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5.2 Polarization Calculations for Exotic Exchange Reactions

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A rescattering box model is presented in which we assume that the exotic exchange reaction $K^-p \to \pi^+\Sigma^-$ occurs as a resuslt of two-steps processes $K^-p \to \rho^0\Lambda \to \pi^+\Sigma^-$ and each step of this process is evaluated under t-channel single-pole approximation. The imaginary part thus obtained when multiplied by the real contributions of one-particle exchange diagrams given by Λ, Σ and $Y_1^*(1385)$ s-channel pole terms, can be used to calculate polarisation for Σ^- in the above exotic exchange process. It should be noted that these reactions are forbidden in single-meson exchange and the reaction mechanisms involving resonance formations or baryon exchanges, are not able to explain the main features of angular distributions and the energy dependence of the cross-section[1-3].

In this model, we calculate the contribution to the invariant amplitudes A and B from Λ, Σ and $Y_1^*(1385)$ pole terms in the s-channel. These are the real part of the amplitudes. The imaginary parts of the invariant amplitudes are obtained[4] from the rescattering box diagram $K^-p \to \rho\Lambda \to \pi^+\Sigma^+$ which involves ρ and Λ on the mass-shell and K, π exchanges in the t-channel. Finally we get the expression for polarisation as follows:

$$P\frac{d\sigma}{dt} = \frac{|\vec{q}_1|}{|\vec{q}_2|} \frac{1}{16\pi\sqrt{s}} \sin\theta \left[A_\Lambda + A_\Sigma + A_{Y_1^*}\right) \mathrm{Im}\, B_{box} - \left(B_\Lambda + B_\Sigma + B_{Y_1^*}\right) \mathrm{Im}\, A_{box}]$$

where $|\vec{q}_1|$, $|\vec{q}_2|$ are the c.m. momentum of initial and final particles, respectively, $\sqrt{s}$ is the total c.m. energy and θ is the scattering angle.

The result of our calculation are shown in Fig.1. We find that the cross-over feature of the polarisation is explained in a natural way by our model. This feature is further supported by the explanations[5,6] offered by our model to the presence of Odorico zeros[7] at small values of t in the invariant amplitude. We have already shown that the production angular distributions and the energy dependence of the cross-sections as calculated by our model are compatible with the experimental results.

In conclusion, these calculations show that the box-diagram amplitudes for the exotic exchange processes constructed from an iteration of amplitudes without exotic exchange connected by on mass-shell two-body or quasi-two-body intermediate states play a dominant role in hadron-hadron scattering in the intermediate energy region (i.e. below the incident beam momentum of 5 GeV/c) where the theoretical knowledge is quite poor. Under such circumstances, our model based on s-channel description gives good agreement in the production angular distributions, energy dependence of the cross-section, and polarization calculations for the process under consideration. We would like to emphasize our assumption that the imaginary part obtained from the s-channel discontinuity can be coupled with the real part of the amplitude obtained from the poles in the s-channel to calculate the polarization. In doing this, we have neglected the u-channel effects. To be more explicit, we assume that in the intermediate energy region, $K^-p \to \pi^+\Sigma^-$ is peripheral and it is dominated by the nearby singularities. Finally the two-meson exchange rescattering box diagram presented here gives a good description of the exotic exchange processes where we do not have any other simple explanation.

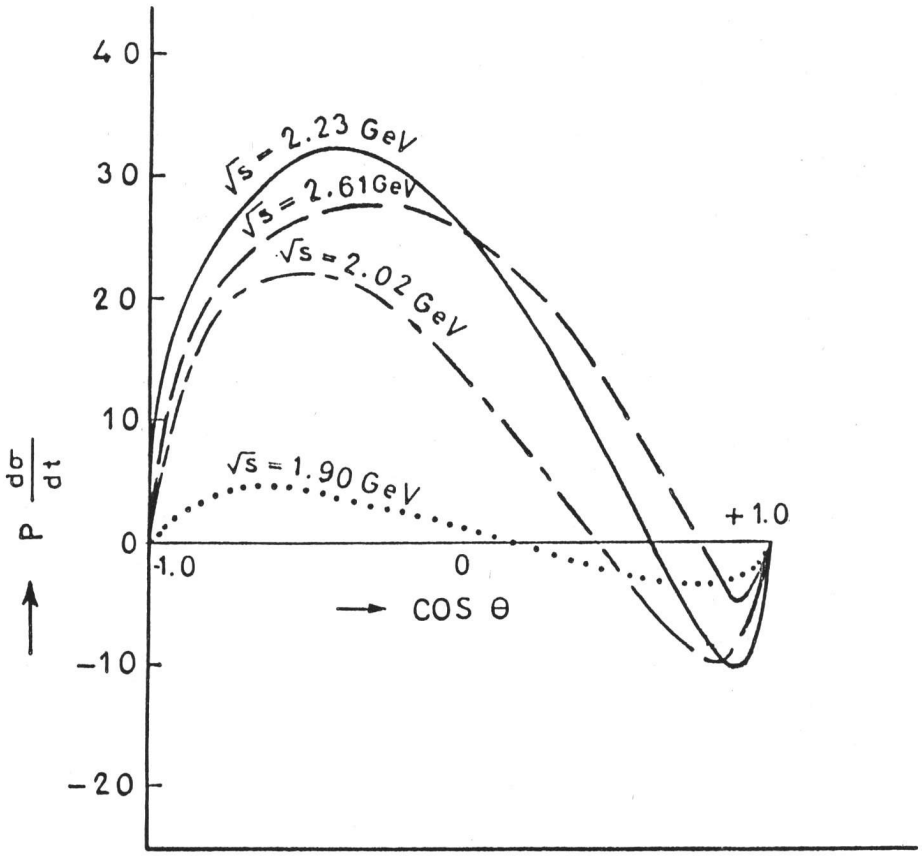

Fig.1: Polarization $P\frac{d\sigma}{dt}$ for Σ^- at centre-of-mass energies 1.90, 2.02, 2.23 and 2.61 GeV, respectively.

References

1) P.N. Dauber et al. Phys. Lett. 62B,(1969) 303.
2) C.P.Singh and B.K. Agarwal, Phys. Rev. 177 (1969) 2350.
3) A.B. Saxena, B.K. Agarwal and C.P.Singh, Phys. Rev. D 1, (1970) 358.
4) C.P. Singh, J. Phys. A 6, (1973) L13.
5) C.P. Singh, J. Phys. A 7, (1974) L1.
6) C.P. Singh, Phys. Rev. D 13, (1976) 767.
7) R. Odorico, Phys. Lett. 34B, (1971) 65.