Introduction to heavy quarks (charm and beauty)

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Perturbative QCD is expected to provide reliable predictions for the production of bottom and (to a lesser extent) charm quarks since their masses are large enough to assure the applicability of perturbative calculations. A direct comparison of perturbative QCD predictions to heavy-flavour production data is not straightforward. Difficulties arise from the presence of scales very different from the quark masses that reduce the predictivity of fixed-order theory, from the non-perturbative ingredients needed to parametrize the fragmentation of the heavy quarks into the observed heavy hadrons, and from the limited phase space accessible to present detectors. Moreover, a breakdown of the standard collinear factorization approach can be expected at low-x. The study of heavy-quark production in hadronic interactions and in e–p collisions at HERA has been therefore an active field in the effort to overcome these difficulties and to get a deeper understanding of hard interactions.

Besides its intrinsic interest, a precise understanding of heavy-quark production is important at the LHC because charm and beauty from QCD processes are relevant backgrounds to other interesting processes from the Standard Model (e.g., Higgs to $b\bar{b}$) or beyond. Theoretical and experimental techniques developed at HERA in the heavy-quark field, such as heavy-quark parton densities or b-tagging, are also of great value for future measurements at the LHC.

The present status of heavy-quark production theory is critically reviewed in the first contribution. The second contribution summarizes the present heavy-flavour data from HERA and gives an outlook of what can be expected from HERA-II. The potential of the LHC experiments for charm and beauty physics is reviewed in the third contribution. Then the relevance of saturation and low-x effects to heavy-quark production at HERA and at the LHC are discussed. The non-perturbative aspects of heavy-quark fragmentation and their relevance to HERA and LHC are discussed in the next contribution. Finally, a comparison of different theoretical predictions for HERA and the LHC based on different approaches is presented.