SHORT COMMUNICATIONS

INELASTIC SCATTERING OF DEUTERONS FROM ^{56}Fe†

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Inelastic scattering has been found to be an extremely useful tool in studying the collective states in nuclei. Following the early work of Cohen and Rubin (1958) there has been tremendous interest in the investigation of vibrational states, particularly in the first 2^+ and "anomalous" 3^- states, in even–even nuclei and in their possible interplay with the well-defined single-particle levels in stripping and pickup reactions and even in (p, n) reactions (Guglet 1960). These states in ^{56}Fe have recently been studied mostly through the inelastic scattering of α-particles (McDaniels *et al.* 1960) and protons (Matsuda 1962; Aspinall, Brown, and Warren 1963; Brown, Warren, and Middleton 1966). Except for a few measurements on some of these states (Jahr *et al.* 1961; Gofman and Nemets 1962) no systematic information is available on the inelastic scattering of deuterons from ^{56}Fe. The present work was undertaken with this in view, and in this communication we report on the properties of a few levels of ^{56}Fe, including the 2^+ state at 0·844 MeV and the 3^- state at 4·503 MeV, deduced from the inelastic scattering of 12 MeV deuterons.

The experiment was carried out with the Aldermaston multichannel magnetic spectrograph (Middleton and Hinds 1962). The target was self-supporting and isotopically enriched ($\sim 99\%$) ^{56}Fe of nominal thickness 100 μg cm^{-2}. A beam of 12 MeV deuterons, obtained from the Tandem generator, was scattered from it and detected simultaneously at 24 angles between 5° and 175° in Ilford K2 emulsion 50 μ thick, positioned in the spectrograph. The plates were scanned in Dacca for deuterons and all the levels up to an excitation of 4·5 MeV were identified and the corresponding angular distributions obtained.

Figure 1 shows the angular distributions of deuterons inelastically scattered from ^{56}Fe leading to the first two excited states at 0·844 and 2·077 MeV and the 4·450 and 4·503 MeV states. The spin and parity of the 4·450 MeV state have not been identified previously; the spins and parities of the remaining states are 2^+, 4^+, and 3^- respectively (Brown, Haigh, and MacGregor 1967). The angular distributions are characterized by a principal maximum the position of which can be seen to vary markedly from one state to another, thus helping in the determination of their spins and parities from theoretical analyses.

The distributions for the 2^+ and 3^- states were analysed in terms of the diffraction model of Blair (1960) and the surface deformation parameters were extracted from the normalized cross sections. The present work confirms the spin and parity assignments of the levels at 0·844, 2·077, and 4·503 MeV and suggests $J^\pi = 6^+$

