Analog of the Giant Dipole Resonance in ^{4}He

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The analog of the giant dipole resonance (GDR) in ^{4}He was investigated by using the ^{4}He(^{7}Li,^{7}Be) reaction at an incident energy of 455 MeV and at forward scattering angles. The resonance-like structure was observed above E_x=20 MeV, which is consistent with the previous work by using various reactions. The structure was ascribable to ΔL=1 transitions from the angular distribution of differential cross sections of the singles spectrum for ^{4}He measured in angular range of $\theta_L \leq 4°$. The singles spectral shape was found to be very similar to the ^{4}He(p, p') spectrum measured at E_L=300 MeV and θ_L=8° where the ΔL=1 transition is dominant [1]. The coincidence spectrum at $\theta_L = 0°$ was obtained by measuring ^{7}Be-scattered particles in coincidence with the 0.43-MeV ^{7}Be γ-ray [2]. The spin-nonflip (ΔS=0) spectrum was deduced from the singles and coincidence spectra by taking into account the detection efficiency for the 0.43-MeV γ-ray of about 12.5%. It should be mentioned that the ΔS=0 spectral shape is rather insensitive to the detection efficiency. From the ΔS=0 spectrum thus deduced, the cross sections of the photodisintegration to the GDR in ^{4}He were derived from the ΔS=0 spectrum by taking into account a similarity of relevant transition operators.

The ΔS=0 cross section with ΔL=1, $d^2\sigma/dEd\Omega$, obtained in the ^{4}He(^{7}Li,^{7}Be) reaction is feasible to deduce the $E1\gamma$-^{4}He photodisintegration cross sections, $\sigma_{E1\gamma}$, by taking into account a similarity of relevant transition operators. The $\sigma_{E1\gamma}$ is described as $4.0K \times E_x d^2\sigma/dEd\Omega$, where K is a proportional coefficient including kinematical factors. The excitation energy E_x in ^{4}He and the double differential cross section are given in units of MeV and mb/sr/MeV, respectively. The proportional coefficient K was determined to be about 0.033 by normalizing the $\sigma_{E1\gamma}$ to the data of the $E1$ total photodisintegration measured at $E_x = 40-45$ MeV. The result of $\sigma_{E1\gamma}$ thus obtained was shown in Figure 1. The GDR was found to have an pronounced peak at around $E_x = 25-30$ MeV. The result agrees with the previous data $\sigma(\gamma, n)+\sigma(\gamma, p)$ recommended by Calarco *et al.* [3], the recent data of $\sigma(\gamma, n) \times 2$ obtained by Nilsson *et al* [4], and the calculation with the LIT method [5]. But the present result is in deep contradiction with the recent data obtained by Shima *et al.* [6].

References

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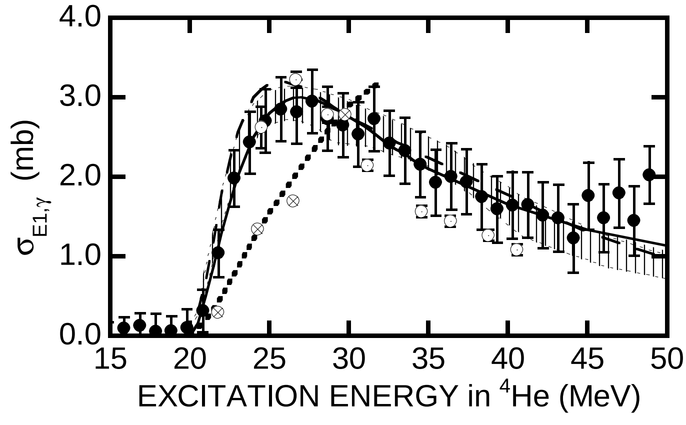

Figure 1: $E1$ photodisintegration cross section (closed circles) evaluated from the ΔS=0 cross section for ^{4}He. The hatched area is the sum of (γ, n) and (γ, p) data recommended by Calarco *et al.* [3]. Two recent data are also shown: (γ,total) ($\otimes$) measured by Shima *et al.* [6] and $(\gamma, n) \times 2$ ($\odot$) measured by Nilsson *et al.* [4]. The dashed and solid curves represents the cross sections calculated by using the LIT method with the NN potentials and the $NN + 3NF$ potentials, respectively [5].