

Higgs Production at High x_F at the LHC and PQCD Predictions without Renormalization Scale or Scheme Ambiguities

I will discuss a novel mechanism for the production of the Higgs boson in inclusive hadronic collisions, which utilizes the presence of multi-connected intrinsic heavy quarks in the proton's $|uudQ\bar{Q}\rangle$ light-front wave function(LFWF). In these inclusive reactions, the Higgs boson acquires the momentum of both the heavy quark and antiquark and thus carries 80\% or more of the projectile proton's momentum. This novel physics is important for Higgs dynamics since it provides new sensitivity to the Yukawa couplings of the Higgs to charm and bottom quarks.

The proton's LFWF is maximal at minimal offshellness; i.e., when the constituents have the same rapidity; i.e., $x_Q \propto \sqrt{m_Q^2 + k_{\perp Q}^2}$. Experiments at the ISR and FermiLab observed Λ_c , Λ_b , and even double-charm baryons hadroproduction at high x_F . NA3 also observed single and double J/ψ hadroproduction at high x_F and the EMC experiment at CERN measured $c(x, Q)$ at high x_{Bj} . The same intrinsic heavy quark QCD dynamics that produces the J/ψ at high x_F will produce the Higgs at high x_F .

We predict that the cross section for the inclusive production of the Standard Model Higgs coming from intrinsic bottom Fock states is of order 150 fb at LHC energies, peaking in the region of $x_F \simeq 0.9$. The corresponding cross section coming from gluon - gluon fusion is relatively negligible. New forward detectors will be required at the LHC, e.g. for detecting forward detection of four muons.

$pp \rightarrow H + X \rightarrow Z^0 Z^* + X \rightarrow (\mu^+ \mu^-) + \mu^+ \mu^- + X$.

We also propose a related novel mechanism for exclusive diffractive Higgs production $pp \rightarrow Hpp$ in which the Higgs boson also carries a significant fraction of the projectile proton momentum.

See: S.J. Brodsky, A.S.Goldhaber, B.Z. Kopeliovich and I. Schmidt,

"Higgs Hadroproduction at Large Feynman x,"

Nucl. Phys. B 807, 334 (2009)

[arXiv:0707.4658 [hep-ph]].

and S.J. Brodsky, B. Kopeliovich, I.Schmidt and J. Soffer,

"Diffractive Higgs production from intrinsic heavy quark flavors in the proton,"

Phys. Rev. D 73 113005 (2006)

[hep-ph/0603238].

I also will present improved pQCD predictions for Higgs boson hadroproduction at the Large Hadronic Collider by applying the Principle of Maximum Conformality (PMC), a rigorous procedure which resums the pQCD series using the renormalization group (RG), thereby eliminating the dependence of the predictions on the choice of the renormalization scheme while minimizing sensitivity to the initial choice of the renormalization scale. The PMC predictions show better agreement with the ATLAS measurements than the LHC-XS predictions which are based on conventional renormalization scale-setting.

See: S.Q. Wang, X.G. Wu, S.J. Brodsky and M. Mojaza,

"Application of the Principle of Maximum Conformality to the Hadroproduction of the Higgs Boson at the LHC,"

Phys. Rev. D 94, no. 5, 053003 (2016)

[arXiv:1605.02572 [hep-ph]].

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