QUARK MATTER 2015
Sep. 27 – Oct. 3, 2015 Kobe, Japan

Contribution ID: **545** Type: **Contributed talk**

Jet fragmentation photons in ultrarelativistic heavy-ion collisions

Wednesday 30 September 2015 09:20 (20 minutes)

Electromagnetic probes have been expected to be penetrating probes of the early-time dynamics and quark-gluon plasma. Indeed, the photon spectra measured in the recent RHIC and LHC experiments provide us with an opportunity to deepen understanding of the photon emission mechanism, as they have significantly larger anisotropies compared to theoretical estimates by the hydrodynamic modeling of the bulk properties, implying a missing photon production mechanism giving rise to the large anisotropy. This also implies that the sensible production mechanism should be able to provide a good amount of photons so the anisotropy survives in averaging over various photon sources.

We discuss a photon production mechanism associated with the fragmentation of jets of quarks and anti-quarks. We show theoretical estimates of the photon yield obtained from a convolution of the phenomenological jet distribution and the photon emission rate by the bremsstrahlung after the hard parton scatterings at the impact of heavy-ion collisions.

Our estimate shows a significant photon yield in a few GeV transverse momentum range and a power low behavior. This transverse momentum dependence may be consistent with a recent observation that the photon spectra measured in distinct collision energies can be fitted by power low exponents and the saturation momentum which characterizes the energy scale before and just after the collisions [Klein-Boesing, McLerran, Phys. Lett. B 741 (2015)]. An implication from this observation is the early-time emission of photons before other scales come into play. As a possible interpretation of the early-time emission, we argue that the power low behavior of the phenomenological jet distribution with an infrared cutoff by the saturation momentum is taken over by the photon spectrum. We also discuss anisotropy of the photon spectrum due to the jet energy loss which captures the anisotropic spatial geometry of the matter.

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Session Classification: Electromagnetic Probes I

Track Classification: Electromagnetic Probes