Hadronization and charm-hadron ratios heavy-ion collisions

Min He and Ralf Rapp

Understanding the hadronization of the quark-gluon plasma (QGP) remains a forefront challenge in the study of strong-interaction matter as produced in ultra-relativistic heavy-ion collisions. Due to their large mass, heavy quarks are excellent tracers of the color neutralization process of the QGP when they convert into various heavy-flavor (HF) hadrons, see, e.g., Ref. [1] for a recent review.

In the present work [2] we have developed an energy-momentum conserving recombination model for HF mesons and baryons that obeys the benchmarks of thermal and chemical equilibrium limits and accounts for space-momentum correlations (SMCs) of heavy quarks with the thermal partons of the hydrodynamically expanding QGP, thereby resolving a long-standing problem in quark coalescence models [3]. The SMCs enhance the recombination of fast-moving heavy quarks with high-flow thermal quarks in the outer regions of the fireball. We have furthermore employed an improved hadro-chemistry which includes "missing" charm-baryon states [4] (i.e., those not listed by the particle data group but predicted by lattice QCD [5] and the relativistic quark model [6]). These were previously found to describe the large Λ_c/D^0 ratio measured in proton-proton (pp) collisions at the LHC [4], and thus we establish a consistent treatment of the hadronization process in pp and nucleus-nucleus (AA) collisions. The SMCs are implemented on an event-by-event basis for the charm-quark distribution functions obtained from our hydro-Langevin simulations of heavy-quark diffusion in the strongly coupled QGP which allows for exact charm-quark conservation. The diffusion process is described by non-perturbative T-matrix interactions, which for the current purpose have been augmented by a K-factor of 1.6 to roughly account for radiative interactions which are presently not included in our set up.

Our results for the Λ_c/D^0 and D_s/D^0 ratios are shown in the left and middle panel of Fig. 1, respectively, in comparison to ALICE data from the LHC and STAR data from RHIC, showing fair agreement. The main effect of the SMC's is a much increased reach of the recombination process in transverse momentum, p_T, causing a significant enhancement over the pp values of the two ratios. In

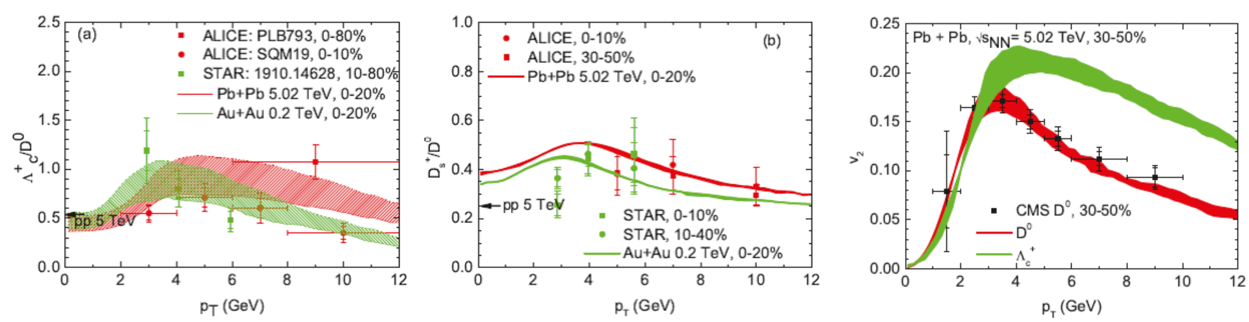

Fig. 1. Transverse-momentum dependence of the L_c/D^0 (left) and D_s/D^0 (middle) ratio (green bands: 0.2 TeV Au-Au at RHIC, red bands: 5 TeV Pb-Pb collisions at the LHC), compared to ALICE (red symbols) and RHIC (green symbols) data. Right panel: Elliptic flow coefficient, $v_2(p_T)$, for D^0 mesons (red band) and Λ_c baryons (green band), compared to CMS D^0 data (black symbols).

addition, the near-equilibration of strange-quark production in AA collisions increases the total D_s production also at low p_T [7]. Finally, the SMCs lead to an improved description of the measured high-p_T elliptic flow (see right panel in Fig. 1), which was underestimated in our previous calculations without SMCs [7].

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