論文の内容の要旨

Dynamical Evolution of Quark Degrees of Freedom in the Relativistic Heavy Ion Collision within the Color Glass Condensate Framework

（カラーグラス凝縮による相対論的重イオン衝突におけるクォーク自由度の動的発展）

氏名　モラレス ロドリゲス パブロ アンドレス

In the context of ultra-relativistic heavy-ion collisions, most of the phenomenological approaches typically assume some initial matter distributions in hydrodynamic simulations. While hydrodynamic models are successful for the late stages of the collision, at early times of the collision the quarks and gluons emerge from the microscopic dynamics of quantum chromodynamics (QCD). On top of the QCD dynamics, during the earliest stages extremely high magnetic fields of the order of $e\boldsymbol{B} \sim 10^{18}$ G are expected from peripheral collisions. The existence of such strong magnetic fields leads to a set of novel effects such as the magnetic catalysis of quark matter and exotic transport phenomena. Much of discussion in the recent literature is focused on the exciting possibility to observe the *CP*-violating effects caused by chiral anomalies: The Chiral Magnetic/Separation Effect (CME/CSE) and the Chiral Vortical Effect (CVE). Anomalous processes as well as the axial charge generation play an important role and are indispensable in understanding the anomalous transport in a quark-gluon plasma (QGP). However, the lack of theoretical prediction on a clear-cut signature for anomalous phenomena has frustrated its observation in heavy ion collision experiments.

This thesis represents an attempt to formulate the axial charge dynamics in an expanding geometry using a simplified setup motivated by the heavy ion collision. Although most of preceding works assume constant magnetic fields, the lifetime of the magnetic fields is as short as QCD time scales. Therefore, precise knowledge on the initial conditions for the heavy ion collision is required to make a theoretical prediction. This early-time regime with strong magnetic fields is dominated by the coherent gluon fields which can be described well by the Color-Glass- Condensate (CGC) framework. In this thesis, the generation of the axial charge density was studied in systems with the CGC inspired initial conditions for constant background fields. The effect of finite quark masses was given a special attention and the mass suppression of the axial charge generation was numerically confirmed, which is quite non-trivial not directly inferred from the axial Ward identity.