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Quasi-Elastic Scattering (e, e'd) and (e, e'p) from ^{6}Li

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Abstract:

Electrons of 2.7 GeV have been scattered from ^{6}Li and detected at 13.8^{o} and 15.0^{o}, in coincidence with outgoing protons and deuterons, kinematically corresponding to quasifree scattering (momentum-transfers 10.5 and 12.2 fm^{-2}). Electron- proton- and deuteron spectra, angular distributions and momentum spectra of the recoil nucleus are presented.

Several authors [1)-4)] have pointed out the aspects of using high-energy-electrons in nuclear structure studies. Considering the effects of short-range correlations between bound nucleons we expect:

a) an increase of the nucleon momentum distribution in its high-momentum part [4)]

b) two-nucleon-emission in the quasi-elastic scattering of an electron from a nucleus, which is improbable in the one-photon-exchange approximation, if we assume the independent particle model.

In the higher momentum-transfer region there are (e, e'p) coincidence measurements on several nuclei [5)] and also (p, p'd) coincidence experiments [6)]. Because of the difficulty to perform a triple-coincidence experiment we have chosen a special case of the outgoing two-nucleon system, that is the deuteron.

In this letter we present preliminary results of a scattering experiment with detection of the scattered electrons in coincidence with the outgoing protons and deuterons, kinematically corresponding to quasifree scattering.

We used the DESY slow ejected electron beam with an energy of (2.7 ± 0.015) GeV. The metallic Li-target (95.6% ^{6}Li) had an effective target thickness of 0.57 cm ($L_{rad} = 0.0037$). The set-up for the detection of the scattered electrons and the recoil particles has been described in detail elsewhere [7)].

The electron spectrometer consisted of a magnet with a homogeneous field, four digitized wire spark chambers and a scintillation counter set-up including a shower counter, separating electrons and defining a scattering event. Its momentum-resolution was $\pm$ 0.6%, the covered solid angle (0.68 $\pm$ 0.01) msterad.

The recoil-particle detection consisted of twelve horizontally and twelve vertically mounted scintillation counters (43.2 cm x 3.6 cm x 1 cm) with four thick counters (21.6 cm x 21.6 cm x 5 cm) behind them. This counter matrix covered a solid angle of $31^{\circ} \times 31^{\circ}$.

With the incident electron energy of 2.7 GeV and the fixed electron scattering angle 13.8° (1.6° aperture angle in the deflection plane) the squared four momentum transfer corresponding to elastic electron-deuteron scattering was 10.5 fm^{-2} (for e-p scattering 10.0 fm^{-2}). At 15° the squared four-momentum transfers are 12.2 fm^{-2} (e-d) and 11.6 fm^{-2} (e-p).

It was difficult to separate the deuterons from the low-energy-tail protons occuring with a rather large rate, because the quasi-elastic peak is broadened due to the Fermi-momentum. Therefore it was necessary to use a differential method, comparing for every recoil particle its set of pulse heights in the three counter planes with calibration energies from the elastic e-p and e-d scattering. The total energy loss of particles, stopped in the third plane, allowed to discriminate between protons and deuterons. This method has been tested with the elastic scattering by protons and deuterons from liquid H_2 and D_2 targets, and the efficiency turns out to be about 82% and 67% respectively, slightly depending on the particle energy. The energy-resolution has been evaluated to be 15% for protons and deuterons.

The results at 10.5 fm^{-2} are plotted in fig. 1a)-d) for deuterons and fig. 2a)-d) for protons. The error bars in fig. 1 are composed of the statistical error and the uncertainty in the background subtraction and the identification efficiency. In fig. 2 no background subtraction was necessary. The resolution the the nuclear recoil spectra fig. 1d) and 2d) is about 30 MeV/c.

The data are radiatively uncorrected, a first order correction, considering the scattered electron peak as a broadened elastic one, would raise the spectra in fig. 1a) and b) by 20%, in fig. 2a) and b) by 17%.

The absolute cross-section calibration has an error of about 30%.

The ratio of quasi-elastically scattered deuterons from ^{6}Li to the corresponding elastic e-d scattering is (1.8 ± 0.7) at 10.5 fm^{-2}. At 12.2 fm^{-2}, this ratio is (1.6 ± 0.6), and the energy and angular dependences are quite similar.

