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D2 Radiative Capture of 14 MeV Neutrons

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Over the last few years a technique for measuring 14 MeV neutron γ-ray spectra integrated over solid angle 4π has been developed and measurements

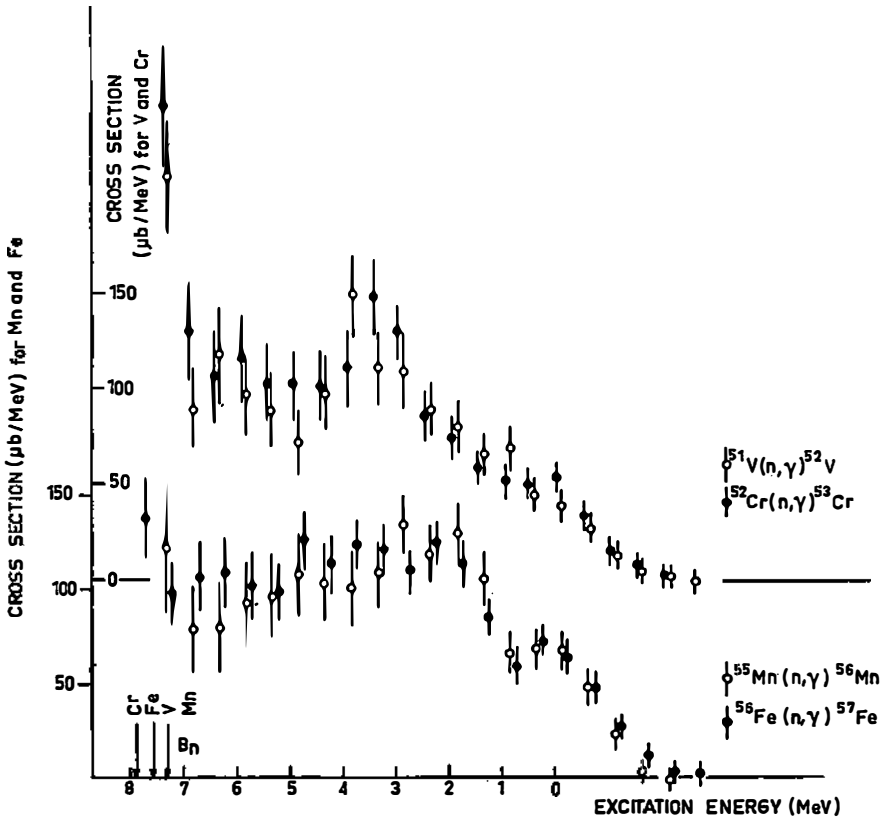

Fig. 1

made for some light and medium-weight nuclei. The spectra range from about 14 MeV to 22 MeV and represent the transitions to the bound states of final nuclei. Due to poor (12%) experimental resolution, the spectra exhibit only a

rough gross structure. At the γ-ray energies from 16 to 19 MeV normaly a rather intense broad peak appears. Later, this peak was ascribed to the effect of the giant dipole resonances on the capture mechanism and to the rather intense direct capture transitions populating the d or f single-particle levels located most frequently at excitations of final nucleus from 2 to 5 MeV. For two pairs of nuclei with the same number of neutrons, the spectra were found to be equal.

