Research Results

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A. Dynamics and stationary configurations of Nambu-Goto closed strings in five-dimensional spacetimes [2, 7, 8]

Singular points called cusps are generically formed on closed Nambu-Goto strings in four-dimensional spacetime. Since the phenomena depend on spacetime dimensions, closed strings in higher-dimensional spacetime cannot have cusps on the world sheets. Therefore, closed strings without cusps are specific objects in higher-dimensional spacetimes. The latest paper [2] gives configurations of stationary closed strings in five-dimensional flat spacetimes as general solutions of equations for stationary strings. We found elegant geometrical structure of strings of which projected shape onto two independent two-dimensional planes is drawn as (star) polygons. As a special configuration, the solutions include toroidal spiral strings (given in [7, 8]) that have homogeneous world sheets. The specialty has an advantage to understand stationary closed strings in detail. These results suggest that closed strings in higher-dimensional spacetimes emit gravitational wave with periodic wave forms, and the dependence of gravitational wave forms on spacetime dimensions is important theoretical and observational issue.

B. Stable bound orbits and chaotic orbits in singly rotating black ring spacetimes [1, 4, 5]

There seems to exist no stable circular orbit in higher-dimensional spherical black hole. The difference from four-dimensional case is understood as the dependence of properties of gravitational fields on spacetime dimensions. On the other hand, the existence of stable bound orbits in black ring spacetimes is not a trivial issue because they have more complicated gravitational fields. Under the research background, we investigate geodesics in singly rotating black ring spacetimes and revealed that stable bound orbits exist for both massive and massless particles [1, 5]. Furthermore, the paper [4] shows that a part of bounded orbits of massive particles in finite regions outside the horizon behaves chaotic. These results show qualitative difference of gravitational fields between black holes and black rings. Furthermore, the existence of chaotic geodesics is strong evidence for the absence of hidden symmetries in black ring spacetime. This provides a new knowledge of symmetries of black rings.