Plan of future research

Hirotaka Yoshino

I would like to contribute to the progress of science, making use of numerical techniques that I have acquired so far and of deep understanding on physical phenomena in strong gravity. I would choose research issues that deepen our understanding of general relativity, and have possibility to find new physics. In the next few years, I will study the following topics.

System of a black hole and axion field

As the most important issue, I continue the research of Ref. [I-4] to clarify the following points:

- Determination of the final state of an axion cloud for each set of system parameters;

  Up to now, we have obtained the indication that when the self-interaction of the axion field is important, the axion cloud emits the amount of energy to the distant place which is approximately same as that of the extracted energy from the black hole. I will determine this final state of the axion cloud for various values of system parameters.

- Calculation of gravitational waves from an axion cloud;

  By completing the code for calculating gravitational waves, I will give predictions on the wave forms of emitted gravitational radiation. The wave form calculated here will be used as templates for analyzing observational data at the gravitational wave interferometers like the aLIGO and the KAGRA.

- Time evolution of parameters of the system of a black hole with an axion cloud;

  Because the axion cloud extracts the energy and angular momentum of the black hole, their values change in time. I will calculate this process and provide a prediction on the distribution of mass and angular momentum of observed black holes.

I point out that although there are other groups studying the system of a black hole with massive scalar fields, they ignore self-interaction of scalar fields. I am aiming at making a research with originality by including the effects of self-interaction.

Behavior of light around a black hole:

I continue the research on the behavior of light around a black hole as well. In the axisymmetric spacetime, I have obtained the indication that the area of a photon surface is bounded from below as $A \geq 8\pi J$, where J is the angular momentum of the spacetime. I am planning to prove this. In a similar way, I will clarify the properties of black holes that have sufficient generality.

Other topics:

If I have time, I would challenge other topics, such as the determination of existence/nonexistence of static black hole solution in the Randall-Sundrum scenario, or calculation of gravitational waves emitted from merger of binary black holes/neutron stars in the Einstein-Cartan theory, where "torsion" degree of freedom is added to the theory of general relativity.

Also, I am now collaborating with Prof. Ken-ichi Nakao and his student, Mr. Kazuma Takahashi in particle physics group to clarify how a gravitationally collapsing star looks by electromagnetic observations. With Prof. Hideki Ishihara and his student Mr. Nobuyuki Asaka in astrophysics group, I started a plan to study the behavior of light around binary black holes. In this manner, I am interested in discussing and collaborating with group members. I will contribute to activity of the groups by motivating and energizing students.