Charmonium dissociation temperatures in quenched lattice QCD

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We study charmonium dissociation temperatures using lattice QCD. The dissociation temperatures of J/ψ, ψ', and χ_c states play key roles in sequential J/ψ suppression scenarios. To distinguish a bound state from the scattering states, charmonium spectral functions have been studied on the lattice using e.g. the Maximum Entropy Method. Recently, however, we have pointed out that a constant mode in finite temperature meson correlators can lead to misleading conclusions about the stability of charmonium states when the constant mode is not removed in the spectral function [1]. In this study, we adopt a finite volume method [2] taking into account the effects of the constant mode. We investigate the charmonium mass spectra under different spatial boundary conditions. We combine a variational analysis to improve the signals of excited states such as ψ' states. Besides the dissociation temperatures, we discuss the temperature dependence of the wave function (the Bethe-Salpeter amplitude) of the charmonia [3] to see whether the c-quark and $\bar{c}$-quark stay together with each other or not above T_c.

Here we present figures for the latter calculations. The left panel shows the volume dependence of S-wave state wave functions. The variational analysis can provide not only lowest state wave funcion but also next lowest one. The right panel shows the same result for P-wave states. We can not find any signals of charmonium dissociation at $T = 2.3T_c$ even in P-wave states. The results are important to discuss J/ψ suppression scenarios in heavy ion collision experiments.

The simulations have been performed on supercomputers (NEC SX-5) at the Research Center for Nuclear Physics (RCNP) at Osaka University and (NEC SX-8) at the Yukawa Institute for Theoretical Physics (YITP) at Kyoto University.

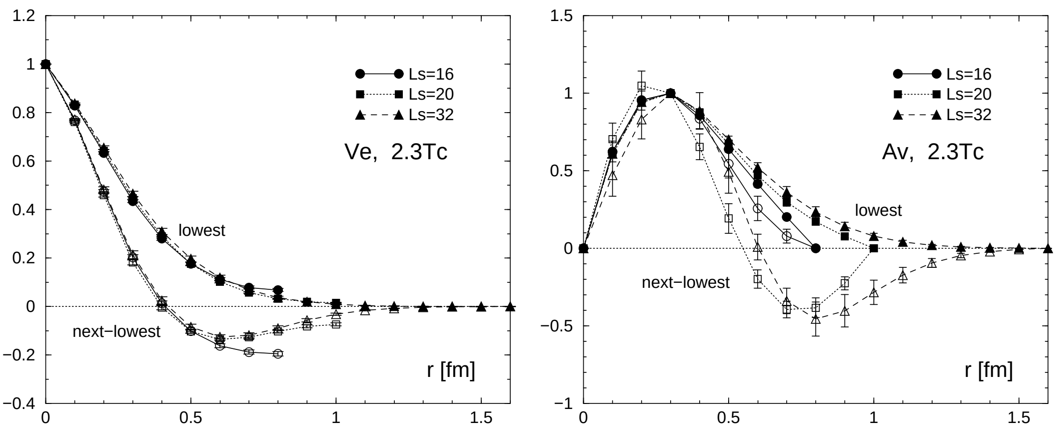

Figure 1: Volume dependence of the lowest and next lowest wave functions for S-wave states (Left) and P-wave states (Right).

References

[1] T. Umeda, "A constant contribution in meson correlators at finite temperature," Phys. Rev. D **75**, 094502 (2007) [`hep-lat/0701005`].

[2] H. Iida, T. Doi, N. Ishii, H. Suganuma and K. Tsumura, "Charmonium properties in deconfinement phase in anisotropic lattice QCD," Phys. Rev. D **74**, 074502 (2006) [arXiv:hep-lat/0602008].

[3] T. Umeda, R. Katayama, O. Miyamura and H. Matsufuru, "Study of charmonia near the deconfining transition on an anisotropic lattice with O(a) improved quark action," Int. J. Mod. Phys. A **16**, 2215 (2001) [arXiv:hep-lat/0011085].