Heavy quark correlations and the effective volume for quarkonia production in heavy ion collisions

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Using the Boltzmann transport approach, we have studied the effect of initial spatial and momentum correlations between a heavy quark pair, such as that produced from a $p + p$ collision, on their collision rate in a partonic medium [1] that is relevant for their thermalization and the production of quarkonium from regeneration [2, 3]. Characterizing this effect by an effective volume given by the inverse of the ratio of their collision rate to the collision rate of a thermally equilibrated and spatially uniformly distributed heavy quark pair in a unit volume, we have found that the effective volume is finite and depends sensitively on the momentum of the heavy quark and the temperature of the medium. Generally, it increases linearly with time t at the very beginning, thus an enhanced collision rate, and the increase then becomes slower due to multiple scattering, and finally it increases as $t^{3/2}$ as shown in Fig.1.

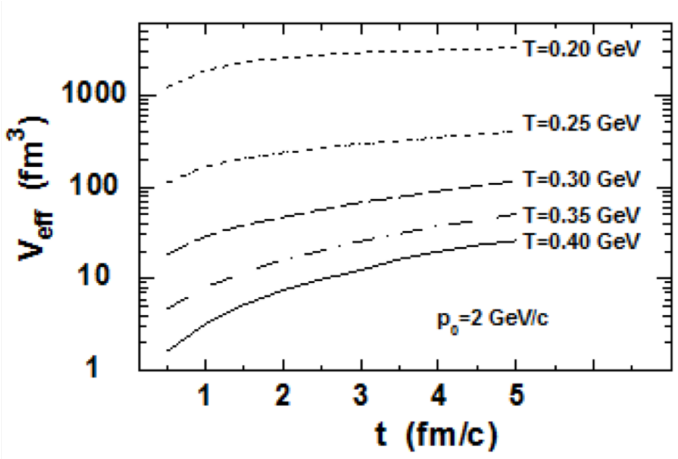

FIG 1. Time evolution of the effective volume V_{eff} of heavy quarks with initial charm momentum $p_0 = 2$ GeV/c for different medium temperatures.

Consequently, the chance for a heavy quark pair to collide with each other per unit time decreases monotonically with time. Also, heavy quarks of lower initial momentum in a medium of higher temperature have a larger chance to collide. Furthermore, the distribution of the center of mass energy of the heavy quark air is found to correspond to an effective temperature that is lower than the actual temperature of the medium. All these properties are important for quarkonium regeneration in collisions where heavy quarks are rarely produced.

[1] Y.P. Liu, C.M. Ko, and F. Li, Phys. Rev. C **93**, 034901 (2016).

[2] M.I. Gorenstein, A. Kostyuk, H. Stoecker, and W. Greiner, Phys. Lett. B **509**, 277 (2001).

[3] A. Andronic, P. Braun-Munzinger, K. Redlich, and J. Stachel, Nucl. Phys. **A789**, 334 (2007).