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High statistics study of in-medium S- and P-wave quarkonium states in lattice Non-relativistic QCD

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Many precision measurements of quarkonium suppression at the LHC, e.g. the nuclear modification factor R_AA of J/Psi, are well described by a multitude of different models [1]. Thus pinpointing the underlying physics is difficult and first principles guidance is needed. In-medium spectral properties, e.g. mass shifts or the broadening of states can help us to understand quarkonium production in a kinetically equilibrated setting. While potential based approaches with lattice input [2] have been used to estimate such modifications, a direct and quantitative determination from first principles lattice QCD is still outstanding.

Advancing towards this goal we present here a high statistics study of bottomonium and charmonium S-wave and P-wave spectral properties at finite temperature using the effective field theory NRQCD on the lattice. This EFT allows us to capture the physics of quarkonium without modelling assumptions in a realistic thermal QCD medium, described by state-of-the-art lattices of the HotQCD collaboration at almost physical pion mass [3]. The availability of two Bayesian methods for spectral functions (MEM and BR [4]) makes it possible to thoroughly test the systematic uncertainties of their reconstruction.

Our new lattice QCD correlation functions and reconstructed spectra corroborate a picture of sequential modification of states with respect to their vacuum binding energy. We find that remnant features of the bottomonium S-wave may survive up to T˜400MeV, while the P-wave ground state disappears around T˜300MeV. The charmonium analysis hints at melting of the P-wave below T˜190MeV while some S-wave remnant feature might survive up to T˜245MeV.

With the inclusion of charmonium spectra, an extended temperature range and increased statistics by more than an order of magnitude our study provides a coherent picture of in-medium quarkonium modification extending significantly beyond our previous results of Ref. [5].

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[4] Y. Burnier, A. Rothkopf, Phys.Rev.Lett. 111 (2013) 182003
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Preferred Track

QCD at High Temperature

Collaboration

Not applicable

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