INVESTIGATION OF THE REACTION (e, e'p) ON Li^6

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We have investigated, for the first time, the reaction Li^6(e, e'p)He^5 at an energy resolution sufficient to separate the effects from the s and p shells of the Li^6 nucleus. We present below the results of the measurement of the cross section of the reaction Li^6(e, e'p)He^5 as a function of the missing energy B, defined by the relation

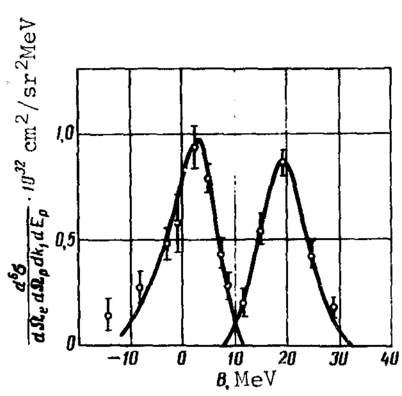
$$B = k_o - k_1 - T_p - T_N , \quad (1)$$

where k_0, k_1, T_p, and T_N are the energies of the initial and final electrons and the kinetic energies of the proton and the residual nucleus, respectively.

The measurements were performed with a beam of electrons of energy 1180 ± 3 MeV from the linear accelerator of our Institute, at constant registration angles of the secondary electrons (20° lab) and protons (68.3° lab) and at constant proton momentum (404 MeV/c). The counting rates of the coincidences of the signals from the proton and electron detectors was measured at different values of the scattered electron energy k_1, corresponding to a change of the missing energy B from -15 MeV to +30 MeV. Under the foregoing kinematic measurement conditions there appears at B = 0 a contribution from the elastic scattering by the hydrogen contained in the Li^6 target, the value of which we established by measuring the angular correlation of the reaction Li^6(e, e'p)He^5.

A target 0.372 g/cm^2 thick was made of metallic lithium containing 90.4% of Li^6. The missing-energy scale was calibrated against the reaction of elastic scattering by hydrogen, with a calibration accuracy ±1 MeV. The secondary electrons and protons were momentum-analyzed by two magnetic spectrometers [1] with solid angles 1.3×10^{-3} and 8.2×10^{-3} sr, respectively.

The electrons were registered with a three-channel telescope subtending 0.4% per channel in momentum and with a distance 0.6% between channels, while the proton telescope subtended 3.12% in momentum. The coincidences of the signals from each of the three channels of the electron telescope with the signal from the proton telescope were registered by time-amplitude converters. The missing-energy resolution of the apparatus was about 9 MeV (the total width at half height), and the subtended recoil-nucleus momentum was 30 MeV/c.



Cross section of the reaction Li^6(e, e'p)He^5.

The measured cross section of the reaction (e, e'p) on the Li^6 nucleus as a function of the missing energy B is shown in the figure. The contribution of the hydrogen contained in the Li^6 target has been subtracted. The cross sections are shown in the figure without the radiative corrections (preliminary estimates show them to increase the cross section by 15 - 17% [2]). The cross section has two maxima at B = 3.5 ± 1 MeV and B = 19 ± 1 MeV, corresponding to the residual nucleus He^5 in the ground state and in a state with excitation energy 16.7 MeV.

It follows from the investigated reaction Li^6(p, 2p)He^5 that these two states are produced by proton knock-out from the p and s shells of the Li^6 nucleus [3]. We note that in recent investigations of the (e, e'p) reaction [4] and of the analogous (π^-,π^-p) reaction on the Li^6 nucleus [5], the energy resolution was insufficient to separate the contributions of the s and p shells.

The cross section $d^5\sigma/d\Omega_e d\Omega_p dE_p$ integrated with respect to B without allowance for the distortion of the proton and electron waves by the nuclear potential was calculated by us in the impulse approximation with oscillator wave functions whose parameters were taken from (p, 2p) experiments on Li^6 [6].

Shell	α MeV/c	$d^5\sigma_{theor}\cdot 10^{31}$ cm^2/sr^2MeV	$d^5\sigma_{exp}\cdot 10^{31}$ cm^2/sr^2MeV	$d^5\sigma_{exp}/d^5\sigma_{theor}$
1s	110	2,02	1,06 ± 0.15	0.525 ± 0.074
1p	40	4.09	1.25 ± 0.18	0.306 ± 0.044

The table lists the theoretical values of the cross sections together with the s- and p-shell proton momentum distribution parameters α used in the calculations. The table gives also the measured cross sections with allowance for the radiative corrections (17%) and their ratio to the theoretical ones (the suppression coefficients).

In view of their weak dependence on the oscillator parameter [7], we estimated the suppression parameters by using the calculations of [8], and found them to equal 0.650 and 0.790 for the s and p shell of the Li^6 nucleus, respectively. It is seen from the tables that the measured suppression coefficient for the s shell is close to the calculated one, whereas for the p shell it is much smaller. The apparent reason of the discrepancy is the small value of the 1p-shell momentum-distribution parameter used in the calculation of $d^5\sigma_{theor}$. If we assume for the p shell a value α = 50 MeV/c, then the suppression coefficient will be close to its theoretical value 0.74.

It follows thus from our measurements that the Li^6 s-shell proton distribution parameter is equal to 110 MeV/c, in agreement with the (p, 2p) experiments, whereas for the p shell its value is 50 MeV/c, which differs from the value 40 MeV/c obtained from the (p, 2p) experiments.

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