FINE STRUCTURE OF GIANT RESONANCE OF THE REACTION $He^4(\gamma, p)H^3$

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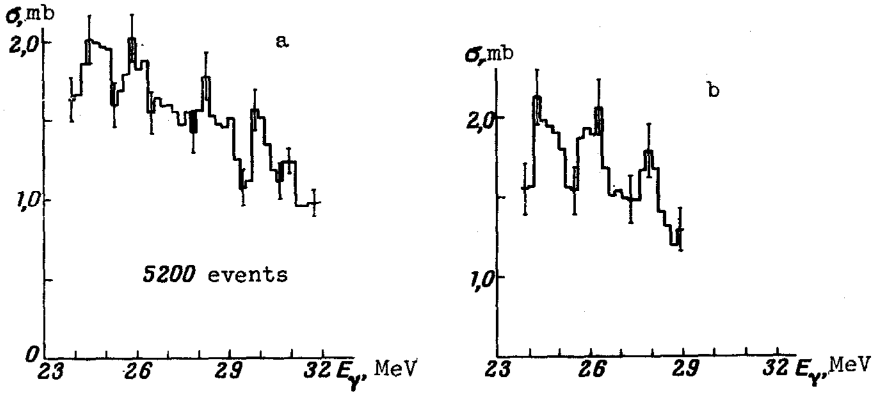
The question of the existence of excited states of He^4 has always attracted great interest. By now, the existence of excited states of He^4 at excitation energies 20, 21, 22, 24, and 30 MeV has been confirmed by a number of workers who have studied nuclear reactions of strongly-interacting particles. References to these data are contained in the survey paper of Argan et al. [1] The fine structure of the energy spectrum of the protons from the reaction $He^4(\gamma, p)H^3$ was observed by Milone [2]. However, no fine structure was observed in the specially organized experiments aimed at investigating the structure of the giant resonance, by Gemmel and Jones [3], who studied the inverse reaction $H^3(p, \gamma)He^4$, and by Clerc et al., who studied the direct reaction [4]. Later Denisov and Kul'chitskii [5] observed one narrow peak in the giant-resonance region.

The present work was performed for the purpose of studying the reaction $He^4(\gamma, p)H^3$ with good energy resolution and with good statistics. We used a diffusion chamber [6] filled with helium to a pressure of 8 atm and placed in the path of a bremsstrahlung beam from a linear electron accelerator with energy 300 MeV. We selected for the measurements events in which the tritium remained in the working volume of the chamber. The gamma-quantum energy was calculated from the measured emergence angle of the tritium and the tritium kinetic energy calculated from the range-energy relation. Measurement of the coordinates of the first and last points of the track on the film was performed with the aid of type UIM-1 microscopes. The error δE_γ in the determination of the gamma-quantum energy, due to inaccuracy in the measurements of the track length, the pressure and temperature of the gas in the chamber is given in the table as a function of the track length ℓ.

ℓ, cm	1 - 1.5	1.5 - 2.0	2.0 - 3.0	> 3.0
δE_γ, MeV	0.21	0.16	0.13	< 0.1

The dependence of the cross section σ on the energy E_γ is shown in Fig. a in the form of a histogram with energy spacing 0.2 MeV. This distribution was constructed from 5200 events.



Energy dependence of the cross section of the reaction $He^4(\gamma, p)H^3$.

The statistical errors are indicated. At gamma-quantum energies 24.8, 26.0, 28.0, and 30 MeV one can clearly see the peaks. The distribution shown in Fig. b includes events in which the tritium emergence angle relative to the direction of the gamma quantum does not exceed 110°, thus improving the energy resolution. The normalization was against the angular distributions of all the events. It is seen that the peaks at 24.8, 26.0, and 28.0 MeV are more pronounced. The first three peaks of the distributions (see the figure coincide at the corresponding energy with the peaks observed by Milone [2].

The peak at 30 MeV has been observed for the first time.

The cross section of Fig. a are averaged over intervals of 1 MeV, then the obtained curve is in good agreement with Gorbunov's curve [7].

In conclusion, the authors are grateful to A. N. Gorbunov for a discussion of the result results.

[1] P. E. Argan, G. C. Mantovani, P. Marazzini, et al., Suppl. Nuovo Cimento 3, 245 (1965).
[2] C. Milone, Phys. Rev. 120, 1302 (1960).
[3] D. S. Gemmel and G. A. Jones, Nucl. Phys. 33, 102 (1962).
[4] H. G. Clerc, R. L. Stewart, and P. C. Morrison, Phys. Lett. 18, 316 (1965).
[5] V. P. Denisov and L. A. Kul'chitskii, Yad. Fiz. 6, 437 (1967) [Sov. J. Nuc. Phys. 6, 318 (1968)].
[6] Yu. M. Arkatov, P. I. Vatset, V. I. Voloshchuk, et al., Program and Abstracts of 17th Conference on Spectroscopy and Nuclear Structure, Nauka, 1967, p. 180.
[7] A. N. Gorbunov, ZhETF Pis. Red. 8, 148 (1968) [JETP Lett. 8, 88 (1968)].

OBSERVATION OF SELF-BENDING OF A NON-UNIFORM INTENSE LASER BEAM IN AN NaCl CRYSTAL

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We present here the results of first observations of a unique manifestation of self-action of a laser beam with non-uniform intensity distribution over its cross section in a medium, namely self-bending. This effect is due to an inhomogeneous variation of the refractive index n of the medium, due to the non-uniform field of the beam, i.e., to the appearance of a gradient of n in a direction perpendicular to its axis; it was recently described in [1][1].

We investigated the propagation of a focused ruby-laser beam (Q-switched, initial mean peak power 50 - 80 MW) in an NaCl crystal. The form of the beam in the crystal was assessed from the distribution of the damage tracks produced along the path of the beam [3]. The cross section of the initial beam was close to elliptic, and an intensity gradient existed along the long axis of the ellipse (see Fig. 1, upper part). This was evidenced, in particular, from the distribution of the damage points produced on the surface of the crystal where the concentrated beam was applied. To increase the density gradient of the beam entering the crystal, the beam was incident on the crystal at an angle, as shown in Fig. 1 (the plane of the figure corresponds to the longitudinal section of the beam along the major axis of the

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[1] The bending of a homogeneous beam propagating in a medium with a refractive-index gradient is known from classical optics [2].