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Investigating the beauty quark dynamics with the non-prompt charm hadron productions in high energy pp collisions at the LHC

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In high-energy proton-proton (pp) collisions at the LHC, non-prompt charm hadrons, originating from beauty hadron decays, provide a valuable probe for beauty quark dynamics, particularly at low transverse momentum (p_T) where direct beauty measurements are challenging. We employ the A Multi-Phase Transport (AMPT) model in its string-melting mode to simulate these processes in pp collisions at $\sqrt{s} = 13$ TeV. By tuning the beauty quark rest mass ($m_b = 6.6$ GeV) and the beauty-specific coalescence parameter ($r^b_{\rm BM} = 1.2$), we achieve improved agreement with experimental data on beauty hadron yields, baryon-to-meson ratios, and non-prompt charm hadron production from ALICE and LHCb. We present the transverse-momentum and multiplicity dependence of non-prompt to prompt charm-hadron ratios, providing new insights into the interplay between heavy-quark production and hadronization process. This study offers a quantitative baseline for future studies of heavy-quark transport and hadronization in small collision systems.

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