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Recommendation for Dr. Leonardo di Giustino

Dear Colleagues,

I am happy to write this letter in strong support of Dr. Leonardo Di Giustino, who has applied for a position as a Postdoctoral Research Associate in your theory group. He is a very talented particle theorist from the University of Parma,

I collaborated this year with Leonardo at SLAC on a project which will greatly improve the reliability and precision of QCD predictions at the LHC and other colliders. See: "Setting the Renormalization Scale in QCD: The Principle of Maximum Conformality," Phys. Rev. D **86**, 085026 (2012). arXiv:1107.0338 As we have demonstrated. the PMC has the potential to greatly increase the sensitivity of experiments at the LHC to new physics beyond the Standard Model.

It is well known that a key problem in making precise perturbative QCD predictions is the uncertainty in determining the renormalization scale μ of the running coupling $\alpha_s(\mu^2)$. The purpose of the running coupling in any gauge theory is to sum all terms involving the β function; in fact, when the renormalization scale is set properly, all non-conformal $\beta \neq 0$ terms in a perturbative expansion arising from renormalization are summed into the running coupling. The remaining terms in the perturbative series are then identical to that of a conformal theory; i.e., the corresponding theory with $\beta = 0$.

A critically point is that the resulting scale-fixed predictions for physical observables using the PMC are *independent of the choice of renormalization scheme* – a key requirement of renormalization group invariance. The PMC predictions are also independent of the choice of the *initial* renormalization scale μ_0.

The PMC thus sums all of the non-conformal terms associated with the QCD β function. Other important properties of the PMC are that the resulting series are free of renormalon resummation problems, and the predictions agree with QED scale-setting in the Abelian limit. The PMC is also the theoretical principle underlying the BLM procedure, commensurate scale relations between observables, and the scale-setting method used in lattice gauge theory. The number of active flavors n_f in the QCD β function is also correctly determined.

In our paper we discuss several methods for determining the PMC/BLM scale for complex QCD processes. We show that a single global PMC scale, valid at leading order, can be derived from basic properties of the perturbative QCD cross section.

Leonardo has done truly impressive work on the PMC project, particularly in developing detailed applications for multi-jet processes such as $e^+e^- \to q\bar{q}g$.

Xing-Gang Wu and I have recently applied Leonardo's PMC scale-setting methods to improve the NLO pQCD prediction for $t\bar{t}$ pair production at the LHC, where subtle aspects of the renormalization scale of the three-gluon vertex as well as large radiative corrections to heavy quarks at threshold play a crucial role. The large discrepancy of pQCD predictions with the forward-backward asymmetry measured at the Tevatron is significantly reduced from 3 σ to approximately 1 σ.

Leonardo is now applying his PMC methods to LHC processes including Higgs production and final states containing a high p_T photon plus heavy quark jets, thus greatly sharpening the precision of the Standard Model predictions.

Leonardo is also an expert on many other aspects of heavy quarks in QCD processes, particularly regarding the subtle problems associated with gluon radiation from the top and bottom quarks.

I am very impressed with Leonardo di Giustino. I think he is an excellent, highly qualified candidate for a postdoctoral position, and I highly recommend him.

Sincerely yours,

Stanley J. Brodsky
Professor
Theoretical Physics