Research plans

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A family of five-dimensional squashed Kaluza-Klein black hole solutions, which asymptote to effectively four-dimensional spacetimes with a compact extra dimension, is one of realistic higher-dimensional spacetime models. In order to discuss the relation between such solutions and our four-dimensional spacetime, I consider the verification of extra dimension by squashed Kaluza-Klein black hole solutions. Further, I generalize five-dimensional squashed Kaluza-Klein black hole solutions to higher-dimensional black hole solutions with a compact extra dimension.

Verification of extra dimension by squashed Kaluza-Klein black hole solutions

In the brane world scenarios, one of interesting problems is a verification of extra dimensions by various physical phenomena in higher-dimensional spacetimes. In such phenomena, I focus on the geodetic precession effect and the classical tests, i.e., light deflection, time delay and perihelion precession, as the first step. The five-dimensional squashed Kaluza-Klein black hole spacetime admits stable circular orbits similar to the four-dimensional Schwarzschild black holes. Then I have considered the parallel transportation of a spin vector along a circular geodesic in the squashed Kaluza-Klein black hole spacetime and derived the geodetic precession angle with the higher-dimensional correction [3]. If a precise experiment of gyroscope precession in the Earth's orbit agrees with the expected value of general relativity, it requires a rigorous upper limit of the size of the extra dimension, or it excludes the squashed Kaluza-Klein metric for describing the geometry around the Earth.

Recently, I have applied the derivation method of Hawking radiation on the basis of the quantum tunneling mechanism proposed by Parikh and Wilczek to the five-dimensional squashed Kaluza-Klein black hole solution and obtained both its Hawking temperature and the effect of the back reaction associated with the radiation [1]. In order to see that the squashed black hole is not the thermal body but the blackbody, I derive the blackbody spectrum for the squashed Kaluza-Klein black hole on the basis of the tunneling mechanism. Further, I discuss Hawking radiation with quantum corrections. If higher-dimensional black holes are created in future accelerator experiments and we assume that the squashed Kaluza-Klein black hole solutions describe geometries around such black holes, I expect that my present work would make a contribution to the verifications of both Hawking radiation and an extra dimension in asymptotically Kaluza-Klein spacetimes.

Higher-dimensional black hole solutions with a compact extra dimension

I would like to extend previous analysis in five dimensions to that in odd dimensions larger than five. Since odd-dimensional spheres S^{2n+3} (n: natural numbers) have structures similar to an S^3, I expect that constructions of black hole solutions are also similar to those in five dimensions. However, as far as I know, the exact black hole solutions with a compactified extra dimension have not been found. As a first step, I would like to construct extremal charged solutions where the mass of the black hole is equal to its charge. In such cases, since the Einstein and the Maxwell equations reduce to the Laplace equation in odd dimensions, I expect that the analysis becomes similar as done in five dimensions. Further, by introducing a positive cosmological constant, I generalize such solutions to dynamical black hole solutions with a compact extra dimension.