

Research Plans

Shunichiro Kinoshita

Recently, a considerable number of studies have been conducted on the application of the AdS/CFT correspondence to realistic strongly coupled systems such as quark-gluon plasma in QCD, superconductor in condensed matter physics, and so on. It is non-trivial and intriguing problem whether one can extend the concept of the AdS/CFT correspondence to time-dependent systems which are not at thermal equilibrium. I will investigate dynamics and thermodynamics of higher dimensional black holes in details and explore physics of holographic systems in terms of dual geometries from the gravitational side.

Non-equilibrium process for holographic QCD:

The D3/D7 system is one of models which can realize holographic QCD in the dual field theory. Considering a stack of D3 branes and probe D7 branes, it is important to discuss dynamics of the D7 branes inside asymptotically AdS spacetime. In addition, to replace the AdS space with the AdS black hole corresponds to the gauge theory at finite temperature and configuration of the D7 brane will change depending mass of the black hole, that is phase transition in the dual field theory.

In such holographic QCD model, in order to investigate non-equilibrium process of the phase transition I will numerically analyze time evolutions of the D7 brane on dynamical background spacetimes such as forming a black hole. Firstly, I will establish formulation to stably solve the equations of motion for the D7 brane on dynamical background, which are derived from the DBI action. Next, I will discuss behaviors of non-equilibrium process when phase transition and relations with thermodynamic quantities of the black hole based on solutions numerically constructed. Especially, I will focus on the order parameter characterizing the phase transition and time dependence of the Hawking temperature of the black hole.

Thermodynamic properties of non-stationary spacetime:

The fact that black holes have thermodynamic properties is one of important issues to establish quantum theory of gravity. Moreover, it plays a fundamental role when we apply the AdS/CFT correspondence to studies of strongly-coupled system by using gravity.

Based our previous work in which we derived the Hawking temperature for non-stationary black holes by a semi-classical approach, I would like to explore other thermodynamic properties and establish thermodynamic relations for non-stationary spacetimes.

I believe it is important to reveal thermodynamic properties of non-stationary black holes if we will apply the AdS/CFT correspondence to time-dependent phenomena.