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THE REAL PART OF THE ELASTIC p-p SCATTERING AMPLITUDE IN THE RANGE 2-10 GEV

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It was shown in papers [1,2] that the small angle differential cross-section for the elastic p-p scattering (without the Coulomb cross-section) at 6 and 10 GeV is greater that the optical point $[\frac{d\sigma}{d\Omega}|_{opt} = (\frac{k\sigma_t}{4\pi})^2$.

The effect observed is interpreted in two ways: either the scattering amplitude has a real part ($\frac{\mathrm{Re}\,A}{\mathrm{Im}\,A} \approx -0.4$) and then a constructive interference takes place, or the spin dependent term is significant.

In order to investigate the energy dependence of this effect the elastic p-p scattering was studied in the 2-10 GeV range. The method used and the analysis of the experimental data were the same as in [2].

The angular resolution of the scattered proton in this experiment was $10^{-3}-10^{-4}$ rad. in the laboratory system. Due to the great number of events (15000-20000 at each energy) the relative errors were 2,5-5 percent. The errors of the differential cross sections are due mainly to the error of the monitoring which is $\approx$ 7% and to the error of the optical point value of about 5%.

The analysis of the experimental data was carried out according to the Bethe formula [3]:

$$\frac{d\sigma}{d\Omega}(\theta) = g_o^2 + g_I^2(1+\beta^2) + \alpha^2 g_R^2 - 2g_o(\alpha g_R + \frac{2}{137\beta_\ell} g_I \ln \frac{1{,}06}{ka\theta})$$

Here

$$g_o = \frac{2}{137 k \beta_\ell} \cdot \frac{F(\theta)}{\theta^2}$$

is the Coulomb scattering amplitude

$$g_I = \sqrt{(\frac{d\sigma}{d\Omega})_{opt}} \cdot \exp[-\frac{\theta^2 \ln 2}{2\theta_I^2}],$$

$$g_R = \sqrt{(\frac{d\sigma}{d\Omega})_{opt}} \cdot \exp[-\frac{\theta^2 \ln 2}{2\theta_R^2}],$$

are the imaginary and the real part of the nuclear scattering amplitude respectively

$$F(\theta) = \exp[-\frac{\theta^2 \ln 2}{2\,\theta_I^2}].$$

is the formfactor of the nucleon; θ is the c.m.s. scattering angle, $\alpha = \frac{\mathrm{Re}\,A}{\mathrm{Im}\,A}$, β is a parameter that could explain the excess of the differential cross-section over the optical point without assuming a real part of the scattering amplitude; β_ℓ is the proton velocity in the laboratory system and a $\approx 10^{-13}$ cm is the nucleon radius. The parameters $\alpha, \beta, \theta_R, \theta_I$ which characterise the scattering amplitude are determined from experiment. The calculation showed that θ_I was equal to θ_R within the limits of errors, and for this reason an assumption $\theta_I = \theta_R$ was accepted in the final processing of the data.

The results obtained in the experiment are shown in Fig.1. The statistical errors and the errors due to all possible origins are given separately. In the whole investigated energy range there is a real part in the amplitude of the elastic p-p scattering. The values of $\alpha = \frac{\mathrm{Re}A}{\mathrm{Im}A}$ and χ^2-test at 2 and 10 GeV are given in table 1. It is seen that

Table 1

E GeV	α	χ^2	the number of degrees of freedom
2	0	61	14
	-0.17 ± 0.08	5	9
10	0	141	16
	-0.25 ± 0.07	10,9	11

the case $\alpha = 0$ (if there is no real part in the scattering amplitude) does not agree with the experimental data. The experiment could not be explained with a spin-dependent term ($\beta^2 = 0.0 \pm 0.1$).

However this experiment does not exclude the possibility that the scattering amplitudes in singlet and triplet states have a more complicated dependence on the scattering angle and which could also explain the experimental data (for instance, if the scattering amplitude in the singlet state is concentrated in the small angle region).

References

1. B.Bekker, L.Kirillova, A.Nomofilov, V.Nikitin, V.Pantuev, V.Sviridov, L.Strunov, M.Khachaturian and M.Shafranova, International Conference on High Energy Physics at CERN, 582 (1962).
2. L.F.Kirillova, V.A.Nikitin, A.A.Nomofilov, V.A.Sviridov, L.N.Strunov and M.G.Shafranova, JETP, 45, 1261 (1963).
3. H.Bethe. Ann. of Phys. 3, 190 (1958).
4. J.D.Dowell, R.J.Homer, A.H.Khan, W. K.Mc Farlane, J.S.C.Mc Kee and A.W A.W.o'Dell. Proc. Sienna Conference, 683 (1963).
5. P.Soding, Phys. Lett. 8, 286 (1963).

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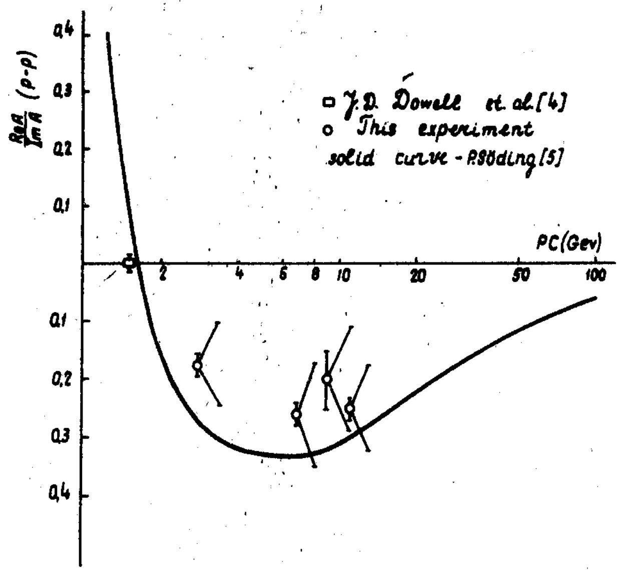

Fig. 1. The ratio of the real part of the amplitude of p-p elastic scattering to its imaginary part.