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Local thermalization of gluons

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Fast local thermalization of gluons and quarks characterizes the initial stages of relativistic heavy-ion collisions. For a theoretical description, effective weakly-coupled kinetic theories that rely on the quantum Boltzmann equation have been proposed and solved numerically. In the present work, I aim to account for the time evolution during the rapid equilibration of partons through a nonlinear diffusion equation for the occupation-number distributions in the full momentum range. It is shown that in case of constant transport coefficients, the equation can be solved analytically in closed form through a nonlinear transformation. The occupation-number distribution is then obtained via the logarithmic derivative of a generalized (time-dependent) partition function.

Although the nonlinear boson diffusion equation (NBDE) for the thermalization of gluons had been proposed in [1], the analytical solution had initially been derived only for the free case. In order to obtain the full Bose-Einstein distribution in the stationary limit, however, one has to consider the IR boundary condition [2] at the singularity $p = \mu$ with the initial chemical potential $\mu_i < 0$ for number-conserving elastic gluon scatterings, and $\mu = 0$ for inelastic scatterings. It is shown that analytical solutions of the NBDE can still be obtained [2].

The model is applied to the equilibration of gluons in heavy-ion collisions at LHC energies, where initial central temperatures of $500 - 600$ MeV are reached in the course of local thermalization. Equilibrium is attained through the nonlinear evolution of the distribution functions at short times $t < 0.1$ fm/c in the infrared, whereas it takes more time in the large-momentum region to approach the Maxwell-Boltzmann tail of the distribution function. Thermalization in the IR occurs much faster through inelastic as compared to elastic gluon scatterings, thus preventing the formation of a gluon condensate via number-conserving elastic collisions. These results are consistent with QCD-based numerical findings in [3].

[1] Wolschin, G.: Equilibration in finite Bose systems. Physica A 499, 1 (2018).
[2] Wolschin, G.: Nonlinear diffusion of gluons. Physica A 597, 127299 (2022) .
[3] Blaizot, J.P., Liao, J., Mehtar-Tani, Y.: The thermalization of soft modes in non-expanding isotropic quark gluon plasmas. Nucl. Phys. A 961, 37 (2017).

Preferred track

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Subfield

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Attending in-person?

Yes

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