Giant Resonances in ^{46}Ti

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The study of the isoscalar giant monopole resonance (GMR) is important because its energy, $E_{\mathrm{GMR}} = (m_3/m_1)^{1/2}$ where $m_k=\sum(E_n-E_0)^k|<0|r^2|n>|^2$, is related to the nuclear compressibility [1]. The energy of GMR has been investigated for ^{40}Ca and ^{58}Ni nuclei using inelastic scattering of 240-MeV alpha particles. Their GMR energies obtained were 20.76 ± 0.51 MeV [2] and $21.48^{+3.01}_{-0.32}$ MeV [3], respectively. An investigation of the GMR in ^{46}Ti has been made to check the mass dependence of GMR energies between these two nuclei [4]. Preliminary results for energy-weighted sum rule (EWSR) and GMR energy in ^{46}Ti are reported here.

A beam of 240 MeV alpha particles provided from the Texas A&M K500 superconducting cyclotron bombarded a self-supporting ^{46}Ti foil 2.0 mg/cm^2 thick located in the target chamber of the multipole-dipole-multipole spectrometer [5]. Inelastically scattered alpha particles from the target nucleus were momentum-analyzed and measured by a focal plane detector [6]. Elastic scattering and inelastic scattering from the first excited state were measured at spectrometer angles from 4° to 35°. Giant resonance data was measured at 0° and 3.5°. The differential cross section was obtained from the beam intensity, target thickness, solid angle, and dead time correction. Uncertainties include both statistical errors and systematic errors that are at least 10%. The dead time was measured by comparing the number of pulses received in the computer with the number of pulses that were sent through the electronic circuit to the data acquisition system generated from random pulses (in real time). The experimental technique has been described in Refs. [7, 8].

Elastic scattering data were fitted to obtain potential parameters for folding model calculations. The folding potential used is a density-dependent Gaussian α-nucleon potential with an imaginary Woods-Saxon term, which was suggested by Satchler and Khoa [9]. The calculation was carried out using the computer code PTOLEMY [10] with relativistic corrections [11]. The input form factors were obtained using the computer code DOLFIN [12] with a Fermi distribution for the charge density distribution of the ground state having c = 3.84 fm and a = 0.55 fm [13]. The folding parameters are shown in Table 1.

Table 1: Optical potential parameters.

V (MeV)	W (MeV)	R_i (fm)	A_i (fm)	R_c (fm)
40.317	36.825	3.963	1.214	4.658

The fit to the elastic scattering and the calculation for the first excited state using the $B(E2)$ value from EM work [14] are shown in Fig. 1 together with the experimental data.

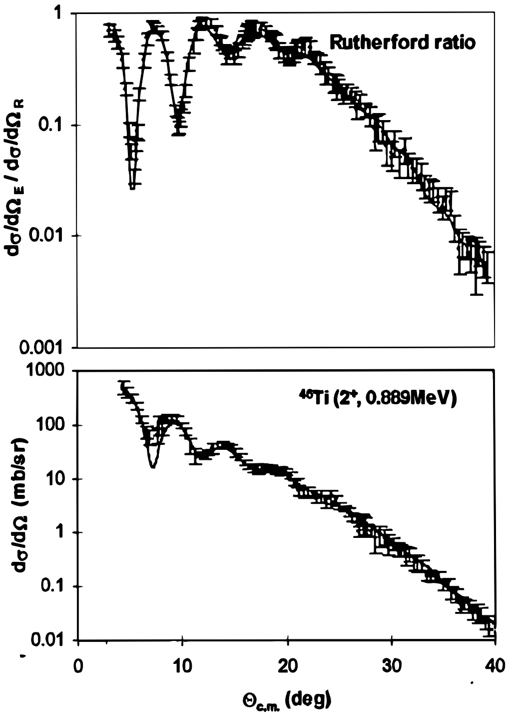

Figure 1: Angular distributions of ratio to Rutherford for elastic scattering and the differential cross-section for the first excited state. The solid circles indicate experimental data. The solid curves were obtained from DWBA calculation with the density-dependent single folding model.

Fig. 2 shows a GR spectrum with the continuum chosen for the analysis. Both the peak and the continuum were divided into several energy bins and were fitted with *L* = 0-4 calculations. Details of the analysis are described in Ref. 2. Fig. 3 shows the strength distributions obtained for isoscalar *E*0, *E*1, and *E*2. The centroids and the EWSR strengths obtained are listed in Table 2.

