of the background subtracted under the GR is shown in Fig. 3. Also shown is the plot of the analyzing power A(θ) of the continuum at $E_x \sim$ 21-25 MeV as a function of θ. It is found that A(θ) in both cases is nearly a constant and has an average value of ∿ 0.06. The present work indicates that simultaneous measurement of A(θ) and σ(θ), besides confirming the GQR and GMR strengths obtained from other measurements, can also put much more stringent limits on the amount of L=4 strength allowable in this region.

A more detailed analysis of the data and comparisons with DWBA calculations are in progress.

1) F.E. Bertrand, Annu. Rev. Nucl. Sci. 26, 457 (1976).

2) Proc. Giant Multipole Resonance Topical Conference, Oak Ridge, TN (1979).

3) P.P. Singh, et al., IUCF Annual Report, 1979.

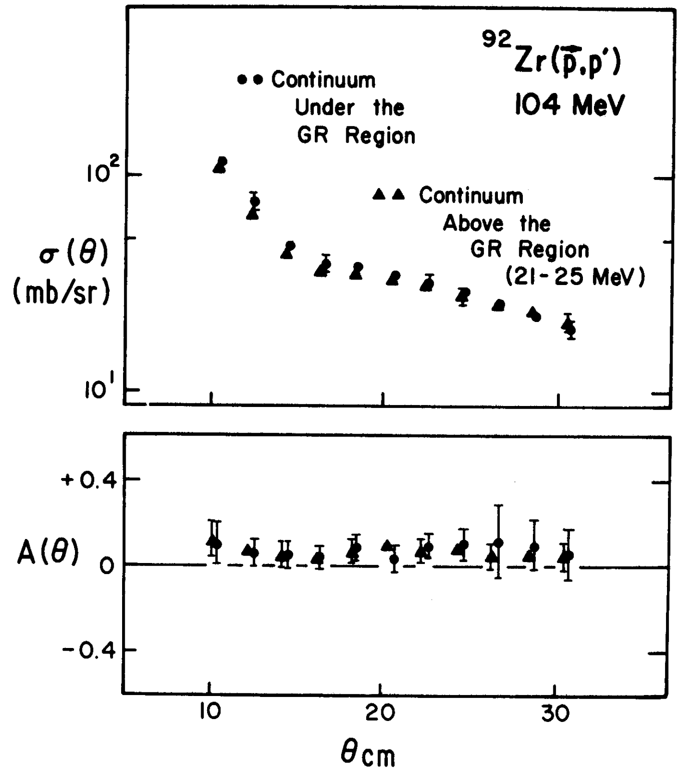

Figure 3. The behavior of the background subtracted from under the GR and the continuum above the GR at E_x = 21-25 MeV.

SEARCH FOR α-CLUSTER STATES IN THE GIANT RESONANCE REGION

W.W. Daehnick, N. Easwar, and J.V. Maher
University of Pittsburgh, Pittsburgh, Pennsylvania 15260

R.E. Segel
Northwestern University, Evanston, Illinois 60204

W.P. Jones, F. Soga and P.P. Singh
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

We have measured (^{6}Li,d) spectra at 10° for the interaction of 90 MeV ^{6}Li with targets of ^{12}C, ^{16}O, ^{24}Mg, ^{54}Fe, ^{90}Zr, and ^{196}Pt. Spectra from the ^{12}C and ^{16}O (mylar) targets exhibit the same selectivity reported[1] for this reaction with lower energy ^{6}Li, but states at high excitation energy are less obscured by the breakup background at this higher energy. The breakup background on ^{24}Mg is also sufficiently weak that many transitions to highly excited states in ^{28}Si stand out clearly; there is some correlation between the excitation energies of states populated in this reaction and those reported[2] to be isoscalar giant quadrupole resonance fragments in a ^{28}Si(α,α')^{28}Si study. Several states in the excitation energy region 8-10 MeV are weakly populated in ^{58}Ni, but no structure is observed above the slowly-rising breakup background in the region of the giant quadrupole resonance. No transitions populating discrete states are observed for the heavier targets. Future work will concentrate on studying the giant quadrupole resonance of ^{28}Si.