Asymmetries in Peripheral Spin Dependent Elastic Collisions

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A study of polarization observables in the domain of low momentum transfer provides important information on high energy spin dependence in hadronic elastic and diffractive processes. Recent measurements of the single spin analyzing power for low angle proton proton elastic collisions at energies of

$$\sqrt{s} \,=\, 13.7 \text{ GeV} \quad \text{and} \quad \sqrt{s} \,=\, 200 \text{ GeV}$$

in two significant experiments at the Relativistic Heavy Ion Collider indicate impressively low bounds on the magnitude of the single helicity flip hadronic amplitude. Such estimates have been evaluated in the region of peripheral scattering where electromagnetic and strong interaction effects are comparable.

The bound on the single flip hadronic amplitude relies to a degree on knowledge of the spin averaged proton proton hadronic amplitude, and to a lesser extent on the relative size of double helicity flip hadronic amplitudes, particularly their imaginary parts in the form, for example, of

$$\frac{\Delta\sigma_{\rm T}(s)}{2\,\sigma_{\rm tot}(s)} \,=\, 1 \,-\, \frac{\sigma_{\uparrow\uparrow}(s)}{\sigma_{\rm tot}(s)}$$

involving the difference between the parallel and antiparallel transversely polarized proton proton total cross sections. In addition, longitudinal cross section differences play a rôle as do the phases associated with the Coulomb shift and the hadronic helicity non-flip amplitude.

A study of such contributions to the maximum of the asymmetry $A_{\rm N}$ seeks to emphasise the importance of evaluating all of the helicity dependent hadronic amplitudes through further measurememts of spin observables in the low momentum transfer region at a number of energies and over a range of nuclei of different spins. Nothing should be left undone on the margin of the impossible in striving to understand the spin dynamics of non-perturbative QCD.