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Charmonium production using decays to hadronic final states at LHCb

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Non Relativistic QCD (NRQCD) provides so far the most successful framework to describe the production of the $J^{PC} = 1^{--}$ quarkonium states. However, a comprehensive description of the production and polarisation of the J/ψ state at Tevatron and LHC in the complete p_T and rapidity range remains a challenge. The heavy quark spin symmetry yields direct links between the long distance matrix elements describing hadroproduction of different charmonium states. The production of linked charmonium states - η_c and J/ψ , $\eta_c(2S)$ and $\psi(2S)$, and the three χ_c states - can thus be described simultaneously.

Experimentally the production of non-1⁻⁻ charmonium states can be studied by reconstructing their decays to fully hadronic final states. The LHCb measurement of the $\eta_c(1S)$ prompt production and production in inclusive b-hadron decays via the decay $\eta_c(1S) \rightarrow p\bar{p}$ is discussed together with its strong impact on NRQCD-based theory models. Recent LHCb measurement of the χ_c and $\eta_c(2S)$ states production in inclusive b-hadron decays using their decays to $\phi\phi$ is also presented; the discrepancy with existing theoretical prediction is demonstrated. Prospects of measuring prompt $\eta_c(2S)$ production at the LHCb using 2018 data is discussed.

Auteur principal: M. USACHOV, Andrii (LAL)
Orateur: M. USACHOV, Andrii (LAL)
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