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Thermalization of Quark-Gluon Plasmas

How does a soup of high-energy quarks and gluons equilibrate from very non-equilibrium initial conditions, such as in the immediate aftermath of heavy ion collisions? A theorist's natural instinct is to first warm up by solving the problem for arbitrarily high-energy collisions, where the running strong coupling is arbitrarily small. But even in this limit, the physics of equilibration turns out to be rich and complicated and not yet completely understood. I will describe the pieces involved in the equilibration of quark-gluon plasmas in the small coupling limit. First, I will review thermal gauge theory in equilibrium and its excitations. Next, I will discuss the relaxation of small deviations from equilibrium and how hydrodynamical properties can be calculated (at leading order) from first principles. Finally, I will talk about large deviations from equilibrium and the role of collective effects such as plasma instabilities in thermalization.