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Realistic in-medium heavy-quark potential from high statistics lattice QCD simulations

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The heavy-quark potential is a highly versatile theoretical tool. It allows one to summarize many aspects of the intricate interactions between a QQbar bound state and its surrounding medium in a single complex valued quantity. It is systematically defined from QCD [1,2] and at the same time provides an intuitive understanding of the physics of in-medium quarkonium modification. I.e. it offers the means to investigate from first principles how e.g. color screening and collisional excitations conspire to lead to quarkonium suppression in heavy-ion collisions [3,4].

Here we present the first direct computation of this potential from realistic lattice QCD simulations with near physical pion masses [5]. Current ensembles with $N_\tau = 12$ from the TUMQCD collaboration offer unprecedented high statistics, those with $N_\tau = 16$ unprecedented time resolution, making possible a robust extraction of its values from the spectral functions of Wilson line correlators. To this end we deploy a combination of Bayesian reconstruction methods (BR), as well as the Pade approximation, in turn diminishing individual method artifacts.

Re[V] shows a smooth transition from a confining to a Debye screened behavior. At all temperatures its values lie close to the color singlet free energies. Based on Re[V] we estimate the Debye mass. The modification of Im[V] at very high temperatures is compared to predictions of hard-thermal-loop perturbation theory.

Applications of the complex potential in the modeling of charmonium and bottomonium in heavy-ion collisions are briefly touched upon ([3,4,6]).

[1] N. Brambilla, J. Ghiglieri, A. Vario and P. Petreczky PRD78 (2008) 014017
[2] A.R., T. Hatsuda, S. Sasaki PRL 108 (2012) 162001
[3] Y. Burnier, O. Kaczmarek, A.R. JHEP 1512 (2015) 101
[4] N. Brambilla, M. Escobedo, J. Soto, A. Vairo PRD96 (2017) 034021
[5] A.R. & TUMQCD collaboration (in preparation)
[6] B. Krouppa, M. Strickland, A.R. arXiv:1710.02319

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