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Thermal photon production rate from lattice QCD

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Thermal photon production in heavy-ion collisions is a crucial tool for studying quark-gluon plasma (QGP), as photons carry information about the local environment from the point of creation. The thermal photon production rate from an equilibrated plasma is proportional to the spectral function in the vector channel. We estimate the photon rate from the difference between the transverse and longitudinal spectral functions (T-L) in 2+1 flavor lattice QCD with a pion mass of 320 MeV and quenched QCD. The advantage of this T-L spectral function is that the UV part of the spectral function is much suppressed compared to the spectral function in other channels, yet both give identical photon rates. As a result, the lattice correlator from this T-L spectral function is dominated by the important IR part of the spectral function, which is advantageous for the spectral reconstruction process. Since extracting the spectral function from the lattice correlator is an ill-posed problem, we have used various techniques for the spectral reconstruction process. These include modeling the spectral function constrained by its asymptotic behavior at high energies along with the sum rule. We have used a polynomial model of the spectral function and the Padé ansatz for this purpose. Additionally, we have attempted the Backus-Gilbert method and Gaussian process regression to estimate the photon rate. We show that, within systematic uncertainties, all the methods provide a consistent photon production rate.

Primary authors: FRANCIS, Anthony (National Yang Ming Chiao Tung University); BALA, Dibyendu (Bielefeld University); JACKSON, Greg; TURNWALD, Jonas; WINK, Nicolas; KACZMAREK, Olaf (University of Bielefeld); ALI, Sajid (Bielefeld University); UEDING, Tristan (Bielefeld University)

Presenter: BALA, Dibyendu (Bielefeld University)

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