

Research Results

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My research interests lie in gravitational physics. In particular, I focus on black hole physics and cosmology in higher dimensional spacetime. One the most promising candidate for the fundamental theory, which attempts to unify gravity with the other forces into a consistent quantum theory, is the superstring theory. It is naturally and consistently formulated in higher dimensional spacetime rather than four dimensions.

Caged black hole with Maxwell charge:

In higher-dimensional spacetimes, it is well known that various black objects can exist for the same conserved quantities, mass, electric charge, and so on. In particular, in the Kaluza-Klein spacetime where some extra-dimensions are compactified, it has been analytically or numerically examined that black strings whose event horizons are extending to extra dimensions and black holes with spherical horizons.

In this work, I and my collaborator have analytically constructed charged black hole solutions in the Kaluza-Klein spacetime compactifying one dimension by using the matched asymptotic expansion up to leading order of an expansion parameter. We have derived conserved quantities characterizing the constructed solutions up to leading order, and also confirmed that the first law of thermodynamics satisfies and showed that those solutions continuously becomes the exact solution in extremal limit.

Angular momentum at null infinity in higher dimensions:

Asymptotically flat spacetimes which asymptotically approach the Minkowski spacetime have null infinity at which electro-magnetic or gravitational wave propagating at light speed can arrive. In this work, I and my collaborator have defined angular momentum at null infinity (Bondi angular momentum) for arbitrary higher dimensions including odd dimensions by using Bondi coordinates.

We have showed that this angular momentum together with the Bondi mass defined previously are covariant with respect to the Poincaré transformation and asymptotic symmetry at null infinity in higher dimensions becomes the Poincaé group. Also, we have showed that the angular momentum can be defined without any ambiguities in higher dimensions because the asymptotic symmetry does not contain super-translation which has infinite degrees of freedom unlike in the case of the four dimensions.