Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **74** Type: **Oral Competition (Graduate Student) / Compétition orale (Étudiant(e) du 2e ou 3e cycle)**

Electromagnetic radiation from the pre-equilibrium/pre-hydro stage of the quark-gluon plasma

Thursday 11 June 2020 15:00 (15 minutes)

A remarkable achievement of the relativistic heavy-ion program is the realization that relativistic fluid dynamics can describe the evolving system of quark-gluon plasma (QGP) from its early moments to a time when the growing mean-free-paths drive the system out of equilibrium. The effectiveness of this hydrodynamic description is judged by comparing calculated hadronic observables with experimental measurements. Alternatively, electromagnetic radiation could be considered a more distinguishing signal as it is emitted throughout the evolution of the hadronic system. Considerable work has gone into the calculation of photons and dileptons using modern hydrodynamic approaches, however, the calculation of the electromagnetic emissivity of the pre-hydro stage is currently less advanced.

In this talk, we use a transport approach that models the time-evolution of gluons and fermions by solving the Boltzmann transport equation in the diffusion approximation. The initial state is a gluon distribution of a form inspired by the colour glass picture, where quarks and anti-quarks are then generated through interactions. The early stage evolution is modelled by a 1D expansion, during which non-equilibrium parton interactions can also produce real and virtual photons. We show how reliably these Glasma photons can report on the initial momentum anisotropy of the early parton distribution as well as the final net anisotropic emission of photons measured at RHIC and at the LHC (i.e. the "photon v_2 puzzle"). We show that the non-equilibrium photons can, in fact, leave an imprint on the final low p_T spectra. This opens the exciting possibility that a measurement of the electromagnetic signal can access the very first instants of heavy-ion collisions.

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Session Classification: R-DNP-1 : Best student competition

Track Classification: Nuclear Physics / Physique nucléaire (DNP-DPN)