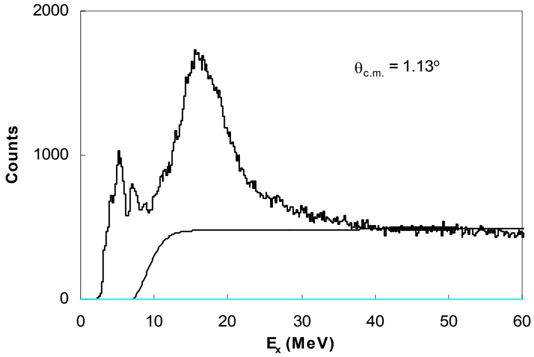

Figure 2: An inelastic α spectrum for $\theta_{c.m.}$ = 1.13°. The solid line indicates the continuum curve.

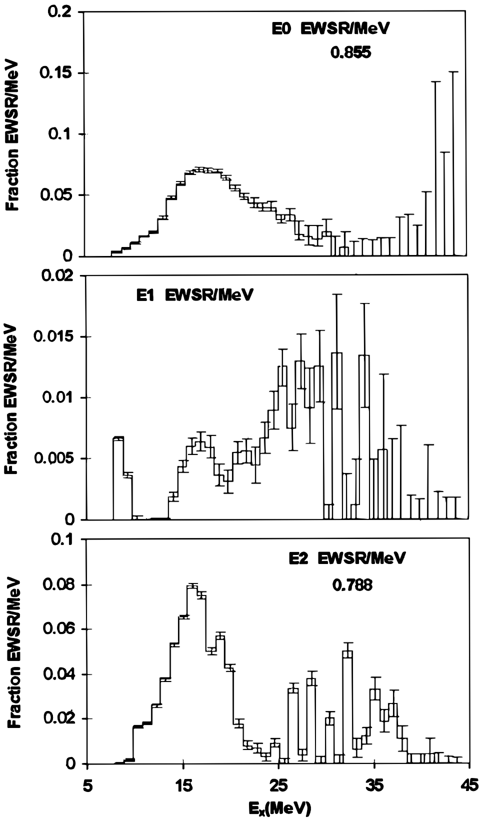

Figure 3: The *E*0, *E*1 and *E*2 strength distributions obtained from 8 MeV to 43 MeV are shown.

Table 2: Multipole parameters obtained for ^{46}Ti.

	Centroid (MeV)	%EWSR
*E*0	$18.4^{+2.9}_{-2.0}$	86^{+32}_{-11}
*E*1 (*T*=0)	$21.8^{+1.0}_{-0.3}$	15 ± 3
*E*2	$18.82^{+0.33}_{-0.23}$	79 ± 9

A total of 86^{+32}_{-11} % of the *E*0 EWSR including both the peak and continuum contributions has been found with a centroid of

$18.4^{+2.9}_{-2.0}$ MeV. The large uncertainties of the $E0$ EWSR and centroid at the higher excitation energy come from the multipole fit to the continuum. The $E0$ strength obtained between 8 MeV and 33 MeV exhausted 86^{+12}_{-11} % of the EWSR with a centroid at $15.86^{+0.38}_{-0.25}$ MeV. The $E0$ strength and the rms width are consistent with those in ^{40}Ca and ^{58}Ni.

The total $E2$ strength was centered at $18.82^{+0.33}_{-0.23}$ MeV and exhausted 79 ± 9 % of the $E2$ EWSR. However the bump around 35 MeV in excitation energy is sensitive to the choice of the continuum curve. The $E2$ strength obtained between 8 MeV and 26 MeV exhausted 54 ± 6 % of the EWSR with a centroid at $15.86^{+0.18}_{-0.16}$ MeV.

About 15 ± 3 % of the isoscalar $E1$ EWSR was located with a centroid of $21.8^{+1.0}_{-0.3}$ MeV. These are similar to those identified in ^{40}Ca and ^{58}Ni. A striking peak that one could see in the GMR and GQR strength distributions didn't appear and the strength was spread from 14 MeV through 35 MeV similarly to ^{40}Ca and ^{58}Ni.

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