Research Plan

Objectives

Analysis of higher dimensional black holes in the Large D limit

The Einstein equation is the non-linear partial differential equation, which is quite difficult to solve in general. In the large D limit, however, the Einstein equation reduces its inhomogeneity by one and becomes much more tractable. My research objective is to study the property and dynamics of higher dimensional black holes in more general shapes and with various matter fields and modified gravity theory by the large D expansion method.

Research Plan

I am planning to develop the study of the large D limit in several directions.

(i) Formulating the large gradient variation in the large D

Conventional formulations developed so far do not correctly capture phenomena where there is a large variation and wave propagation in the far region. Especially, although several studies on gravitational collapse and black hole collision imply the existence of a certain large D description, there has been no success so far in the analysis by the large D approach. Studying the large D limit of these phenomena will greatly enlarge the range of the applicability of the large D limit.

(ii) Generalization of Large D Effective Theory

The large D limit greatly simplifies the analysis of Einstein's equations. The fluctuations of the horizon of black holes become much simpler and are often solved analytically, or with unsophisticated numerical methods. Until now, several non-uniform solutions are solved by the large D effective approach in each different setup. I will study the higher dimensional solutions in more general setup, to obtain the general large D effective theory which is valid for general background and spacetime symmetry. Using the general effective equation, I will investigate the non-uniform black hole solutions and these dynamics. I will also extend the general effective theory analysis to the case with the charges and other matter sources.

Generalization to the higher curvature gravity (i.e. Gauss-Bonnet or Lovelock theory) is another interesting topic. Because the higher curvature corrections are expected from the string theory, it is natural to include these corrections when the higher dimension is considered. Currently, Bin Chen and collaborators have shown that the large D effective theory is applicable to Gauss-Bonnet black holes. An open problem is that if this also happens for the rotating black holes, and general Lovelock black holes.

(iii) Application through AdS/CFT correspondence

Since the large D effective approach is quite useful to treat the non-uniform black hole spacetimes, the application to the AdS/CFT correspondence for the study of the boundary field theory will give interesting analytic implications.
For now, I will undertake the following topics:
- Shockwave collision on the AdS black brane
- Holographic Superconductor