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/Preliminary Results/

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QUASIELASTIC SCATTERING OF 670 MEV PROTONS ON DEUTERON CLUSTERS IN ^{6}Li AND ^{7}Li NUCLEI /Preliminary Results/

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Institute for Physics, Budapest and the
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The investigation of quasielastic production of complex particles from nuclei at medium bombarding energies gives valuable information about the cluster structure of the target nucleus. The measured cross sections and momentum distributions of the deuterons, tritons, ^{3}He and alpha particles knocked out give evidence of a quasi-free character of the interaction of fast protons with nucleon associations within the nuclei [1-4]. Though the main features of such reactions are particularly investigated, the theoretical interpretations are not clear cut, owing to the fact, that only one of the particles is observed in the final state.

Up to the present there are only a few kinematically complete experiments. In the range of medium energies the $^{12}C/p,pd/^{11}C$ reaction [2] /rather qualitatively/, the $^{6}Li/p,pd/^{4}He$ [3] and the $^{3}He/p,pd/^{1}H$ [4] reaction were measured.

In this paper there are presented the preliminary results of the experiments running on the synchrocyclotron in the Laboratory of Nuclear Problems of JINR, Dubna. The reactions ^{6}Li/p,pd/^{4}He and ^{7}Li/p,pd/^{5}He have been investigated at 670 MeV bombarding energy. A two-arm spectrometer was built to carry out kinematically complete measurements in a wide momentum range simultaneously. /Fig. 1./ The energy spread of the beam at the target is $\pm$5 MeV with an intensity of 10^9 protons/sec and angular dispersion of 0.5^o. The deuterons are observed at a laboratory angle $\Theta_d=6.75^o$ within a solid angle of 50 μstr determined by a collimator. The protons going out backwards are detected at $\Theta_p=148^o$ within a solid angle of 10 mstr. This geometry corresponds to the free /p,d/ scattering at an angle of $\Theta_{c.m.}=165^o$ in center of mass system. The deuterons are analysed by momentum using an analysing magnet /deflection angle 20^o/, and are identified by a time of flight spectrometer /TOF//time resolution $2\tau=0.5$ nsec, base 3.7 m/. The trajectory of the particles is measured by a telescope of four multiwire proportional chambers /MWPC//64 wires each/. The momentum resolution of the magnetic spectrometer is $\pm$0.25%. The full resolution of the spectrometer is $\Delta p/p=0.8\%$ determined by the energy spread of the primary proton beam and the size of the target. The spectrometer covers a momentum interval of $\Delta p/p \sim 8\%$, which permits the simultaneous measurement of the whole momentum range of the quasielastically scattered deuterons. The protons scattered backwards are measured by a scintillation detector telescope consisting of a 5 mm thick dE/dx and a Ø 80x200 mm NE102 plastic scintillator E detector /SC and D/. The energy resolution of the detector D is $\Delta E=4$ MeV at a proton energy of $\sim$50 MeV. The total energy resolution of the apparatus is $\sim$15 MeV.

The spectrometer was calibrated by the d/p,d/p reaction on free deuterons /LiD target/. The targets used in the experiment: LiD, ^{6}Li /enriched to 90%/ and ^{7}Li /natural isotope mixture/ have a size of 5 mm /perpendicularly to the beam/ x20 mm /in the beam direction/.

Figure 2 shows the block diagram of the electronical set-up. For every event there are measured the amplitude and time data for all the detectors /except S_1 and S_3/, the coordinates of MWPC-s and are stored in list mode by a HP 2116C computer. The equipment permits the on-line and off-line analysis of data as well.

From the parameters measured one can determine for every coincidence event the momentum of the deuterons and the energy of the protons scattered in a fixed backward direction, that means the complete kinematics. The sum of the kinetic energy of the deuterons and the backscattered protons is closely connected with the excitation energy of the residual nuclei ^4He and ^5He. The missing energy $E_{miss} = E_0 - (E_d + E_p + E_{recoil})$ is shown in fig. 3a for the reaction $^6Li/p,pd/^4He$. The energy of the main peak in fig. 3a corresponds to the ground state of the ^4He nucleus as final state. A small peak about 20 MeV higher apparently corresponds to the events when the alpha particle is disintegrated

This means that in the geometry used most of the alpha particles are produced in the ground state. Fig. 3b shows the similar spectrum for the $^7Li/p,pd/^5He$ reaction. In contrast to ^6Li here the ^5He ground state is formed with small probability. The events are more probable when the residual nucleus remains excited at an energy $\sim$11 MeV. This is in agreement with the fact, that the ^5He nucleus has no bound states, as the widths of the ground and first excited states are rather big and the only state having a small width /about 10 keV/ is the second excited state at the energy 16.7 MeV.

The energy spectrum of the secondary protons corresponding to a definite excitation of the residual nucleus is connected directly with the momentum distribution of the residual nucleus. This distribution – within the limits of accuracy of the impulse approximation – corresponds to the momentum distribution of the deuteron clusters. In figs. 4a and 4b there are shown the energy spectra of the secondary protons for the reactions $^6Li/p,pd/^4He$ in the ground state and $^7Li/p,pd/^5He$ in the excited state. From these spectra it is possible to determine the half width of the momentum distribution

of the clusters which is $\sim$100 MeV/c for ^6Li and $\sim$ 130 MeV/c in the case of ^7Li.

