

Research Plan

Objectives

Study 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, when the gradient along the horizon is moderate, the Einstein equation reduces to the more tractable effective membrane equation with one fewer inhomogeneity. 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 limit. I also investigate the large D limit in non-vacuum cases with charges and other matter fields as well as that for the modified theories of gravity.

Research Plan

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

(i) Exploring the large D limit with the large gradient variation

Conventional formulations developed so far do not correctly capture the phenomena with the large variation along the horizon 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 a little success so far in the analysis by the large D approach. I and collaborator showed that the large D limit with another new scaling ansatz describes the topology-changing solutions involving the pinching horizon, which implies the relation between the Ricci flow and the large gradient regime. Studying the large D limit of these phenomena will greatly enlarge the range of the applicability of the large D limit.

(ii) General Application of Large D Effective Theory

Large D effective theory approach is applicable for the spacetime with rotations, charges and other matter fields. Applying the large D effective theory method to more general cases, I will study the variety of black holes. Due to the strongly suppressed gravitational wave emissions, rotating non-axisymmetric black holes are allowed to be stationary at large D. I will investigate the non-axisymmetric solutions using the large D effective approach. The spacetime with charges and other matter fields will be also studied.

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.