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Heavy-flavor transport and hadronization in proton-proton collisions

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Recent experimental results on the Λ+c/D0 ratio in proton-proton collisions –strongly enhanced compared to expectations relying on universal fragmentation fractions/functions in different colliding system, from e+e– to pp –led to speculations about possible medium effects affecting hadronization, previously considered a distinctive feature only of heavy-ion collisions. Here we show how the assumption of the formation of a small, deconfined and expanding fireball also in pp collisions, in which charm quarks can undergo rescattering and hadronization, allows one to qualitative reproduce unexpected experimental findings in the heavy-flavor particle ratios and distributions. For this purpose we apply to the proton-proton case the same in-medium hadronization mechanism previously developed to address heavy-ion collisions and based on local color-neutralization via recombination of charm quarks with nearby opposite color charges from the background fireball. In our model the presence of diquark excitations in the hot medium favors the formation of charmed baryons and the recombination process, involving quite collinear partons from the same fluid cell, turns out to be an efficient mechanism to transfer the collective flow of the system to the final charmed hadrons.

The model – described in detail in EPJC 82 (2022) 7, 607 – allowed us to provide a good description of the charmed-hadron ratios and momentum-distribution in nucleus-nucleus collision. Its extension to the proton-proton case provides a consistent explanation for the enhanced Λ+c/D0 ratio observed in these collisions and leads to other interesting results for the charmed-hadron momentum distributions – entering into the definition of the R_AA, in which the pp result can no longer be considered as the no-final-state-effect benchmark – and for their elliptic-flow coefficient, reflecting the initial deformation of the fireball.

Having validated our modelling of the initial state of the fireball and its hydrodynamic evolution against the measured soft-particle multiplicity in pp collisions, we believe our results are pretty robust and provide a unified picture of heavy-flavor production from pp to AA collisions.

Category

Theory

Collaboration (if applicable)

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