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Fluctuation measurements as a probe of hot QCD matter

Quantum chromodynamics (QCD), the fundamental theory of the strong interaction, predicts that at sufficiently high energy densities, nuclear matter undergoes a phase transition into a deconfined state known as the quark–gluon plasma (QGP). Ultrarelativistic heavy-ion collisions provide ideal conditions to explore the QCD phase diagram and investigate the properties of the QGP as a function of temperature and baryon chemical potential. At very high energies, such as those achieved at the Large Hadron Collider (LHC), and near vanishing baryon chemical potential, the transition from hadronic matter to the QGP is expected to be a smooth crossover. At larger values of baryon chemical potential, this crossover may terminate at a critical endpoint (CEP), beyond which the transition becomes first order. Identifying the CEP is a key objective of current and future beam energy scan programs at RHIC, the CERN SPS, and FAIR.
Fluctuation measurements are essential tools for probing the QCD phase structure and the nature of the QGP. In this talk, I will present an overview of recent experimental results across a wide range of collision energies and discuss their implications for our understanding of the QCD phase diagram.

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