Future Research Plans

Stability of soliton stars by numerical calculations

In the coupled systems of gravitational field and boson fields, soliton solutions, which are called boson star, are known. Boson stars have not been observed, but they are interesting exotic stars because they can be dark matter candidate and seed of supermassive black holes. We focus on boson stars which are obtained by considering gravitational fields, scalar field, and gauge field. In our previous works, nontopological solitons appear in the model. Boson stars in the model are called soliton stars.

Stability of the soliton stars is discussed from several perspectives. The first is to discuss energy stability. Since the soliton star can be interpreted as a condensation of bosonic particles, by comparing the energy of the soliton star and one of rest mass for bosonic particles, it can be given the condition that the soliton star does not disperse into free bosonic particles. However, since this is not enough to discuss stability, we will also discuss the stability of other perspectives.

The next point of view is the discussion of linear stability. This can be discussed by solving the linear equations for perturbation in classical fields for the soliton stars. The linear stability is characterized by sign of an eigenvalue of this perturbation. We analyze the stability near the maximum mass, which is particularly important in theory of boson stars.

In addition, time evolution is investigated by numerical simulations to investigate stability against nonlinear perturbations. In order to develop the time of the Einstein equation, a method is taken by dividing the four-dimensional spacetime into a time and three-dimensional space, and developing the metric of space over time. In this way, we investigate the process of soliton stars collapsing into black holes.

Hybrid solitons

We have been investigated about nontopological soliton. But in the theory of this study, since spontaneous symmetry breaking occurs, topological solitons called "cosmic strings" can also be constructed. From this view, it is possible to newly construct a hybrid soliton solution that has the properties of cosmic strings and nontopological solitons at the same time. This hybrid solitons cannot be configured with the common model of nontopological solitons or topological solitons, so they are unique solutions in this study. In this study, we discuss the properties and stability of this hybrid solitons, and consider its application to general relativity and cosmology.