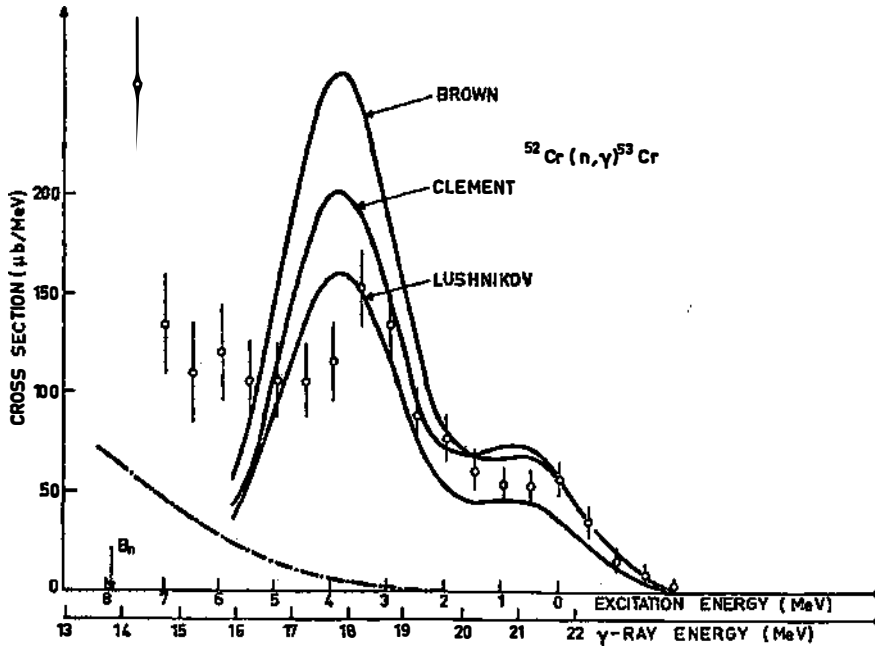

Fig. 2

The measured spectra, Fig. 1, were compared with those calculated by means of three different approaches to the model of direct-semidirect radiative capture after Brown[1], Clement et al.[2], and Lushnikov and Zaretsky[3] (Fig. 2). According to this model the collective dipole states are excited due to residual forces, the particle enters a bound orbital and the dipole states deexcite by γ emission. Using approaches from ref.[1] and from ref.[3] the spectra were calculated for ^{32}S, ^{52}Cr and ^{56}Fe. Approach from ref.[2] was used only for calculation of the spectrum of ^{32}S. Brown's approach yields spectral intensities about 20% higher than the experimental. Results from Lushnikov and Zaretsky's approach agree with the experimental within the experimental error for ^{52}Cr. Fitting the spectrum, calculated after Clement, to the experimental values of ^{32}S, a free parameter v_1 was determined to be 160 MeV.

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D3 Spectrometry of Charged Particles

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D4 Possibility of Finding the α-Clustering Probability from (n, α) and (p, α) Studies

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Knock-on and heavy particle stripping processes have been observed in (n, α) and (p, α) reactions. This necessarily implies a transfer of an α-cluster from the target in the initial state and the capture of a neutron or a proton in the final state by the core, which is usually not perturbed. As a consequence one can expect the single neutron or single proton states to be predominantly excited in such a process as in the corresponding (d, p) or (^{3}He, d) reactions. A test of these conjectures has been provided by the comparison of (d, p) and (n, α) reaction spectra leading to the same final nucleus.

Such comparisons have recently been made in the studies of $^{124, 125, 126, 128}$Te (n, α) (ref.[1]) and ^{93}Nb (n, α) (ref.[2]) reactions. The energy spectra both in (d, p) and in (n, α) processes showed considerable single neutron features. In the case of ^{103}Rh (n, α) and ^{115}In (n, α) reactions[3] the measured alpha energy spectra were compared with the calculated single neutron levels from the Nilsson model. Since the experimental energy resolution was not very good, the Nilsson neutron levels were smeared out to obtain a level density appropriate to that region. The agreement was fairly good. It was further observed that the best fit between the experimental spectra and the calculated neutron level sequence was obtained for only those values of the deformation parameter δ (which determines the Nilsson model sequence) which were expected from other experimental data and the systematics of the neighbouring nuclei.

The measured energy spectra were also compared with the statistical model calculation[1–3]. It was found that except in the case of ^{103}Rh (n, α), the energy distributions of alpha particles were far from being statistical. This probably shows that compound nuclear contributions are relatively small.

Very recently Kulišić et al.[4] also studied the (p, α) reaction on ^{115}In, ^{165}Ho and ^{209}Bi at 40 MeV. The results are at preliminary stage at present.

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