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Electromagnetic emission from strongly interacting hadronic and partonic matter created in heavy-ion collisions

Elecromagnetic probes, such as dileptons, can provide a clear information about the properties of strongly interacting hadronic and partonic matter created in heavy-ion collisions since they are undisturbed by the strong final state interaction. The dileptons are emitted during the whole evolution of the expanding system from many different sources - from hadron decays to the quark-gluon plasma (QGP) thermal radiation, so the consistent description of dilepton production requires an application of dynamical models.

In this work we investigate the dilepton production in heavy-ion collisions as well as in proton-proton and proton-nucleus reactions from low invariant energies of a one GeV (SIS) to ultra-relativistic energies of a few TeV (LHC). Our study is based on the Parton-Hadron-String Dynamics (PHSD) transport approach - a microscopic, non-equilibrium transport approach that incorporates both hadronic and partonic degrees-of-freedom and provides a comprehensive description of relativistic heavy-ion collisions, covering the entire process from the initial out-of-equilibrium nucleon-nucleon collisions, through the formation and interactions of the quark-gluon plasma, and extending to the hadronization and final-state off-shell interactions of the produced hadrons.

The main dilepton sources in the PHSD are the hadronic decays and bremstrahlung, thermal QGP radiation (including $q + \bar{q} \to e^+e^-$, $q + \bar{q} \to g + e^+e^-$, $q + g \to q + e^+e^-$ processes), primary Drell-Yan production (computed here dynamically in the PHSD framework) and semileptonic decays from correlated charm and bottom pairs. We find that the PHSD provides a good description of the dilepton data of the HADES, STAR and ALICE experiments. We investigate the influence of in-medium effects such as a collisional broadening of the vector meson spectral functions and present the excitation function of the dilepton "excess" in invariant mass range $0.4 < M < 0.75$ GeV as well as it's centrality dependence for different energies.

For the 1st time we report on the μ_B-dependence of the QGP thermal radiation - calculated in the PHSD within the Dynamical-Quasi-Particle Model (DQPM) used for the description of the non-perturbative QGP - and show that its influence increases with decreasing bombarding energy, where μ_B becomes larger. We present the excitation function of dileptons produced from thermal QGP - including the μ_B dependence of quasiparticle thermal masses and widths and their interactions - versus correlated charm that the QGP overshines the correlated charm at invariant energies $\sqrt{s} \sim 30$ GeV for central Au+Au collisions. This gives an access to the thermal QGP dileptons at BES-RHIC and future FAIR experiments. Furthermore, we study the contribution of the QGP to the dilepton spectra for p+p reactions at LHC energies and find that it increases with increasing collision energy. Thus, after subtracting the contributions of correlated charm and bottom pairs from dilepton experimental data it might become accessible, too.

Category

Theory

Collaboration (if applicable)

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