Gluon Polarization in Nucleons ◇

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In QCD the gauge-invariant gluon polarization ΔG in a nucleon can be defined either in a non-local way as the integral over the Ioffe-time distribution of polarized gluons, or in light-cone gauge as the forward matrix element of the local topological current. We have investigated both possibilities within the framework of QCD sum rules. Although the topological current is built from local fields, we have found that its matrix element retains sensitivity to large longitudinal distances. Because QCD sum rules produce artificial oscillations of the Ioffe-time distribution of polarized glue at moderate and large light-like distances, the calculation of the matrix element of the topological current results in a small value of $\Delta G(\mu^2 \sim 1GeV^2) \approx 0.6 \pm 0.2$. In a more consistent approach QCD sum rules are used to describe the polarized gluon distribution only at small light-like distances. Assuming that significant contributions to ΔG arise only from longitudinal length scales not larger than the nucleon size leads to $\Delta G(\mu^2 \sim 1GeV^2) \approx 2 \pm 1$.

Z. Phys. **C**, in print

◇ Supported by BMBF project 06 TM 878

X_{cJ} Production in e^+e^- Annihilation ◇

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Inclusive production of X_{cJ} in e^+e^- annihilation is an excellent probe of the role of higher Fock states in the production of heavy quarkonia. Within the non-relativistic QCD approach, contributions from the short-distance production of colour-octet $c\bar{c}$ pairs are significantly larger than those from colour-singlet production. At the same time, they are significantly smaller than expected in the colour evaporation approach. Measurements of X_{cJ} production at CLEO and future B-factories will thus constitute a major test of theoretical approaches to the production of quarkonium.

◇ Supported by BMBF project 06 TM 876

Chiral Constituent Quarks and Their Role in Quark Distribution Functions of Nucleon and Pion ◇

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We investigate the structure of constituent quarks and study consequences for quark distribution functions of hadrons. Constituent quarks are constructed by dressing bare quarks with Goldstone bosons using the chiral quark model. We calculate resulting corrections to the twist-2 structure functions $f_1(x)$, $g_1(x)$ and $h_1(x)$. The Goldstone boson fluctuations produce a flavor asymmetry of the quark distribution in the nucleon in agreement with experiments. They also generate significant depolarization effects which reduce the fraction of the nucleon spin carried by quarks. Corrections to the transversity spin structure function $h_1(x)$ differ from those to $g_1(x)$, and in particular we find a large reduction (40%) of the d-quark tensor charge, which is consistent with recent lattice calculations. We also study the pion structure function and find the momentum fraction carried by the sea quarks in the pion to be considerably larger than that in the nucleon.

submitted to Nuclear Physics **A**

◇ Supported by BMBF project 06 TM 876 and Alexander von Humboldt Foundation