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Proton structure in a light-front quark-diquark model

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We present a quark-diquark model for nucleons where the light front wave functions are constructed form the soft-wall AdS/QCD prediction. The model is consistent with quark counting rule and Drell-Yan-West relation. The scale evolution of the PDFs are simulated by making parameters scale dependent. The model reproduces the scale evolution of unpolarized PDF for a wide range of energy scale and matches accurately with the HERAPDF15(nnlo), MSTW2008(nnlo), NNPDF21(nnlo). The helicity and transversity PDFs predicted in this model agree with phenomenological fits. The axial and tensor charges are shown to agree with experimental data.

We further investigate the transverse momentum $\mathbf{p}_\perp$ dependent parton distribution functions(TMDs) for both T-even and T-odd sector at the leading twist. In this model the pretzelosity TMDs, $h_{1T}^{\perp}(x, \mathbf{p}_\perp^2)$, are found to be negative for u quark and positive for d quark as predicted by phenomenology and most of the models e.g, Bag Model, CQM etc. Interestingly, though not explicit, our model has implicit $x - \mathbf{p}_\perp^2$ factorization which is assumed in phenomenological extraction of TMDs. The final state interaction produces a complex phase which can be included in LFWFs to calculate the Sivers functions $f_{1T}^{\perp}(x, \mathbf{p}_\perp^2)$ and Boer-Mulders functions $h_1^{\perp}(x, \mathbf{p}_\perp^2)$. We compare our results to the experimental data of SSAs and find reasonably good agreements.

We also investigate the more general five dimensional Wigner distributions for both u and d quarks in a proton and calculate the GTMDs. We present a detailed study of the quark orbital angular momentum and its correlation with the quark spin and the proton spin. The quark density distributions with the different polarizations of quarks and proton are presented in transverse momentum plane as well as in transverse impact parameter plane.

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