Contribution ID: **309**   Type: **Parallel Talk**

Direct photons in relativistic heavy-ion collisions: Tomography at multiple energy scales

Monday 14 May 2018 17:10 (20 minutes)

In this talk, we present a systematic study of direct soft photon observables from the RHIC Beam Energy Scan (BES) to the LHC energies. We utilize the power of photons as clean and penetrating probes of the strongly-coupled nuclear matter created in relativistic heavy-ion collisions, together with the fact that the rapidly expanding Quark-Gluon Plasma (QGP) imprints its evolution on the photon spectrum and momentum anisotropies.

At higher energies, using the improved centrality selection in the recent hybrid approach [1], we first show that the tension in the direct photon elliptic flow between theory and experimental measurements is considerably reduced at both top RHIC and LHC energies. Then, predictions of the photon observables in Pb+Pb collisions at 5.02 TeV will be highlighted. At lower energies, a study of direct photon production in Au+Au collisions at 39 and 62.4 GeV will also be discussed. In particular, the role of finite baryon chemical potential in thermal photon emission will be quantified for the first time. The interplay between different collision energy scaling behavior for prompt and thermal photons in the final direct photon observables will be analyzed. This survey establishes photons as a powerful tool to elucidate the dynamics of QGP over a wide range of collision energies, to extract QCD transport coefficients, and to serve as a necessary complement to hadronic measurements.

[1] S. McDonald, C. Shen, F. Fillion-Gourdeau, S. Jeon and C. Gale, "Hydrodynamic predictions for Pb+Pb collisions at 5.02 TeV", Phys. Rev. C 95, no. 6, 064913 (2017)

Content type

Theory

Collaboration

Centralised submission by Collaboration

Presenter name already specified

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Session Classification: Electromagnetic and weak probes

Track Classification: Electromagnetic and weak probes