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Tri-hadron Azimuthal Correlations and the Conical Emission by Strong Color Fields without Collective Flow in p+p and p+Pb Collisions

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The azimuthal angular correlations (”ridge”) were well-known from the A+A collisions where the collimation of the hadrons in the azimuthal angle was ascribed to the collective flow of the Quark Gluon Plasma (QGP). The di-hadron correlations in the high multiplicity p+p and p+Pb collision events from the CMS experiment revealed a ridge structure that was very much like the ones from the A+A collisions. These results, which were not predicted by Monte Carlo based QCD simulations, attracted great interest since the formation of QGP and consequently a collective flow were not anticipated in p+p and p+Pb collisions.

Soon after the report of the CMS collaboration, it was shown that this ridge can be explained by the multiladder QCD diagrams (”glasma diagrams”) that were enhanced at the saturation scale at small-x. By means of these diagrams, the two particle gluon production rate can be written in terms of the unintegrated gluon distribution functions (UGD) of the colliding hadrons (or hadron and nucleus). Then, the UGD that is extracted from the running coupling BK equation (rcBK) is substituted in this formula. Later these correlated two gluons can be related to the observed di-hadrons via fragmentation functions. The strength of azimuthal correlations depends on the momenta and relative azimuthal angle of the di-hadrons as well as the saturation scale. It should be emphasized that this framework does not demand any collective flow to explain the data. Despite the excellent agreement between the data and the results of the glasma diagrams, however, the analyses employing the collective flow and the application of hydrodynamics to p+p and p+Pb collisions are also successful. Hence, this puzzle demands a study of tri-hadron correlations that may possibly settle the origin of the ridge in p+p and p+Pb events. Tri-hadron correlations will also put the Color Glass Condensate and saturation physics to more stringent test.

We calculate tri-hadron correlations from the glasma diagrams by using the rcBK UGDs for p+p ($\sqrt{s}$ =7 TeV) and p+Pb ($\sqrt{s}$ =5.02 TeV) collisions for several values of the momenta and relative azimuthal angle of the trigger and two associated hadrons. We repeat these calculations for different values of the saturation scale to predict the systematics of the track multiplicity of the actual measurements. Our tri-hadron azimuthal correlation results show that the glasma diagrams give rise to structures similar to the conical emission or Mach cone that have been discussed previously in the context of A+A collisions. However, we see these structures not only on the away side but also on the near side as distinguished from the Mach cone in A+A collisions which occur only on the away side. The azimuthal correlations due to the multiladder gluon production (glasma) are also clearly distinguished from the correlation structures that might be caused by other medium effects such as energy loss and jet deflection. We make quantitative predictions for the high multiplicity tri-hadron azimuthal correlations for p+p and p+Pb collisions at LHC. These tri-hadron correlations have not been measured yet by the experimental collaborations.

On behalf of collaboration:

None

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