Chiral symmetry and non-perturbative transversity

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Transversity distributions are unique in the sense that they are related to hadronic matrix elements of *chirally odd* operators in QCD. In contrast, all known low–energy probes of hadrons (e.m. and weak currents) as well as the "usual" unpolarized or longitudinally polarized distributions correspond to *chirally even* operators. Since chiral symmetry is spontaneously broken in the QCD vacuum, hadrons can be expected to react very differently to chirally odd probes as compared to chirally even ones.

In this talk we review the results of a study of the transversity distributions at a low scale ($\mu \sim 600\,\mathrm{MeV}$) in the large–$N_c$ limit of QCD, where the nucleon can be described as a chiral soliton [1, 2]. Quantitative estimates are obtained within a particular realization of this picture based on the effective low–energy theory derived from the instanton model of the QCD vacuum (chiral quark–soliton model) [3, 4]. This approach gives a very realistic description of the "usual" unpolarized and longitudinally polarized quark– and antiquark distributions [5].

The main results can be summarized as follows:

- The *isovector* transversity distributions, $\delta u(x) - \delta d(x)$ and $\delta\bar{u}(x) - \delta\bar{d}(x)$, are leading in the $1/N_c$–expansion compared to the *isoscalar* ones, $\delta u(x) + \delta d(x)$ and $\delta\bar{u}(x) + \delta\bar{d}(x)$, and found to be numerically large in the model calculations.

- The *quark* transversity distributions, $\delta u(x) \pm \delta d(x)$, are similar in shape and magnitude to the longitudinally polarized quark distributions $\Delta u(x) \pm \Delta d(x)$.

- The *antiquark* transversity distributions behave very differently from their longitudinally polarized counterparts. In particular, the flavor asymmetry of the antiquark transversity distribution $\delta\bar{u}(x) - \delta\bar{d}(x)$ is *much smaller* than that of the longitudinally polarized distribution $\Delta\bar{u}(x) - \Delta\bar{d}(x)$. This can be unterstood as a consequence of the differences between the chirally odd and even twist–2 operators when "bosonizing" them in the large–N_c limit.

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