# Research Plans

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**Rotating boson stars as candidates for compact astronomical objects**

It is believed that almost all compact astronomical objects observed currently are rotating. Hence, in order to describe them, we consider rotating boson stars as candidates for compact astronomical objects other than BHs. In our previous study, only stationary and spherical boson stars were investigated. In particular, it was found that, in the case of the stationary and spherical boson stars in the GH scalar model coupled with gravity, solutions exist ranging from extended objects with a mass equal to that of the Sun to compact and supermassive ones, depending on the choice of parameters. There are possibilities that the various properties possessed by the stationary and spherical boson stars can be extended to those of the rotating case. Therefore, this study aims to derive rotating boson stars in this system and clarify the properties of these solutions, and understand observed compact astronomical objects more deeply.

**Possibilities for extending BH vacuum magnetospheres**

Our previous study clarified the vacuum magnetospheres generated by the toroidal current on the equatorial plane in Kerr spacetime. Our next steps are to extend the framework and to clarify (1) phenomena associated with the dynamics of charged particles in these magnetospheres, and (2) the magnetosphere with plasma.

(1) In the magnetosphere divided into two regions, it is possible that charged particles are accelerated to high energies at the boundary surface. These high-energy particles are important for investigating the high-energy astronomical phenomena such as relativistic jets. The aim of this study is to evaluate the acquired energy through the analysis of the dynamics of charged particles. This analysis is currently in progress and nearing completion. Moreover, it was found that the boundary surface, which divides the magnetosphere into two regions, was formed by assigning an electric charge to the BH. Thus, we also aim to estimate the charge accretion rate onto the BH by using a similar framework.

(2) From observations, it is suggested that plasma exists in the magnetosphere. If the plasma exists within the magnetosphere, it is expected that the electric field generated by the BH's rotation causes the plasma to undergo charge separation, and the component of the electric field parallel to the magnetic field vanishes. It is known that in such a magnetosphere, the rotational energy of BHs can be extracted through the electromagnetic field, and this is a leading candidate for an energy source of high-energy phenomena such as relativistic jets. We will extend the BH magnetosphere obtained in [3] to that with plasma, and discuss the possibility of energy extraction.

**Magnetosphere around boson stars**

Although two topics above are first analyzed in this study, we aim to investigate the magnetospheres around objects such as boson stars, other than BHs, in the future. This is expected to suggest the observables which can distinguish BHs and other objects.