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Photon flow harmonics v_n with chemical equilibration and non-ideal gas distribution

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Elliptic flow v_2 of direct photons are found to be larger than those from most hydrodynamic estimations at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC), which is recognized as the "photon v_2 puzzle". The recent discovery of large triangular flow v_3 hints that this is at least partially due to the medium properties. Theoretical explanation of the photon data should be essential for understanding the dynamical properties of the quark-gluon plasma (QGP).

We discuss enhancement of direct photon flow harmonics due to (i) quark chemical equilibration [1] and (ii) in-medium corrections to phase-space distributions [2], both of which modify the photon emission rate. The former scenario is motivated by the observation that chemical equilibration can be slower than thermalization in the transition from the gluon-rich color glass condensate to the QGP [3]. In the latter scenario, we consider non-ideal gas distributions using a quasi-particle picture so that they reproduce the equation of state from (2+1)-flavor lattice QCD. Both mechanisms reduce the effective number of degrees of freedom for the quark distribution. This suppresses early photons with smaller anisotropy, leading to larger anisotropy in total direct photons.

We use a hydrodynamic model to numerically estimate thermal photon v_2 and v_3 with and without the above effects. The calculations show visible enhancement of the photon flow harmonics. Quadrangular (v_4) and pentagonal (v_5) flow are also estimated as theoretical guides to quantify possible anomalous enhancement of anisotropy.

[1] A. Monnai, Phys. Rev. C 90, 021901(R) (2014).
[2] A. Monnai, arXiv:1504.00406 [nucl-th].
[3] A. Monnai and B. Mueller, arXiv:1403.7310 [hep-ph].

On behalf of collaboration:

NONE

Primary author: Dr MONNAI, Akihiko (RIKEN BNL Research Center)

Presenter: Dr MONNAI, Akihiko (RIKEN BNL Research Center)

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