Oscillation of the spin-correlation parameters

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A model developed previously for the description of spin effects [S. M. Troshin and N. E. Tyurin, Hadronic J. **6**, 259 (1983); Phys. Lett. **144B**, 260 (1984); J. de Physique **46**, C2-235 (1985)] reproduces the experimental energy dependence of the parameter A_{nn} at ZGS (ANL) and AGS (BNL) energies and fixed value of $p_\perp$.

Troshin and Tyurin[1] analyzed on the basis of the quark model for the U matrix[2] the behavior of the spin-correlation parameters A_{nn}, A_{ll}, and A_{ss} in the elastic pp scattering at large angles. They predicted that the dependence of the parameters A_{nn} and A_{ll} will oscillate as a function of the energy at a fixed scattering angle. A comparison with the experimental data at $\theta_{\text{c.m.}} = 90°$ showed good agreement. They have also found that the oscillation of the parameter A_{nn} $(s, 90°)$ is the same in nature as that of $d\sigma/dt$ $(s, 90°)$.

In the studies of Troshin and Tyurin[1] the principal attention was given to the elastic pp scattering at 90° because of the availability of experimental data for this scattering angle. From this model we can also obtain expressions for the spin-correlation parameters for arbitrary angles. An interest in this study has arisen because of the publication of new experimental data[3] which were recently obtained at AGS. At 18.5 GeV/c the parameter A_{nn} was found to be $A_{nn} = -2 \pm 16\%$ at $p_\perp^2 = 4.7$ $(\text{GeV}/c)^2$. This result supports the conclusion that the behavior of the parameter A_{nn} is oscillatory in nature.

In terms of the model which we are using, we can write the expression for the parameter A_{nn} at large angles in the form

$$A_{nn}(s,\theta) = \left(1 + \left(\frac{t}{u}\right)^{3/2} + \left(\frac{u}{t}\right)^{3/2}\right)^{-1} \left\{1 + \frac{6m_q^2}{(1-k)^2 s}\left[1 + \frac{2}{N}(1-\kappa)\right]\cos 2\Delta(s)\right.$$

$$\times\left[\left(1 + \left(\frac{t}{u}\right)^{3/2} + \left(\frac{u}{t}\right)^{3/2}\right)^{-1} - \frac{1}{3}\left(1 + 2\left(\frac{t}{u}\right)^{3/2} + 2\left(\frac{u}{t}\right)^{3/2}\right)\right] + \frac{2}{(1-k)^2 N^2 s}(tu)^{-1/2}(t-u)^2$$

$$\left.\times\left(1 - \frac{2}{1 + \left(\frac{u}{t}\right)^{3/2} + \left(\frac{t}{u}\right)^{3/2}}\right)\right\}. \qquad (1)$$

The corresponding expressions for the amplitudes are given in Refs. 1. In Eq. (1) $m_q = m_u = m_d$ is the mass of the valence quark, the factor $\kappa > 1$ takes into account a more-central mechanism for the scattering of a quark with a change in the helicity, $N = n_1 + n_2$ is the total number of valence quarks, and k is the fraction of the hadron energy carried by valence quarks. The function $\Delta(s) = \varphi_f(s) - \varphi_0(s)$ is the difference in the phase factors which describe the scattering of quarks with a change in the helicity and without such a change, respectively.

The use of expression (1) in the calculation of the spin-correlation parameter gives the value $A_{nn} = -6\%$ for $p_L = 18.5$ GeV/c and $p_\perp^2 = 4.7$ (GeV/c)^2 ($\theta_{\text{c.m.}} = 46°$). We have used here the parameter values which were used to describe the parameter A_{nn} at $\theta_{\text{c.m.}} = 90°$ (Ref. 1). The behavior of the parameter A_{nn} with

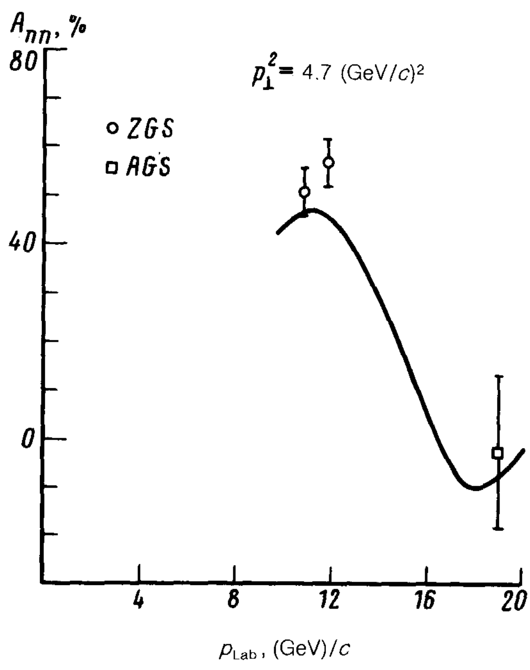

FIG. 1.

increasing energy and fixed $p_\perp$ is described in Fig. 1. At energies above 18.5 GeV/c, the parameter A_{nn} must, according to Eq. (1), again change sign at $p_L \simeq 20$ GeV/c.

The behavior of the spin-correlation parameter upon transition from ZGS energies to AGS energies at constant $p_\perp$ is traceable to two factors: (1) a decrease in A_{nn} as the angle $\theta_{\text{c.m.}}$ is reduced from 90° to smaller angles and (2) the energy-dependent superimposable oscillations.

The energy oscillations of the spin-correlation parameters are dynamic in nature. On the basis of the present model it can apparently be concluded that the scattering of valence quarks is accompanied by resonance effects.

The new data obtained at AGS support the conclusion that the spin effects in the hadron interactions at high energies are important effects.

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[1]S. M. Troshin and N. E. Tyurin, Hadronic J. **6**, 259 (1983); Phys. Lett. **144B**, 260 (1984); J. de Physique **46**, C2-235 (1985).
[2]S. M. Troshin and N. E. Tyurin, Preprint IHEP 83-62, Serpukhov, 1983.
[3]G. R. Court *et al.*, Preprint UM HE 86-03, 1986.

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