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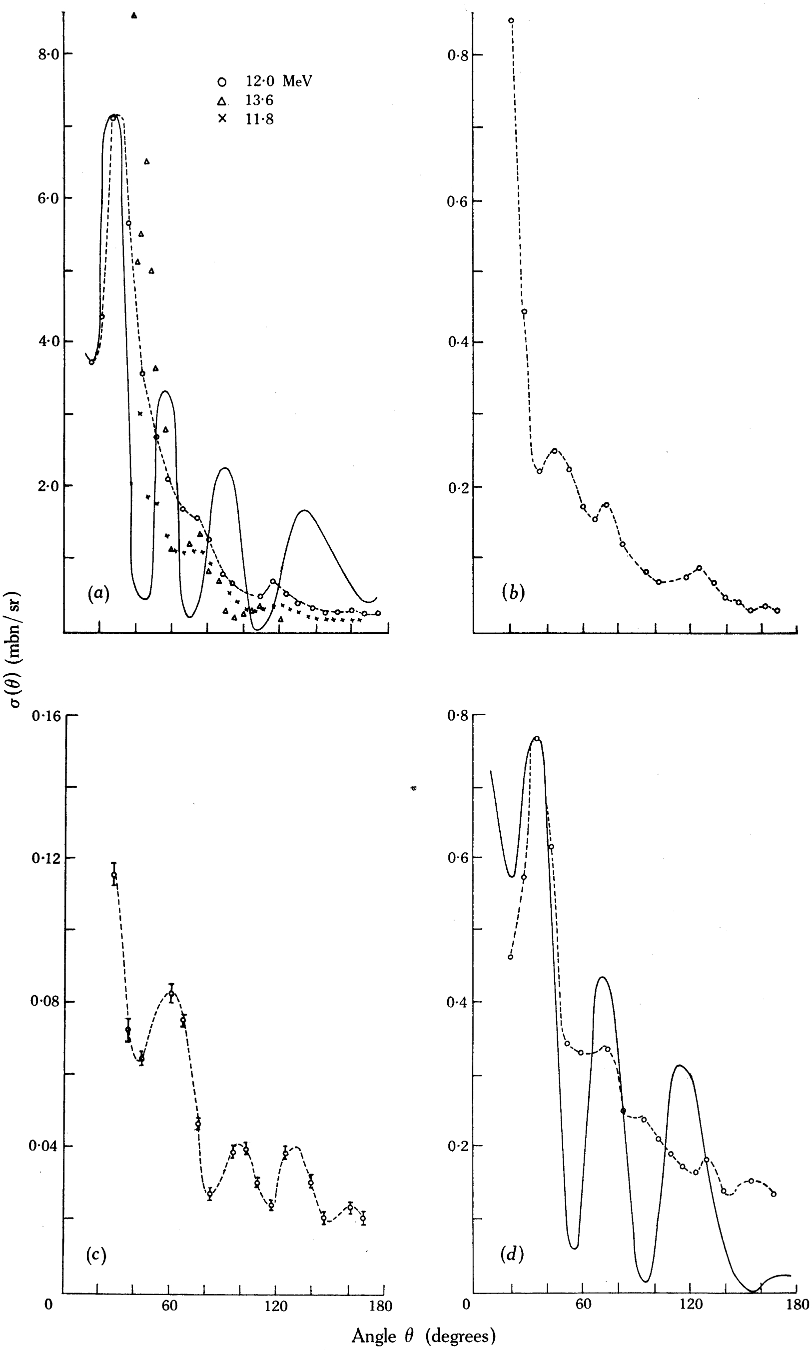

Fig. 1.—Angular distribution of 12 MeV deuterons inelastically scattered from ^{56}Fe with the excitation of the (*a*) 0·844, (*b*) 2·077, (*c*) 4·450, and (*d*) 4·503 MeV states. Also plotted in (*a*) are data from Gofman and Nemets (1962) for 13·6 MeV and from Jahr *et al.* (1961) for 11·8 MeV scattering. The dashed curves are the best eye-estimated ones representing the experimental results and the solid curves are from Blair model analyses.

for the 4·450 MeV level. The relative intensities of these groups at the principal maximum and at 42·5° (lab. angle) are given in Table 1 as a guide. The yield for the octupole vibrational state (4·503 MeV) is extremely large compared with those for the excited states in the range 0·85–4·5 MeV; it is, however, smaller than that for the quadrupole vibrational state (0·844 MeV). This result agrees with those from (p, p′) and (α, α′) experiments. The 4·450 MeV state, on the other hand, is one of the weakest groups (this has possibly been caused by the centrifugal potential barrier) thus confirming its large angular momentum.

TABLE 1

LEVEL STRUCTURES STUDIED IN ^{56}Fe

Excitation (MeV)	J^{π}	Relative Intensity at: Peak	Relative Intensity at: 42·5°	Deformation Parameter
0·844	2^+	100	100	0·41 (quadrupole deformation)
2·077	4^+	3·9	8·0	
4·450	6^+	1·6	2·5	
4·503	3^-	14·4	24·0	0·16 (octupole deformation)

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