The Explicit Procedures for Reconstruction of Full Set of Helicity Amplitudes in Elastic Proton-Proton and Proton-Antiproton Collisions

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Elastic scattering of hadrons has always been a crucial tool for study the dynamics of strong interaction. In the absence of the complete theory of strong interaction the predictions or interpretation of the experimental observables are furnished by the phenomenological approaches. One of the reliable approaches is the asymptotical model. One may refer to the several well-known predictions of such model like the upper limit for growth of the total cross-section (Froissart limit), equality of the proton-proton and proton-antiproton total cross-sections (Pomeranchuk's theorem), equality of the differential cross-sections for the proton-proton and proton-antiproton elastic scattering, equality of the polarizations (in modulo) in crossing channels for binary reactions, or γ_5 - invariance hypothesis leading to zero polarizations. But none of these predictions is strongly confirmed yet in experiments. Other models (like Regge model) suffer from necessity to introduce many free parameters which should be defined by fitting to the experimental data. In such a situation the direct reconstruction of the scattering matrix from the complete set of the experimental data will be the appropriate method. Unfortunately such set of experiments were never been fulfilled in the high energy region. We hope that such program will be realized at RHIC, PAX and other facilities in near future. In order to make the predictions for the measurable observables in those facilities one needs to have a method which should be well justified, contains a small number of free parameters and applicable at wide range of the kinematics variables. The joint consideration of proton-proton and proton-antiproton elastic scattering provides the unique opportunity for model independent reconstruction of full sets of helicity amplitudes.

The explicit procedures are described for reconstruction of the full set of helicity amplitudes in proton-proton and proton-antiproton elastic scatterings. The procedures are based on the derivative relations for the helicity amplitudes, the explicit parametrization of the leading spin non flip amplitudes and crossing - symmetry relations. Asymptotic theorems are used for definition of free parameters in derivative relations. We also study the Odderon influence in the helicity amplitude reconstruction. Reconstruction procedures are model independent and are valid at extremely wide initial energy domain and wide range of square of momentum transfer. These procedures might be useful in studying the spin phenomena in proton-proton and proton-antiproton elastic scattering at high energy.

The description of high-energy soft processes is one of the most important, fundamental and difficult problem of high-energy physics at present. The beginning RHIC operation with polarized proton beams, PAX project at FAIR for polarized antiproton beams provide unique opportunities for the joint investigation of elastic scattering and spin phenomena in wide energy region.