ELASTIC pp SCATTERING IN THE REGION OF THE COULOMB INTERFERENCE AT MOMENTA 1.1 - 1.7 GeV/c

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Dutton et al. [1, 2] measured the differential cross section of elastic pp scattering in the momentum interval from 1.3 to 17 GeV/c. The data obtained there deviate strongly from the theoretical calculations based on the dispersion relations. For example, at 1.29 GeV/c the ratio of the real part of the spin-independent forward scattering amplitude $A_{ns}(0)$ to the imaginary part is $\alpha_{exp} = -0.76 \pm 0.13$, as against $\alpha_{theor} = 0.3$. The present study is devoted to this discrepancy.

To measure the differential small-angle pp-scattering cross section we used a new method, in which a pulsed ionization chamber filled with hydrogen served simultaneously as a gas target and as a recoil-proton detector (Fig. 1). An analysis of the signals from the chamber of electrons and of the signal delay times relative to the instant of passage of the scattered particle through the chamber has made it possible to determine the energy T_p and the emission angle ϕ of the recoil protons, and also to separate the gas-target volume inside the working volume of the chamber and to exclude background reactions. The number of protons passing through the chamber was determined by direct counting with a scintillation-counter telescope $S_1^{\wedge}S_2^{\wedge}S_3$. The pulses produced at the chamber electrodes by passage of the primary particles were compensated by a special circuit triggered by pulses from the counters $S_1^{\wedge}S_2$. The recoil protons were registered in the energy range from 1 to 4 MeV, and the sum of the pulses from the anode and the ring was used to measure energies above 3 MeV. The energy resolution (line width at half-height) was ~40 keV, the time resolution was 0.3 - 0.5 μsec, and the angle resolution from 0.5 to 5°. The gas-target volume was determined with approximate accuracy 2%. The entire information concerning the scattering act was fed through seven spectrometric channels to a computer. The linearity and stability of the amplitude and time channels and the efficiency of the registration of the events were all monitored continuously during the course of the measurements by using exact-amplitude generators.

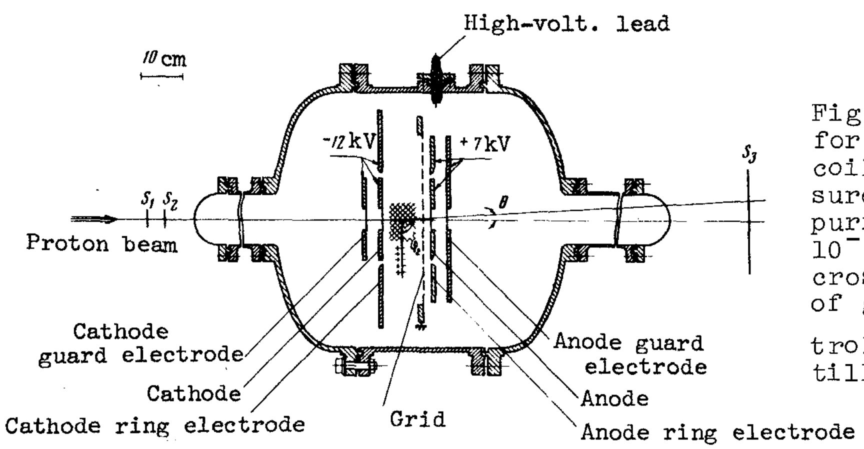

Fig. 1. Ionization chamber for the registration of recoil protons: hydrogen pressure in chamber 8 atm: impurity content: $N_2 < 6 \times 10^{-3}$%, $O_2 \leq 10^{-5}$ vol.%; cross-hatched area - volume of gas target. $S_1S_2S_3$ - controlling telescope of scintillation counters.

The experiment was performed with the extracted proton beam of the synchrocyclotron of our Institute. The beam filling factor was approximately 50%. The beam intensity was maintained at a level of 1.5×10^4 protons/sec, in which case the counting rate of the useful events was about 100 per hour. The measurements were made at energies 1000, 750, 700, 650, and 510 MeV, with copper absorbers used to decrease the beam energy. In this case the composition of the beam and the energy spectrum of the protons were monitored by measuring the time of flight. Figure 2 shows the measured differential cross sections. To determine the ratio Re $A_{ns}(0)$/Im $A_{ns}(0)$, we used the interference formula

$$\frac{d\sigma}{dT_p} = \left(\frac{d\sigma}{dT_p}\right)_{opt} \left[1 + \beta + \left(\alpha - \frac{A_c}{\mathrm{Im}\, A_{ns}(0)}\right)^2\right],$$

where α = Re $A_{ns}(0)$/Im $A_{ns}(0)$, $(d\sigma/dT_p)_{opt} = M\sigma_{tot}^2/8\pi$, β is a parameter that takes into account the contribution of the spin-dependent amplitudes, $A_c = k/137MT_p\beta_p$ is the Coulomb-scattering amplitude, Im $A_{ns}(0) = (k/4\pi)\sigma_{tot}$, T_p is the kinetic energy of the recoil proton, σ_{tot} is the total cross section of the pp interaction, M is the proton mass, β_p and

