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Parton Degrees of Freedom: Connected and Disconnected Sea Partons from CT18 Parametrization of PDFs

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We point out a problem in the phenomenological definition of the valence partons inside the proton. Parton degrees of freedom are definitively classified in the Euclidean path-integral formulation of the hadronic tensor in QCD. They include the valence and connected sea partons, the connected sea antipartons, and the disconnected sea partons and antipartons. We resolve the problem by showing that the proper definition of the valence partons should be in terms of those in the connected insertions only. It is advocated that the connected sea and the disconnected sea should be separated in the global analysis of the PDFs. This allows a direct comparison of moments of PDF with the individual lattice matrix elements for the u , d , and s partons in the connected and disconnected insertions respectively.

In this study, the separation of the connected and disconnected sea partons is accommodated with the CT18 parametrization of the global analysis of the parton distribution functions (PDFs). This is achieved with the help of the distinct small x behaviors of these two sea partons and the constraint from the lattice calculation of the ratio of the strange momentum fraction to that of the \bar{u} or \bar{d} in the disconnected insertion. We compare the resulting PDFs of this new fit, using the same data set as the original CT18 fits, with the published CT18 family of PDFs. We also compare the predicted cross sections for W^\pm and Z productions at the LHC energies.

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