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Pinning down QCD-matter shear viscosity in A+A collisions via EbyE fluctuations using pQCD + saturation + hydrodynamics

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We compute the initial fluctuating QCD-matter energy densities produced in ultrarelativistic heavy-ion collisions from NLO perturbative QCD using a saturation conjecture to control soft particle production [1], and describe the subsequent space-time evolution of the system with dissipative fluid dynamics [2], event by event [3]. The resulting centrality dependence of hadronic multiplicities, p_T spectra, and flow coefficients from this pQCD + saturation + hydro ("EKRT") framework are then compared simultaneously to the LHC and RHIC measurements. We also show that the computed probability distributions of relative event-by-event fluctuations of the flow coefficients, that mostly constrain the initial conditions, match well with the LHC measurements. With such a systematic multi-energy and multi-observable analysis we can test the initial state calculation and applicability of hydrodynamics, and also constrain the temperature dependence of the shear viscosity-to-entropy ratio of QCD matter in its different phases. Furthermore, we demonstrate that correlations of two and three event-plane angles provide additional constraints to the temperature dependence of the shear viscosity. As shown in [3], we can describe all these different flow coefficients and correlations remarkably consistently with the shear viscosity that is independent of the collision energy. Using these constraints from the current RHIC and LHC measurements we then predict the charged hadron multiplicities, p_T spectra, flow coefficients and event-plane correlations for the forthcoming 5 ATeV Pb+Pb collisions.

[1] R. Paatelainen, K. J. Eskola, H. Holopainen and K. Tuominen, Phys. Rev. C 87 (2013) 044904.

[2] R. Paatelainen, K. J. Eskola, H. Niemi and K. Tuominen, Phys. Lett. B 731 (2014) 126.

[3] H. Niemi, K. J. Eskola and R. Paatelainen, arXiv:1505.02677 [hep-ph].

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