Comparison with a nucleon-nucleon correlation theory of Weise and Huber [8] and with other theoretical work [9], [10], [11] is in progress.

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FIGURE CAPTIONS:

Fig. 1: Spectrum of quasi-elastically scattered electrons in coincidence with recoil deuterons (a), spectrum of the deuterons (b), angular distribution of the deuterons (c), and momentum distribution of the recoil-rest-nucleus (d) for ^{6}Li (e, e' d). Primary energy 2.7 GeV, electron detection angle 13.8^{o}.

Fig. 2: Spectrum of quasi-elastically scattered electrons in coincidence with recoil protons (a), spectrum of the protons (b), angular distribution of the protons (c), and momentum distribution of the recoil-rest-nucleus (d) for ^{6}Li (e, e'p). Primary energy 2.7 GeV, electron detection angle 13.8^{o}. Protons with angles smaller than 58^{o} have not been detected.

DEUTERONS 10.5 fm^{-2}

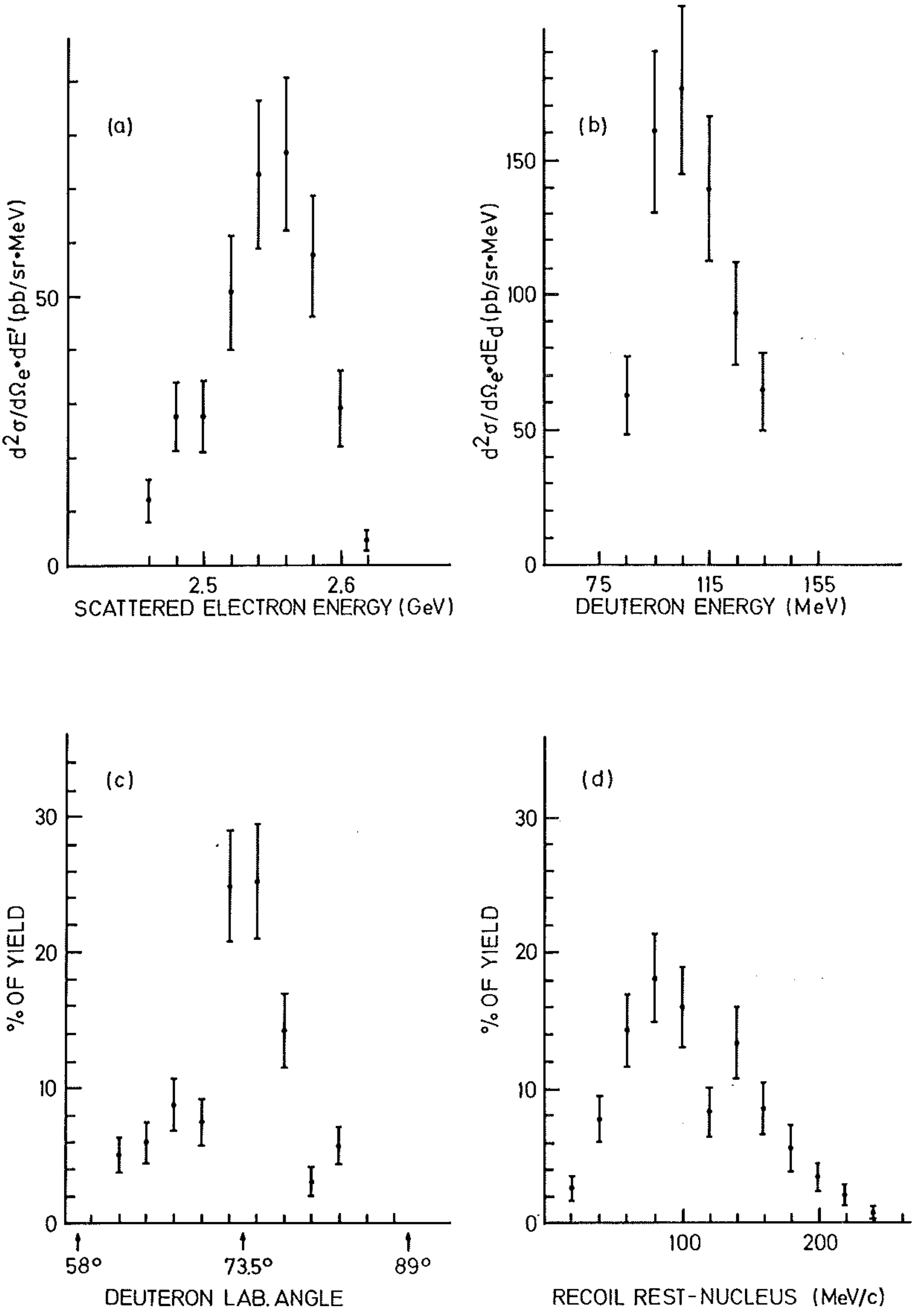

Fig. 1

PROTONS 10.5 fm^{-2}

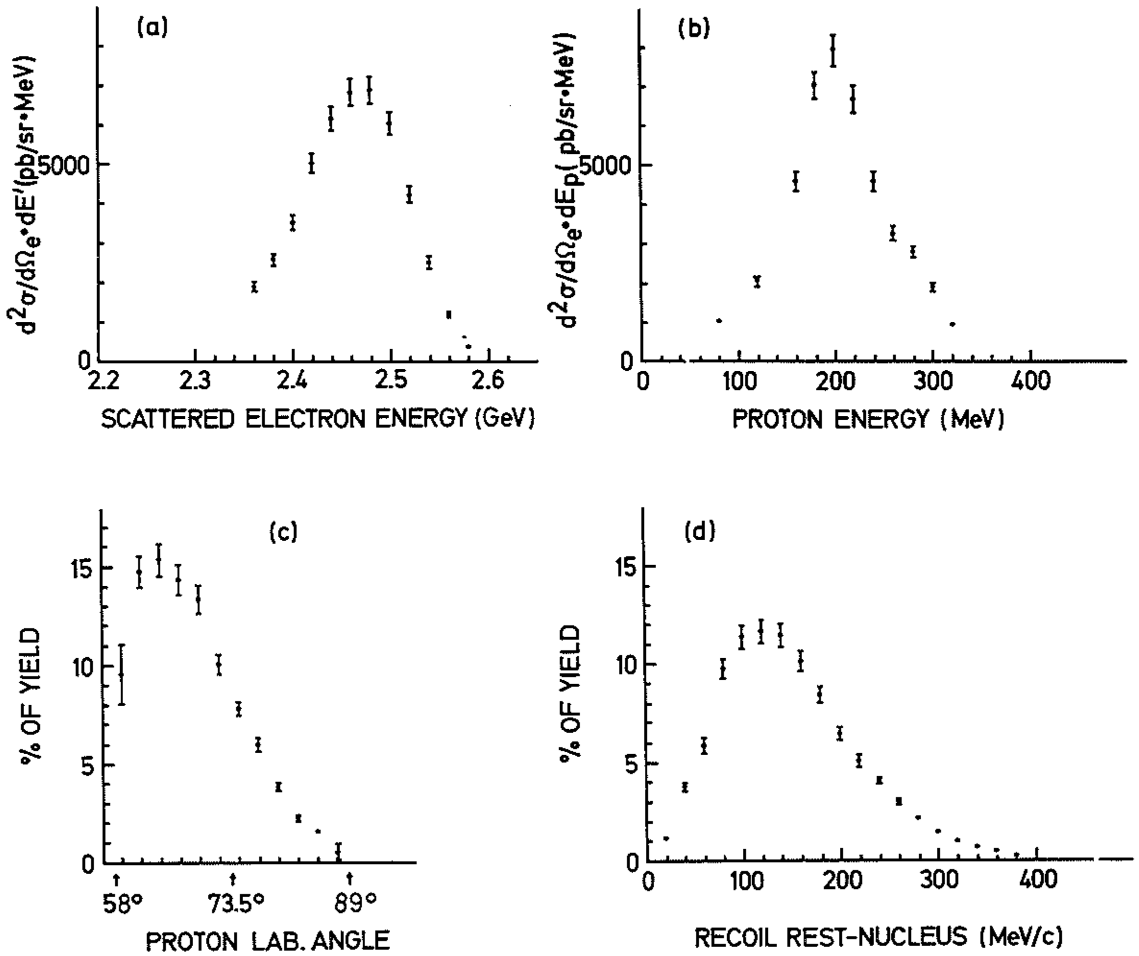

Fig. 2