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New challenges for the open heavy flavor physics in ultrarelativistic collisions

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The study of the QCD interaction at high temperature in the heavy quark (HQ) sector has attracted a wide interest in the last decade. The theoretical efforts to build realistic phenomenological models able to predict the main observables for D mesons, R_{AA} and v_2, has lead to a first estimate of the Ds space diffusion of charm quarks. This has been a successful program that has allowed to have a general consensus that the charm quark interaction is non-perturbative, the estimated Ds is in agreement with current lattice QCD calculations and its thermalization time is of the order of QGP lifetime [1].
Given the success of this first stage of the study, very recently new important perspectives are emerging. These can lead from one hand to improving the determination of Ds and on the other hand open the way for employing HQ as a novel probe of the initial stage of the ultra-relativistic collisions.
More directly related to the determination of the HQ diffusion and hadronization are:
- The surprisingly large Λ_c production at both RHIC and LHC energies. We will show that this affects the $R_{AA}(p_T)$ also of the D meson and hence the determination of the HQ interaction [2]. We show also that an hadronization by coalescence plus fragmentation can largely account for this new finding and discuss new prediction for Λ_b/B ratio.
- The correlation between the v_n anisotropies of the bulk matter and the one of HQs $(v_n(light), v_n(heavy))$ and, in particular, the normalized variance of $\sigma_n / < v_n >$ constitute a novel and more powerful tool to constraint the Ds transport coefficient [3].

HQs have been poorly explored as a probe of the initial vorticity and electromagnetic field. We will show that a large directed flow v1 can be generated by the longitudinal initial tilt along with a splitting between D0 and anti-D0 [3]. The last can be seen also as a probe of the deconfined phase. Predictions in agreement with preliminary STAR data will be presented together with first results compared to ALICE data. A correlation study of the D0 splitting in v_1 with the one of muons from Z0 decay can provide a new insight into the determination of the initial magnetic field and its lifetime.
Furthermore, we will show a novel approach that studies the potential impact of a glasma phase on the HQ dynamics and how this can provide a link between pA and AA collisions [4].

[1] X.Dong and V. Greco, Prog. Part. Nucl. Phys. 104 (2019) 97.
[2] S. Plumari et al., Eur. Phys. J. C78 (2018) 348
[3] S. Plumari et al., "Azimuthal anisotropies correlation between light and heavy hadrons", in preparation.
[4] S.K. Das et al., Phys. Lett. B768 (2017) 260
[5] Y. Sun et al., %"Impact of Glasma on heavy quark observables in nucleus-nucleus collisions at LHC," arXiv:1902.06254 [nucl-th].

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