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An effective theory of medium induced radiation

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We revisit the picture of jets propagating in the quark-gluon plasma. In addition to vacuum radiation, related to the high initial virtuality of a jet, jet particles scatter on the medium constituents resulting in induced emissions. Analytical approaches to resumming these interactions have traditionally dealt separately with multiple, soft [1,2], or rare, hard scatterings [3,4]. A full resummation has so far only been available using numerical methods [5,6,7]. Our goal is to achieve full analytical control of the relevant scales and map out the dominant physical processes in the full phase space. To this aim, we extend existing resummation schemes for the medium-induced spectrum [4,8,9] to the Bethe-Heitler regime, to cover the whole phase space from early to late times, and from hard splittings to emission below the thermal scale. Based on the separation of scales, a space-time picture naturally emerges: at early times, jets start to build from both vacuum and rare, hard scattering induced emissions. At a later stage, determined by a resolution criterion, these emissions initiate a turbulent cascade [10] that rapidly degrades their energy down to, and including the Bethe-Heitler regime. We quantify the impact of such an improved picture, compared to the current state of the art factorization that includes only soft scatterings [11], by both analytical and numerical methods for the jet fragmentation function. Our work serves to improve our understanding of jet quenching from small to large systems and for future upgrades of Monte Carlo generators.

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