ADVANCES IN CONTEMPORARY PHYSICS

HIGH-ENERGY, COSMOLOGY, AND SOFT MATTER

Editor:

Dr. Syed Salman Ahmad Warsi

ADVANCES IN CONTEMPORARY PHYSICS: HIGH-ENERGY, COSMOLOGY, AND SOFT MATTER

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Advances In Contemporary Physics

High-Energy, Cosmology, and Soft Matter

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QUARK GLUON PLASMA: ITS FORMATION AND VARIOUS SIGNATURES

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This chapter gives an introduction to the Quark Gluon Plasma (QGP), a primordial state of matter which was present in the early universe just after the few microsecond of the big bang and is also predicted to be in the core of some compact stars. We have discussed the formation of this novel state of matter in the ultra-relativistic heavy ion collision experiments at relativistic heavy ion collider (RHIC) at BNL in USA and large hadron collider (LHC) at CERN. A brief overview of the major signatures of QGP has been presented. A qualitative discussion about the various theoretical techniques employed to study the properties of the QGP has also been done.

INTRODUCTION:

Physicists have always tried to know the fundamental building blocks of the universe and the interactions governing them. To date, there are four fundamental forces in nature: Gravity is a well-known force, which acts between the massive objects. Einstein's general theory of relativity is the most trusted classical framework to describe the gravity and its various implications in the universe around us. People are working to build a quantum theory for gravity. Electromagnetic force acts between the electrically charged objects. In classical physics, it is described by Maxwell's equations, while quantum mechanically it is explained by Quantum Electrodynamics (QED). Weak is a short range force, which governs the laws of nuclear fusion reaction. The quantum theory of weak interaction is known as Quantum Flavourodynamics (QFD). Strong interaction is responsible for the formation of nuclei in the atoms and acts between the quarks and gluons, the fundamental building blocks of the universe. The quantum field theory governing strong force is called Quantum Chromodynamics (QCD).

According to the Big Bang theory, which is the most reliable theory governing the evolution of the universe, our universe is expanding with time and was smaller and hotter in earlier stages. With decrease in its temperature, it went through various phase transitions such as grand unification, electroweak, and QCD phase transition etc. at different times of its evolution history [1, 2]. Among these, QCD phase transition is our current interest, which had taken place around $T \sim \Lambda_{QCD} \approx 200$ MeV when the universe was few microseconds old. QCD phase transition can be explored in laboratories. The study of dynamics of QCD phase transition is also important in the