Heavy quark potential at finite temperature

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Using the QCD sum rule with its operator product expansion reliably estimated from lattice calculations for the pressure and energy density of hot QCD matter [1], we have calculated the strength of the J/ψ wave function at origin [2] and find that it decreases with temperature when the temperature is above the transition temperature as shown in Fig.1. This result is seen to follow exactly that obtained from the solution of the Schroedingier equation for a charm and anticharm quark pair using the free energy from lattice calculations as the potential and is in sharp contrast to that using the deeper potential associated with the internal energy, which shows an enhanced strength of the J/ψ wave function at origin. This conclusion remains unchanged after including in the Schroedinger equation an imaginary potential from the Hard Thermal Loop (HTL) calculations [3,4], which reaches an asymptotic value of order -100 MeV at r >0.5 fm near T_c. Our result thus suggests that the free energy potential from lattice calculations is the appropriate heavy quark potential for analyzing the charmonium spectrum at finite temperature.

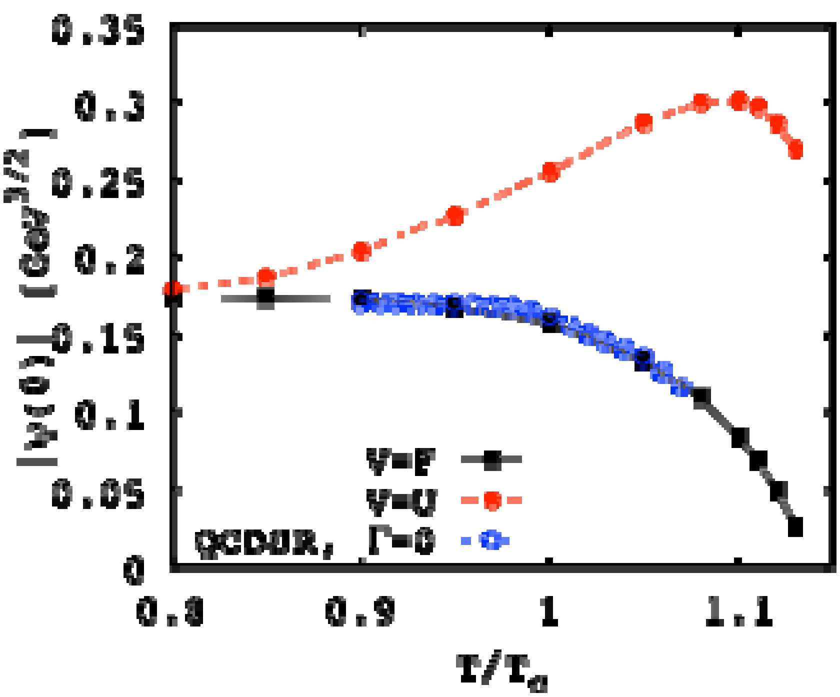

FIG. 1. Temperature dependence of the J/ ψ wave function at origin |ψ(0)| obtained from the free energy (filled squares) and internal energy (filled circles) potentials together with that from the QCD sum rule (open circles).

[1] K. Morita and S.H. Lee, Phys. Rev. D **82**, 054008 (2010); Phys. Rev. C **85**, 044914 (2012).

[2] S.H. Lee, K. Morta, T. Song, and C.M. Ko, Phys. Rev. D, submitted.
[3] M. Laine, O. Philipsen, P. Romatschke and M. Tassler, JHEP **0703**, 054 (2007).
[4] P. Petreczky, C. Miao and A. Mocsy, Nucl. Phys. A 855, 125 (2011).