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Jet production and fragmentation at colliders

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Fragmentation (or in general, hadronization) is the transition from a colored and energetic parton to a colorless hadron is a rich and dynamical process in QCD quantified by the fragmentation function. Fast moving hadrons (or jets) are produced by the fragmentation of colored quarks or gluons that are produced during hard collisions at short distances. The determination of a characteristic time scale for the color neutralization would shed light on the properties of color confinement and help answer the question: how hadrons emerge out of quarks and gluons?

Since the earliest days of collider physics, jets have been an important tool in the exploration of QCD and have provided important discoveries and insights, in all colliding systems, including e-e, e-p hadron-hadron, and nucleus-nucleus. With the advances in experimental techniques, and corresponding theoretical progress over time, jets have become precision tools for studying the partonic structure of matter.
Starting at the Relativistic Heavy Ion Collider (RHIC) at BNL, a suppression by a factor of five of the yield of high p_{T} hadrons in Au-Au collisions, compared to proton-proton collision at the same energy was observed and called "jet quenching". The same phenomenon was confirmed by the heavy-ion program at the CERN's Large Hadron Collider (LHC) where the jet quenching phenomenon was observed at much greater collision energies that became accessible, allowing new and more detailed characterization of the quark-gluon plasma. While interacting with the medium, a modification of the jet structure and a redistribution of jet energy as well as a modification of their fragmentation pattern is expected.
Jets in (SI)DIS are also guaranteed to contribute at the Electron-Ion Collider (EIC) to a variety of key electron-nucleus and electron-hadron physics topics in particular the study of hadronization, aiming to shed light on the nature of color neutralization and confinement.

A selection of results (not focussed on a particular experiment) on jet physics will be discussed and compared to theoretical calculations. The measurements that will be discussed may include p_{T}-differential jet production cross sections or detailed studies of the parton shower through observables like the jet mass, jet fragmentation functions or jet substructure observables. Well defined jet shapes observables can also provide complementary information on the fragmentation process.

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