Isothermal Compressibility and Specific Heat of Hadronic Matter formed in Heavy-Ion Collisions

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According to Big-Bang theory, at the earliest of its expansion, the universe existed as QGP. As it cooled down, the deconfinement-confinement phase transition occurred, and hadrons were formed. Study about this kind of a phase transition can lead us to understand the early stages of universe formation. The transformation of matter at high enough energies, from nucleons to constituent quarks and gluons had been very fascinating and equally very challenging.

In this thesis, we intend to study ultra-relativistic heavy-ion collisions by using fluctuations of charged particle multiplicity and temperature. The study of event-by-event fluctuations of temperature and charged particle multiplicity will give an approximation of the specific heat and isothermal compressibility of the system respectively. A novel method has also been proposed for the specific heat calculation based on the lattice QCD simulation results on the initial energy density in heavy-ion collisions. Together these two observables can predict something about the critical point in the QCD phase diagram. The temperature parameter is obtained from the transverse momentum distribution of the outgoing particles. Several models are studied for obtaining the best approximation to the experimental data on transverse momentum of identified particles from Pb+Pb collisions at $\sqrt{s_{NN}} =$ 2.76 TeV. Charged particle multiplicity distributions are studied for Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and the variation of isothermal compressibility is shown over a temperature range of 150 - 250 MeV.