Jet quenching and gluon saturation

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It is known that jet production is a manifestation of the underlying QCD dynamics. Jets can be defined as collimated sprays of particles that act as proxies for the properties of highly virtual partons, that participate in the hard scattering. Jet production in ultrarelativistic nucleus-–nucleus collisions plays a prominent role in probing the properties of the hot and dense nuclear matter formed in these events [1–3]. Their propagation through QGP is suppressed, or quenched [4, 5] (for a review see [6]). It was early established experimentally that the modifications arose due to final-state interactions. This lead to the theoretical development by Baier—Dokshitzer-–Mueller-Peigne—Schiff and Zakharov for the in-medium stimulated emissions that typically is referred to as the BDMPS-Z formalism [7–10]. Such emissions are responsible for transporting energy rapidly away from the jet axis to large angles [11, 12]. In [11, 13] the BDMPS-Z framework was generalized to account for transverse momentum of produced soft jets. The Blaizot–Dominguez–Iancu–Mehtar-Tani (BDIM) equation was solved in [14] and was applied to estimate the cross section for jet decorelations in Pb–Pb collisions [15]. The observation was that the quenching as described by the BDIM equation leads to sizeable broadening of the momentum distribution. The jet physics is also relevant for initial-state effects. In particular, the events where two jets approximately balance their momenta give an additional handle on probing how initial-state processes and their associated parton distribution functions affect the properties of the final-state jets. This is relevant for another phenomenon that is expected to occur at high-energy collisions, namely gluon saturation (for overview see [16, 17]). It originates from nonlinear initial-state effects leading to recombination of gluons. It is expected that the saturation effects can lead to modification of the cross section for dijets produced in the forward direction [18, 19].

In our contribution to Snowmass 2021 we would like to study what is the combined effect of jet quenching and saturation, and to investigate whether the saturation effects could be visible or would be washed out by quenching.

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