論文の内容の要旨

Hydrodynamic response to jet propagation in quark-gluon plasma

(ジェットに対するクォーク・グルーオン・プラズマの流体力学的応答)

橘　保貴

In this thesis, we study the hydrodynamic response to jet propagation in the quark-gluon plasma (QGP). The QGP, the deconfined state of quarks and gluons, is realized under extreme conditions such as the heavy ion collisions (HIC) where extremely high-temperature is achieved by a head-on collision of two heavy nuclei accelerated at nearly the speed of light. The QGP created in the HIC behaves as an almost-perfect fluid and expands with relativistic velocity. The space-time evolution of the QGP is known to be well described by the relativistic hydrodynamics. In the HIC, high-energy quarks and gluons, so-called jets, are produced by hard processes. They do not participate in the hydrodynamical evolution of the QGP fluid, but traverse the QGP while losing their energies and momenta due to strong interactions. The QGP medium are excited by the incoming energy and momentum from jets and Mach cones emerge as the hydrodynamic response. Such a hydrodynamic response carries the information of various properties of QGP. In Pb-Pb collisions at LHC, low momentum particles at large angles from the jets are enhanced in dijet asymmetric events. Since these low momentum particles are considered as constituents of the hydrodynamic fluid, their enhancement at large angles can be interpreted as the hydrodynamic response to the jets.

Motivated by the experimental data in the HIC, we study the space-time evolution of the QGP in dijet asymmetric events to make a theoretical connection between the medium response to the jet propagation and the enhancement of the low-momentum particles in the HIC. We formulate a hydrodynamic model with source terms to describe the space-time evolution of the QGP fluid with jet propagations. Then, we perform simulations in the case of the dijet traversing the center of the expanding medium. We find the Mach cones which are distorted strongly by the radial expansion of the medium. We show the enhancement of low momentum particles at large angles in dijet asymmetric events take place as a result of the distorted Mach cone. Furthermore, we perform simulations by changing both the jet production points and the initial energies of dijet. We evaluate the effect of the number of dijet events and carry out the event averaged calculations. As a result, we show that the enhancement of low momentum particles at large angles is the universal phenomenon originating from the hydrodynamic response to the jet propagation.