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Proton spin at small-x

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Resolution of the proton spin puzzle, which is inability of the constituent quark model to explain discrepancy between the spin-$1/2$ of the proton and the amount of spin carried by its quarks and gluons, as measured in experiment, is an outstanding problem in modern hadronic physics. One possibility is that "missing"spin of the proton may be found at small values of Bjorken-x. I'll give an overview of the current status of the theory of spin at small-x. Starting with a conventional approach which is based on a high-energy expansion in the shock-wave background, I'll discuss the small-x evolution of the gluon and flavour-singlet quark helicity distributions. The evolution contains mixing between different types of operators appearing as sub-eikonal corrections to the leading order shock-wave approximation. The evolution is consistent with the spin-dependent DGLAP evolution at small-x. At the same time, I'll show that the helicity evolution doesn't provide a complete picture of the problem since it lacks the anomaly contribution. I'll demonstrate that there is a class of spin-dependent observables which are dominated by the triangle anomaly in both Bjorken ($Q^2 \to \infty$) and Regge ($x_B \to 0$) asymptotics. The anomaly manifests itself as an infrared pole which appears in both limits. The cancellation of this pole involves a subtle interplay of perturbative and nonperturbative physics that is deeply related to the $U_A(1)$ problem in QCD. I'll demonstrate the fundamental role played by a Wess-Zumino-Witten term, coupling the topological charge density to a "primordial"isosinglet meson, both in the cancellation of the infrared pole and topological mass generation of the eta prime meson. I'll argue that such topological effects can be measured in polarized DIS at a future Electron-Ion Collider.

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