Research Plan

Objectives

Universality of the Large D limit

Gregory-Laflamme instability of the black string cannot be analytically solved in usual way, but it was solved by expanding with $1/D$ in the large D limit. In the large D analysis, the perturbation equation simplified extremely so that the analytical treatment becomes possible. The same has happened in the case of the scalar absorption probability. Therefore, it is expected that such simplification is the more universal phenomenon, that is, in the more general cases in which the analytical treatment was usually impossible, the similar simplification will happen. My research objective is to show the large D limit can be applicable to the more general gravitational phenomenon and its universality in the General Relativity. Furthermore, the simplification in the large D limit will imply that the dynamics of the gravity in this limit are described by the certain simple theory. I also investigate such equivalent description.

Exploring the black holes in the large D limit

Our works revealed that the large D limit is the good approximation, at least, in the linear order analysis. However, this can be also useful approximation in solving the Einstein equation nonlinearly. Since the decoupling property in this limit comes from the following fact that, in the large D limit, the near horizon spacetime varies mainly in the radial direction and the gradient in other directions can be ignored, and therefore the equation decouples into the radial part and the other parts. This will be also true for the nonlinear equation.

Research Plan

Toward the objectives and considering the above result, I am planning the following researches.

Exploring the static black holes in the large D limit

Applying the large D limit into the Einstein equation, we will study the static solutions in the limit.

From the numerical results, even in the simple static spacetime, such as the non-uniform black strings and black branes and with the negative cosmological constant, the black funnel and droplet are expected. We investigate the existence of such solutions and other undiscovered solutions in the limit.

Exploring the stationary black holes in the large D limit

In the higher dimension, rotating black holes are known to become unstable with the sufficiently large rotation. Especially, the existence of new deformed solutions bifurcating from the stationary mode perturbations was expected and some solutions were constructed numerically. Applying the large D limit into the stationary Einstein equation, we investigate such deformed rotating solutions.

Description of Dynamics of the Large D Gravity

The result in the Myers-Perry black hole with equally rotating case may imply the existence of a simple description for the near horizon geometry dynamics of the Myers-Perry black holes. I will also investigate the alternative description of the near horizon dynamics in the large D limit.