Research results

Ken Matsuno

○**Higher-dimensional black holes with compactified extra dimensions [1-22, 24, 25]**

Higher-dimensional black hole solutions are actively discussed in the context of string theories and braneworld models. Since our observable world is effectively four dimensional, we can regard higher-dimensional black hole solutions with compactified extra dimensions as candidates of realistic models. We call these Kaluza-Klein black holes. The four-dimensional Schwarzschild metric uniquely describes the general relativistic gravitational field in vacuum with spherical symmetry. However, even if we impose asymptotic flatness to the four-dimensional part of the higher-dimensional spacetime model with Kaluza-Klein structure, the metric is not uniquely determined. A family of five-dimensional squashed Kaluza-Klein black hole solutions represent fully five-dimensional black holes near the squashed S^3 horizons and asymptote to effective four-dimensional spacetimes with a twisted S^1 as an extra dimension at infinity. Then we can regard a series of squashed Kaluza-Klein black hole solutions with a twisted compactified extra dimension as one of realistic higher-dimensional black hole models. Several aspects of squashed Kaluza-Klein black holes have been discussed, for example, thermodynamics, Hawking radiation, stabilities, gyroscope precession, thin accretion disk, X-ray reflection spectroscopy, strong gravitational lensing and black hole shadow. Recently, we study motions of photons in an unmagnetized cold homogeneous plasma medium in the five-dimensional charged static squashed Kaluza-Klein black hole spacetime. In this case, a photon behaves as a massive particle in a four-dimensional spherically symmetric spacetime. We consider the light deflection by the squashed Kaluza-Klein black hole surrounded by the plasma in a weak-field limit. We derive corrections of the deflection angle to general relativity, which are related to the size of the extra dimension, the charge of the black hole and the ratio between the plasma and the photon frequencies.

○**Particle acceleration by ion-acoustic solitons in plasma [23]**

We propose a new acceleration mechanism for charged particles by using cylindrical or spherical nonlinear acoustic waves propagating in ion-electron plasma. The acoustic wave, which is described by the cylindrical or spherical Korteweg-de Vries equation, grows in its wave height as the wave shrinks to the center. Charged particles confined by the electric potential accompanied with the shrinking wave get energy by repetition of reflections. We obtain power law spectrum of energy for accelerated particles. As an application, we discuss briefly that high energy particles coming from the Sun are produced by the present mechanism.