Contribution ID: **10** Type: **not specified**

Diffusion of heavy quarks in the early stage of high energy nuclear collisions

Thursday 14 July 2022 14:20 (20 minutes)

Heavy quarks are considered potential probes of the QCD matter produced in high-energy heavy-ion collisions. In the pre-equilibrium stage of relativistic heavy-ion collisions, strong quasi-classical gluon fields emerge at about $\tau_0 = 0.08$ fm/c which evolves according to the classical Yang-Mills (CYM) equations. These set of classical fields are known as Glasma. We study the diffusion of the heavy quarks, namely, charm and bottom quarks in the early stage of heavy-ion collisions. The diffusion in the evolving Glasma fields is compared with that of the Markovian-Brownian motion in a thermalized medium. The diffusion of HQs in the evolving glasma (EvGlasma) is investigated within the framework of Wong equations while we use famous Langevin equations for the Brownian motion with diffusion coefficients evaluated within the pQCD framework.We observe that for a smaller value of saturation scale, Q_s, the average transverse momentum broadening is approximately the same for the two cases, but for larger Q_s, Langevin dynamics underestimates the σ_p. This difference is related to the fact that heavy quarks in the Glasma fields experience diffusion in strong, coherent gluon fields that lead to a faster momentum broadening due to memory, or equivalently to a strong correlation in the transverse plane. We present another interesting result related to bottom quarks. We have observed that bottom quarks are more affected by the pre-equilibrium phase due to their large masses. Their slow motion makes them spend a longer time within a single filament and experience the coherent gluonic fields for a longer time .

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Session Classification: Open HF in A-A collisions