Measurements of the polarization transfer parameter K_{n00n} in *pp* scattering at 800–970 MeV

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Measurements of the angular dependence of the polarization-transfer parameter K_{n00n} over the interval of c.m. scattering angles (50%, 130%) at incident-proton energies of 850 and 900 MeV are reported. Measurements were taken at angles of 70°, 90°, and 110° at 800 MeV and at 90° at 970 MeV for comparison with results reported previously.

Resolving the question of the existence of dibaryon resonances in the two-proton system and determining the parameters of these resonances require measurements of a rather large number of polarization parameters over the energy interval 0.5–1.5 GeV. Phase-shift analyses[1,2] of the existing experimental data do not yield an unambiguous

set of partial-wave amplitudes at 800 MeV and above, and the conclusions regarding the characteristics of the resonance states are contradictory. In the interval 800–1000 MeV, corresponding to the high-energy decay of $^3F_3$ and $^1D_2$ resonances, the experimental evidence for determining the phase shifts for *pp* scattering is especially sparse. Until now, the minimum set of experiments[3]

$$\left\{\frac{d\sigma}{d\Omega},\ P_{n000}\,(A_{000n}),\ A_{00nn},\ D_{n0n0},\ K_{n00n}\right\},$$

required for determining the moduli of the spin amplitudes and for carrying out a phase-shift analysis was not available for this energy interval. In the present letter we report measurements of the parameter $K_{n00n}(\theta)$; these measurements, combined with the results of measurements of the parameter[4,5] A_{00nn}, make it possible to carry out a more systematic phase-shift analysis in this energy interval.

An unpolarized proton beam extracted from the synchrocyclotron of the Leningrad Institute of Nuclear Physics was slowed by polyethylene absorbers to energies of 800, 850, 900, and 970 MeV and directed by magnets to a "frozen" polarized proton target. The beam intensity was in the range $(1-2)\times10^8$ s^{-1}, and the beam dimensions were 2×2 cm^2.

The polarized proton target[6] consisted of 1,2-propanediol. The weight of the bombarded sample was about 10 g. The protons in the target were polarized in the direction perpendicular to the scattering plane. The polarization of the target protons was measured from the NMR signal with a statistical error of 0.5%; during the exposure, the polarization varied over the range 90–70%. In a field of 2.6 T at a temperature of 0.05 K and a beam intensity of 2×10^8 s^{-1}, the relaxation time was 200–300 h, while the polarization direction varied over 30 h.

TABLE I.

	E_p = 800 MeV	E_p = 850 MeV	E_p = 900 MeV
deg	K	K	K
50	–	0.547 ± 0.030	0.539 ± 0.044
60	–	0.664 ± 0.072	0.572 ± 0.037
70	0.630 ± 0.043	0.620 ± 0.045	0.651 ± 0.042
80	–	0.699 ± 0.055	0.686 ± 0.048
90	0.683 ± 0.042	0.663 ± 0.035	0.645 ± 0.040
100	–	0.680 ± 0.063	0.581 ± 0.046
110	0.719 ± 0.038	0.403 ± 0.034	0.636 ± 0.035
120	–	0.782 ± 0.044	0.709 ± 0.028
130	–	0.688 ± 0.035	0.665 ± 0.045

Cases of elastic pp scattering were identified on the basis of coincidences of the signals from two telescopes of scintillation counters with a solid angle of 7×10^{-4} sr. The background from the nuclear component of the frozen polarized proton target depends on the measurement angle, ranging from 6.7% for a c.m. angle of 50° to 18.6% for a c.m. angle of 90°. The polarization of the scattered protons and of the recoil protons, which depends on the parameter K_{n00n}, is measured with two polarimeters. Each polarimeter consists of four proportional chambers with coded information readout[7] and an analyzer target between two pairs of chambers. These polarimeters measure the angular distributions of the protons scattered by the carbon analyzer target. After subtraction of the background, the azimuthal asymmetry of the particle scattering, ε, is related to the value of K_{n00n}, the polarization for pp scattering, P_{n000}, the target polarization P_T, and the analyzing power of carbon, A_{pC}, by

