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The direct photon puzzle and the weak magnetic photon emission

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In heavy ion collisions, the measured spectrum of direct photons at RHIC and the LHC has been found as azimuthally anisotropic as pions. In particular, a large elliptic flow of the direct photos has been observed, which strongly contradicts conventional theoretical predictions, leading to the well-known "direct photon puzzle".

In this talk, instead of a strong magnetic field assumption which has been considered previously, we propose the effect of weak magnetic photon emission, originated from the interplay of a weak external magnetic field and the longitudinal dynamical evolution of the quark-gluon plasma. The weak magnetic photon emission results in an extra source of photon production from the quark-gluon plasma, with a large elliptic flow. In cases of Bjorken flow and more realistic 3+1D hydrodynamical evolution simulated via MUSIC, the effects of weak magnetic photon emission are justified. Given this novel effect, under realistic conditions with respect to heavy-ion collisions carried out at RHIC and the LHC, especially that a weak magnetic field satisfying $|eB| \ll m_\pi^2$, the experimentally measured direct photon elliptic flow can be well reproduced.

Accordingly, we found that the direct photon elliptic flow can be used as a magnetometer for the expanding QGP. For the top energy of RHIC collisions, through event-by-event hydrodynamic simulations with respect to Trento 3D initial conditions, the averaged magnetic field strength can be extracted to be a few percent of the pion mass square. Moreover, a significant increase in v_3 of direct photons is observed as well from the weak magnetic photon emission.

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Category

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