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8.30 A New Type of Polarimeter for Vector- and Tensor- Polarized Deuterons in the Energy Range of 20 to 100 MeV

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To supplement measurements of the cross section and the vector analyzing power iT_{11} in π^+-d scattering[1], we have performed measurements of the energy and angular dependence of the tensor polarization t_{20} of the recoiling deuterons in an energy region between T_π = 100 MeV and T_π = 150 MeV[2]. These exhibit a significant structure in t_{20} at a total energy of 2.14 GeV, with a width of approximately 15 MeV. However, similar measurements described in ref. 3 show a disagreement in the sign of t_{20} in the more forward angular range. The rapidly oscillating structure in t_{20} could not be observed in ref. 3 since the energies and angles measured are different.

Both groups used ^{3}He(d,p)^{4}He as the polarimeter reaction and basically the same measuring technique, in which t_{20} is determined from the measurement of the absolute counting rates of incident deuterons and emitted protons in a high energy run with π^+. The polarimeter has to be previously calibrated in a low energy run with polarized deuterons.

To avoid the difficulties involved in determining absolute counting rates, and to attempt to resolve the sign disagreement, we have introduced an improved measuring technique which still uses the ^{3}He(d,p)^{4}He reaction, but which is independent of the absolute counting rate measurements and uses for the polarization measurements only ratios of counting rates recorded simultaneously at different reaction angles.

The geometry used is shown in fig. 1.

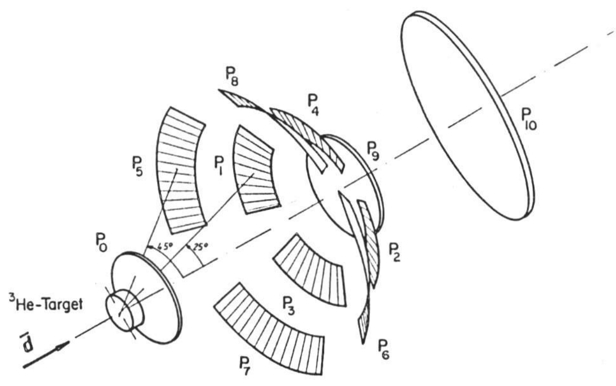

Fig. 1.

Schematic arrangement of the proton detectors. The deuterons from the d(π,π)d elastic scattering, enter from the left side and penetrate a ^{3}He gas cell. The counting rate of the ^{3}He(d,p)^{4}He protons is then measured, simultaneously, in the detectors P_0 to P_{10}.

The scattering angles are defined by these detectors using a coincidence technique.

To measure the vector polarization it_{11} and the three tensor components t_{21}, t_{22} and t_{20} simultaneously, it is necessary to detect the outgoing $^3He(d,p)$ protons at different scattering angles and azimuthal angles. As shown in fig. 1 we have chosen scattering angles $\theta = 0°$, $25°$ and $45°$ such that the interesting analyzing powers of the reaction are greatly different. This detector set-up allows the measurement of it_{11}, t_{21} and t_{22} twice from the 25° and 45° ring and t_{20} from the proton counting ratios between the 0°, 25° and 45° rings.

The polarimeter described was used for the first time in a test run where tests were performed to check the whole set up and make an initial calibration. With this partially calibrated polarimeter we were able to remeasure the t_{20} excitation curve of our old polarimeter at $\theta_{cm} = 150°$. These measurements are shown in fig, 2. The agreement in shape and amplitude between both data sets is excellent.

The present finding of a resonance-like behaviour in π^+-d scattering is supported by several missing mass experiments in light nuclei[4-6], which observe in the mass region 2.14 GeV a narrow structure corresponding to the structure seen in the present experiment.

Further support comes from a theory that is able to calculate longlived states in the N-Δ system[7], by introduction of an N-Δ interaction. This theory is able to describe our angular distribution measurement of t_{20} at T_π = 134 MeV[8] approximately in shape and magnitude[9].

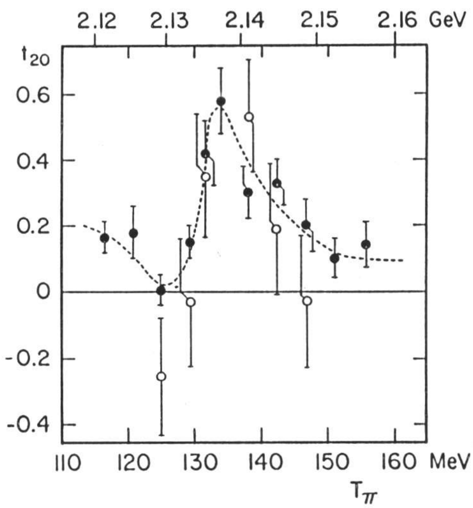

Fig. 2.

Excitation curve of t_{20} for θ_{cm} = 150° from the previous polarimeter (black dots) and the new polarimeter (open circles).

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