$$\epsilon = A_{pC}(P_{n000} + K_{n00n}P_T)/(1+P_{n000}P_T), \tag{1}$$

Values of A_{pC}, averaged over the polar scattering angle in the interval $5°\leqslant\theta\leqslant13°$, were taken from the results of Ref. 8. The azimuthal asymmetry ϵ was measured at different signs of the polarization of the target, so that it was possible to eliminate the effect of a possible instrumental asymmetry and to weaken the dependence of the accuracy of the K_{n00n} calculations on the accuracy of the background measurements. To improve the accuracy of the determination of the primary K_{n00n}, we chose the P_{n000} values by averaging the worldwide data on the polarization in pp scattering in this energy interval.

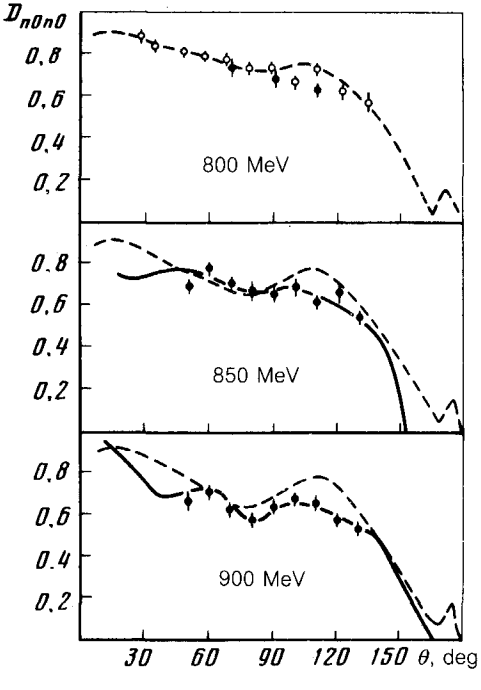

FIG. 1. Angular dependence of D_{n0n0} in the c.m. frame. ϕ—present study; ϕ—data of Ref. 9; solid lines—preliminary phase-shift analysis; dashed lines—phase-shift analysis of Arendt *et al.*[1]

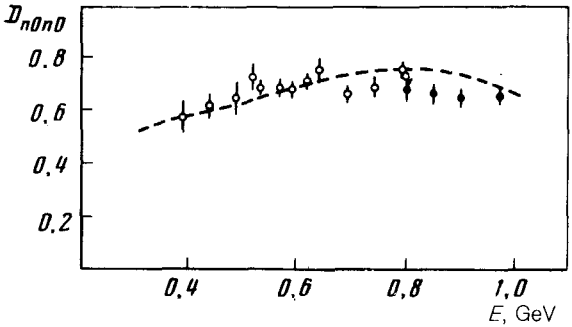

FIG. 2. Energy dependence of D_{n0n0} (90°). ⧫—present study; ⧫—data of Ref. 11.

Table I lists values of K_{n00n}, while Fig. 1 shows the angular dependence of the parameter $D_{n0n0}(\theta) = K_{n00n}(\pi - \theta)$ for the energies 800, 850, and 900 MeV. These are the first measurements of D_{n0n0} (K_{n00n}) at energies of 850 and 900 MeV. The agreement with the results of other studies at 800 MeV (Ref. 9) and 970 MeV (Ref. 10) is evidence that the measurement procedure is correct.

Figure 2 shows the energy dependence of the values $D_{n0n0}(90°) = K_{n00n}(90°)$ over the energy interval 0.4–1.0 GeV. Although we do not observe the clearly defined structural features which are characteristic of the energy dependence of the polarization correlation parameter[12] $C_{nn00}(90°) = A_{00nn}(90°)$, the energy dependence of the partial-wave amplitude for pp scattering in the states $^3P_2$, $^1D_2$, and $^3F_3$ is characterized by a resonance-like behavior. Such a behavior agrees with the results of a preliminary phase-shift analysis at 850 and 900 MeV which we have carried out.

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