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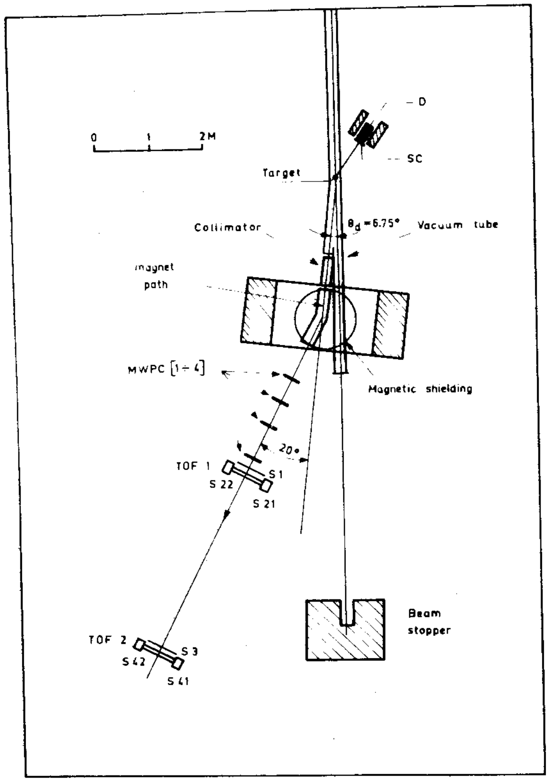

Fig. 1 Experimental set-up
S1,S21,S22,S3,S41,S42,D,SC - scintillation detectors;
MWPC/1-4/ - multiwire proportional chambers

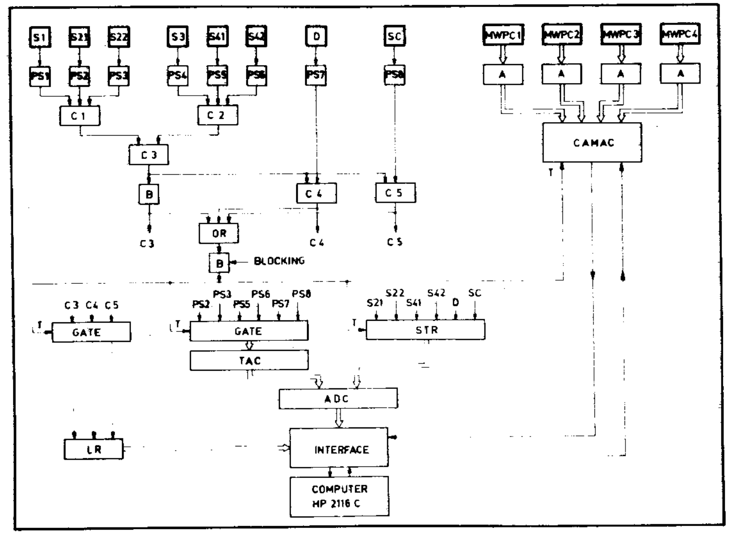

Fig. 2 Block schema of the electronical apparatus
S1,S21,S22,S3,S41,S42,D,SC - scintillation detectors;
MWPC/1-4/ - multiwire proportional chambers; A - amplifier, pulse shaper; PS/1-8/ - pulse shapers;
C/1-5/ - fast coincidences; B- dead time gate;
STR - pulse stretcher; TAC - time to amplitude converter; ADC - amplitude digital converter; LR - logical register; T - master pulse

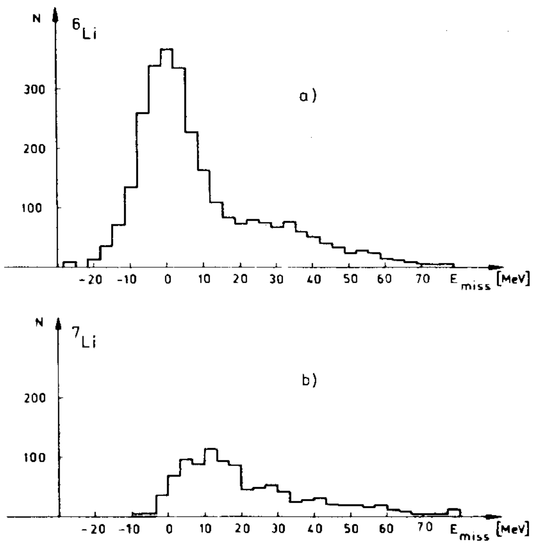

Fig. 3a-3b Event distribution vs. $E_{miss}=E_o-(E_p+E_d+E_{recoil})$ for ^{6}Li/p,pd/^{4}He (a) and ^{7}Li/p,pd/^{5}He (b) reactions

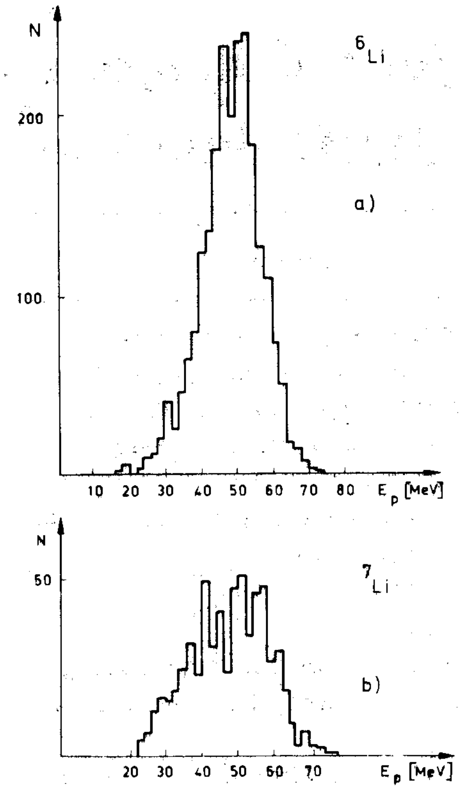

Fig. 4a-4b Energy distribution of secondary protons for ^{6}Li/p,pd/^{4}He /g.s./ (a) and ^{7}Li/p,pd/^{5}He*(b) reactions