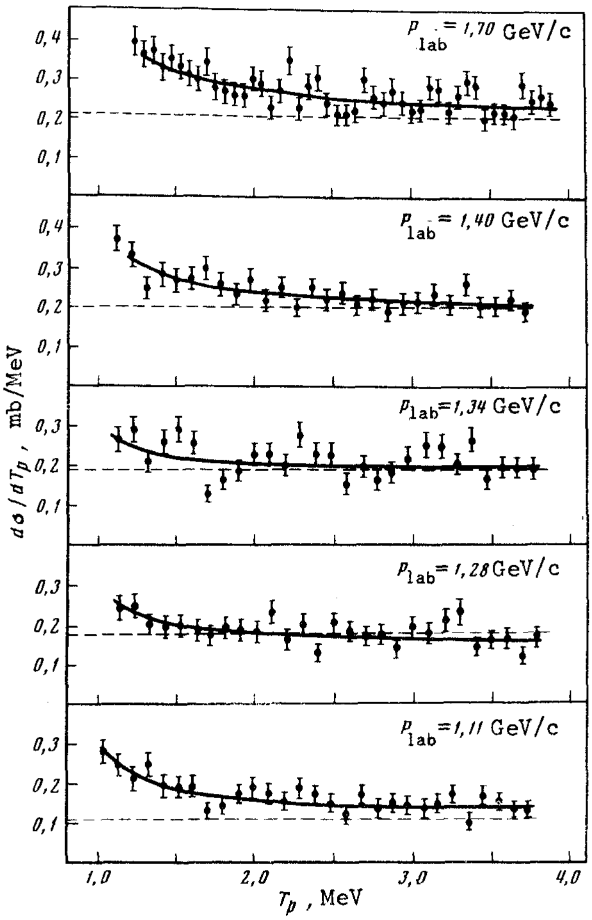

Fig. 2

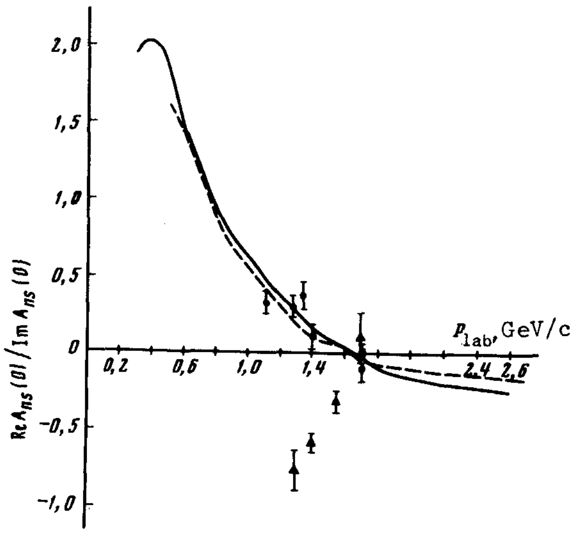

Fig. 3

Fig. 2. Differential cross sections of elastic pp scattering: solid lines - result of calculation by means of the interference formula, with the parameters listed in the table. The dashed lines represent $(d\sigma/dT_p)_{opt} = M\sigma_{tot}^2/8\pi$.

Fig. 3. Comparison of experimental and theoretical values of the ratio Re $A_{ns}(0)$/Im $A_{ns}(0)$. Solid and dashed lines - results of calculations by Barashenkov and Toneev [4] and by Dumbrais [5]. Triangles - results of Dutton et al. [1, 2]. Squares - results of Dowell et al [6]. Circles - our data.

p_{lab}, GeV/c	$\sigma_{tot}^{[3]}$, mb	α	β	χ^2	Degrees of freedom
1.11	34.03	0.32 ± 0.07	0.27 ± 0.06	28	27
1.28	43.23	0.29 ± 0.07	-0.06 ± 0.04	30	26
1.34	44.86[1)]	0.36 ± 0.08	0.06 ± 0.06	59	25
1.40	46.49	0.10 ± 0.08	0.01 ± 0.06	18	25
1.70	47.55	-0.10 ± 0.08	0.01 ± 0.08	48	43

[1)]Interpolated value.

k are the velocity and momentum of the incident proton, and $\hbar = c = 1$. The parameters α and β were fitted by least squares.

The results are listed in the table. Figure 3 shows the values of the parameter α, calculated on the basis of the dispersion relations, as well as the experimental data in the momentum interval 1.1 - 1.7 GeV/c. Our values of α agree well with the theoretical predictions and differ strongly from Dutton's data.

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SINGLE MUON SPECTRA IN THE PROCESSES $p + N \to \mu^+ + \mu^- +$ (HADRONS) AND $W(\to \mu + \nu)$ + (HARDONS) WITHIN THE FRAMEWORK OF THE PARTON MODEL

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In connection with the searches for the intermediate W boson in the reaction

$$p + N \to W^{\pm} + \text{hadrons} \quad (1)$$

with the accelerator of the Institute of High Energy Physics (IHEP) [1], it seems important to obtain theoretical estimates of the expected cross sections

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