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Testing the compatibility of lQCD spatial diffusion coefficient by mean of experimental open heavy flavor observables: R_{AA}, v_2, and v_3

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Heavy-flavour production represents a crucial probe for studying transport properties of the Quark-Gluon Plasma (QGP), with the spatial diffusion coefficient $D_s(T)$ encoding the interaction strength between heavy quarks (HQs) and the medium. Recent lattice QCD (lQCD) results with dynamical fermions show very low values, $2\pi TD_s \approx 1$ for charm quarks at $T = T_c$, much lower than quenched QCD and most phenomenological models ($2\pi TD_s \approx$ 3.5–5). These values imply short thermalization times ($\tau_{th} \approx$ 1–1.5fm/c) for HQs, raising questions about their compatibility with experimental data such as the nuclear modification factor R_{AA}, and flow coefficients v_2, v_3 of D mesons and Λ_c baryons; both in close agreement to the recent experimental data of ALICE and CMS. We study this aspect using an event-by-event Langevin transport model. In particular, we test different scenarios and show that low D_s ($p \to 0$) values can match experimental data only if the thermalization time $\tau_{th}(p) = 1/A(p)$ depends strongly on momentum, as predicted by T-matrix approaches and the extended Quasi-Particle Model (QPMp). In contrast, assuming a constant $\tau_{th} = M_c D_s^{lQCD}/T$ does not reproduce the observed experimental trends. We also study the implications of a small thermalization time for both charm and bottom quarks. Moreover, fast thermalization makes final-state observables largely insensitive to the initial charm-quark momentum distribution up to $p_T \approx M_c$, suggesting a universal behavior driven by a dynamical attractor.

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