POLARIZATION IN pp ELASTIC SCATTERING AT LARGE MOMENTUM TRANSFERS*

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(Received 25 July 1968)

Measurements of the polarization in pp elastic scattering have been made at 5.15 GeV/c over the range $-t=0.2$ to 1.8 (GeV/c)^2. The data are compared with a Regge-pole model, and with the diffraction model of Durand and Lipes in which the absorptive part of the pp interaction is derived from the electromagnetic form factor of the proton. The latter model reproduces the t dependence of the experimental data in a qualitative way.

In an experiment still in progress at the zero-gradient synchrotron (ZGS) we have measured the polarization in pp elastic scattering at 5.15 GeV/c over the range $-t=0.2$ to 1.8 (GeV/c).[1] Previous measurements at high energies have been restricted to somewhat smaller momentum transfers [$-t<1.0$ (GeV/c)^2].[2,1]

The measurements were carried out with the Argonne polarized-proton target in a secondary beam in the external proton beam area of the ZGS. Threshold Cherenkov counters separated protons from pions and electrons in the secondary beam. Scintillation-counter hodoscopes in the beam gave information on the momentum, angle, and position of the particles incident on the polarized target, and crossed arrays of scintillation counters detected the scattered events. The counters were interfaced through electronic logic to an on-line computer which was capable of displaying distributions of the stored events and also scaler information sent to the computer between ZGS pulses.

Events due to pp elastic scattering were separated from other events on the basis of (1) two final-state particles detected, (2) coplanarity, and (3) angular correlation. Background events, which arose mainly from the complex nuclei of the *LMN* target, were subtracted from the free-proton elastic events both by curve fitting under the kinematic peak in the angular correlation, and by simulating the background beneath the peak by the use of non-coplanar events. The two methods gave results which agree closely.

The sign of the target polarization (typically 55%) was reversed every six hours. Seven such runs for each sign of target polarization were made to obtain the data reported here. The total number of incident protons was about 4×10^{10}.

The results are shown in Fig. 1. The experimental points at $-t\leq0.5$ are in agreement with earlier measurements at Berkeley at 4.84 GeV/c.[2]

Data at lower momenta (1.92 to 3.66 GeV/c) suggest that the polarization becomes small (perhaps consistent with zero) for $-t$ larger than about 0.8-1.0.[3,4] We indeed find a dip in this region but the polarization is definitely nonzero. For $-t>1.0$ the polarization becomes comparatively large. We note that the dip in the polarization occurs near $t=-0.85$ which corresponds to the first break or change of slope of the angular distribution at this momentum.[5]

Also shown in Fig. 1 is the prediction of a Regge-pole model.[6] The model makes no prediction for $-t>1.0$. Unfortunately our data can neither support nor reject the striking t dependence of the model for $-t<0.15$.

In a recent Letter, Durand and Lipes described a diffraction model for high-energy pp scattering

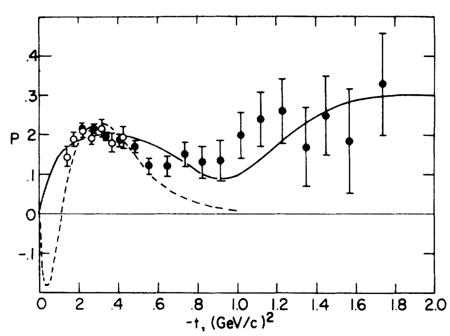

FIG. 1. Polarization in pp elastic scattering at 5.15 GeV/c. Results from this experiment are shown as closed circles. The open circles are the results at 4.84 GeV/c from Ref. 1. There is about a ±10% normalization error in both sets of data. The solid curve is the prediction of the model of Ref. 7 (see also Ref. 8); the dashed curve, of Ref. 6. Both curves have been arbitrarily normalized.

in which the spatial dependence of the interaction is taken from the electromagnetic form factor of the proton.[7] In addition to the absorptive part of the interaction coming from the form factor, a real part, corresponding to refraction in an optical model, and a spin-orbit interaction are included in the model. The spatial dependence of the spin-orbit interaction is rather arbitrary and was chosen so as to fit the high-energy pp polarization data which are available for $-t<0.8$ $(\mathrm{GeV}/c)^2$.[2] The solid curve in Fig. 1 shows the prediction of the model. This curve differs considerably from curve a in Fig. 2 of Ref. 7. According to the authors, the real part of the scattering amplitude was not included in a consistent way in their calculation of the polarization. The solid curve in our Fig. 1 is the result of their corrected calculation.[8] The overall normalization of the polarization in the model is arbitrary. We chose the normalization to give $P=0.2$ at the peak at small $|t|$.

The model is, very qualitatively, in agreement with the data. Both exhibit a dip, with the polarization becoming somewhat larger at large momentum transfers than it is in the forward peak.

We sincerely thank the many members of the Enrico Fermi Institute and of the Particle Accelerator and High Energy Facilities Divisions at Argonne for their assistance and cooperation.

*Work supported by the National Science Foundation under Grant No. GP-6135 (with some assistance from Grant No. GU-2175) and in part by the U. S. Atomic Energy Commission.

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RENORMALIZATION GROUPS

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(Received 24 June 1968)

General renormalization transformations are defined. In case they build up a group, the renormalization group, some of its properties are indicated and finally some physical consequences are sketched.

The renormalization group has been widely used for the determination of the asymptotic behavior of Feynman graphs or for the summation of certain classes of such graphs.[1] In this note, we want to build up a general scheme, to define in its full generality the renormalization group and sketch some of its physical applications. We consider the mth radiative correction of the time-ordered product of N field operators:

$$\Delta^{N,m}(x,\kappa)\equiv\Delta^{N,m}(x_1\cdots x_N,\kappa), \tag{1}$$

where the $\Delta^{N,m}$ are Lorentz scalars and κ is a parameter of the theory, the so-called squared mass $(\kappa=m^2)$ of the particles of the field. We suppose furthermore that we are dealing with regularized $\Delta^{N,m}$ (by a spreading in space and time of the interaction) or with a renormalized theory; in any case, the $\Delta^{N,m}$ will be either analytic functions of the regularization parameter or tempered distributions in the variables x.