Abstract for an Invited Paper
for the DNP11 Meeting of
The American Physical Society

From RHIC to LHC: Lessons on the QGP[1]

ULRICH HEINZ, The Ohio State University

Recent data from heavy-ion collisions at RHIC and LHC, together with significant advances in theory, have allowed us to make significant first steps in proceeding from a qualitative understanding of high energy collision dynamics to a quantitative characterization of the transport properties of the hot and dense QCD matter created in these collisions. The almost perfectly liquid nature of the Quark-Gluon Plasma (QGP) created at RHIC has recently also been confirmed at the much higher LHC energies, and we can now constrain the specific QGP shear viscosity $(\eta/s)_{\mathrm{QGP}}$ to within a factor of 2.5 of its conjectured lower quantum bound. Viscous hydrodynamics, coupled to a microscopic hadron cascade at late times, has proven to be an extremely successful and highly predictive model for the QGP evolution at RHIC and LHC. The experimental discovery of higher order harmonic flow coefficients and their theoretically predicted differential sensitivity to shear viscosity promises additional gains in precision by about a factor 5 in $(\eta/s)_{\mathrm{QGP}}$ for the very near future. The observed modification of jets and suppression of high-p_T hadrons confirms the picture of the QGP as a strongly coupled colored liquid, and recent LHC data yield strong constraints on parton energy loss models, putting significant strain on some theoretical approaches, tuned to RHIC data, that are based on leading-order perturbative QCD. Thermal photon radiation provides important cross-checks on the early stages of dynamical evolution models and constrains the initial QGP temperature, but the recently measured strong photon elliptic flow challenges our present understanding of photon emission rates in the hadronic phase. Recent progress in developing a complete theoretical model for all stages of the QGP fireball expansion, from strong fluctuating gluon fields at its beginning to final hadronic freeze-out, and remaining challenges will be discussed.

[1]Work supported by DOE (grants DE-SC0004286 and DE-SC0004104 (JET Collaboration)).