Effects of initial fluctuations on bottomonium suppression in relativistic heavy ion collsions

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Using the screened Cornell potential [1] and the next-to-leading order perturbative QCD [2,3] to determine, respectively, the properties of bottomonia and their dissociation cross sections in a quark-gluon plasma, we have studied in a 2+1 ideal hydrodynamics the effect of initial fluctuations on bottomonia production in relativistic heavy-ion collisions [4]. We find that while initial fluctuations hardly affect the yield of the 1S ground state bottomonium, their effect on other bottomonium states gradually increases with their excitation energies, as shown in the left window of Fig.1. Compared to the case with smooth initial conditions, the survival probabilities of excited bottomonium states are reduced at low transverse momentum in the case of large initial fluctuations, and this effect is more prominent if the bottomonia are produced earlier in heavy-ion collisions. Since the initial fluctuations are smoothed out quickly with time, bottomonia that take long time to form are little affected by the fluctuations. Presently, the formation times of bottomonia are not well determined. We have used the value of 1.8 fm/c for the 1S state and of 2.3 fm/c for the excited states of bottonomia from fitting the experimental data on their nuclear modification factors. In this case, the effect of initial fluctuations on the nuclear modification factor of bottomonia 1S and 2S states is, however, small as shown in the right window of Fig. 1.

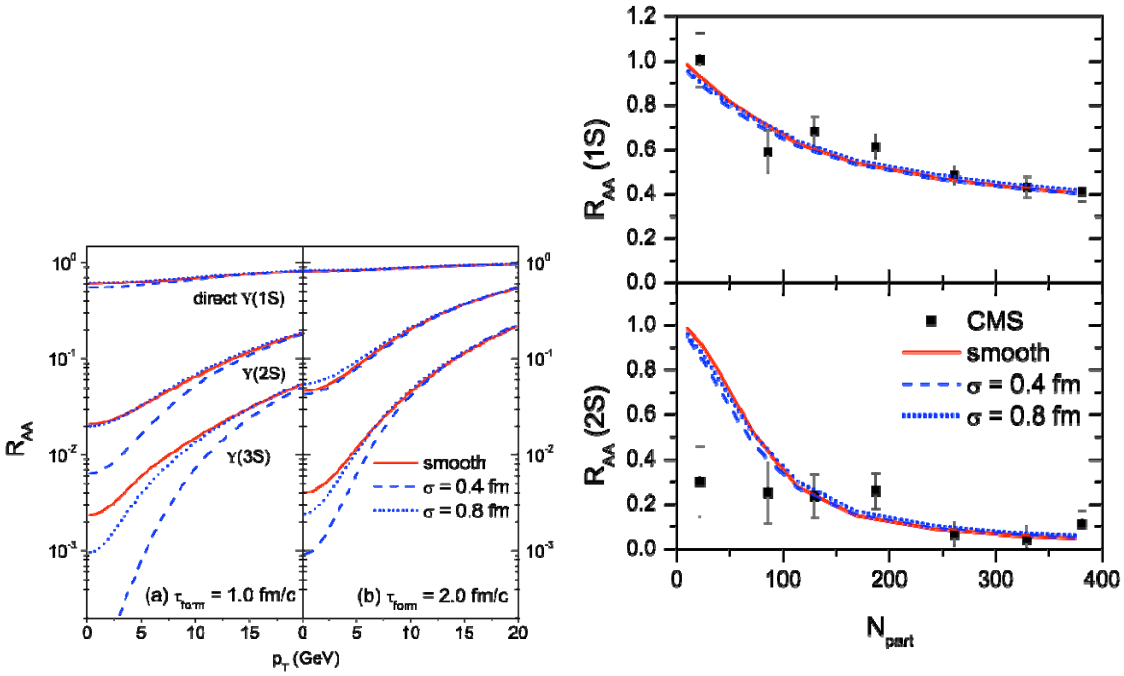

FIG. 1. Left wiondow: Nuclear modification factor R_{AA} of 1S (upper lines), 2S (middle lines), and 3S (lower lines) bottomonium states as functions of transverse momentum for smooth initial conditions (solid lines) and fluctuating initial conditions with smearing parameter σ = 0.4 fm (dashed lines) and 0.8 fm (dotted lines) in minimum-bias Pb+Pb collisions= 2.76 TeV. Panels (a) and (b) correspond to formation times of bottomonia 1.0 and 2.0 fm/c, respectively. Right window: Same as functions of participant number but with the formation times of 1S state and excited states taken to be 1.8 and 2.3 fm/c, respectively. Experimental data are taken from Ref.[5].

[1] F. Karsch, M.T. Mehr, and H. Satz, Z. Phys. C **37**, 617 (1988).
[2] T. Song and S.H. Lee, Phys. Rev. D **72**, 034002 (2005).
[3] Y. Park, K.I. Kim, T. Song, S.H. Lee, and C.Y. Wong, Phys. Rev. C **76**, 044907 (2007).
[4] T. Song, K.C. Han, and C.M. Ko, Nucl. Phys. A **897**, 141 (2013).
[5] S. Chatrchyan et al. [CMS Collaboration], arXiv:1208.2826 [nucl-ex].