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Abstract

• We investigated a detailed analysis of the horizons structure of rotating Hayward's regular black hole. A Hayward black hole has an additional parameter g as compare with the Kerr black hole, which provides deviation from the Kerr black hole. The equations of motion of a test particle around the black hole are derived. Moreover, we described the particle acceleration around the rotating Hayward black hole. It is found that an enormous amount of center-of-mass energy (E_{CM}) is obtained for an extremal black hole. Besides, we acquire a finite upper bound of E_{CM} for a nonextremal black hole. Further, we investigated the effect of constant g on the E_{CM}, as a consequence there is an increase in E_{CM} due to g.

• We studied the horizons and ergosphere of the rotating Bardeen black hole. We discussed the effect of deviation parameter g on the ergosphere and calculate the particle orbits around the rotating Bardeen black hole. We calculated the minimum and maximum values of particle angular momentum for different values of parameter g and a. These values provide an idea whether the particle fall into the black hole or not. Then, we calculated the E_{CM} due to the collision of particles in the vicinity of the rotating Bardeen black hole. As a result, we noticed that the E_{CM} is unbounded for the extremal cases and and it is finite for nonextremal cases. Moreover, the effect of charge g on the E_{CM} is also analyzed that differs it from the Kerr black hole.

• A black hole casts a shadow due to an optical appearance of the gravitational field. When a black hole is placed between a light source and an observer, some photons with low impact parameter moving towards the black hole from a light source form the unstable circular orbits around the event horizon. A very far away observer can detect these photons and hence, the black hole is observed as a shadow. Observing the photon region around the event horizon is one of the possible method to measure the nature of the astrophysical black hole. We studied the shadows of different rotating regular black holes, viz., Ayón-Beato-García, Hayward, and Bardeen. We demonstrated the effect of the parameters, Q, g, g_* on the size of the black hole shadow, and it is found that the radius of the shadow decreases in each case. Moreover, we calculated the distortion in the shape of shadow due to the presence of rotation parameter. As a consequence it increases with the parameters Q, g, g_*. Further, we investigated the optical properties of the black hole shadow in the presence of plasma medium. It is observed that the presence of plasma affects the apparent size of the shadow to be increased, while the parameters of the regular black holes force to decrease the size of shadow.

• Apparent shapes of the shadow for the rotating nonsingular black hole are measured. A rotating nonsingular black hole contains an additional parameters k ($k > 0$) in comparison with Kerr black hole. More especially, it is a generalization of the Kerr black hole and asymptotically ($r >> k$), it behaves as the Kerr-Newman black hole. We described the ergoregion of the black hole and discuss the effect of parameter k on the ergoregion. A separate description of nonrotating and rotating nonsingular black hole shadow is analyzed. We extended our study to see the influence of parameter k on the size and distortion of the black hole shadow. It turns out that the size of the shadow decreases and the distortion increases with parameter k.

• An exact solution of the spherically symmetric black hole surrounded by quintessence matter in Einstein-Gauss-Bonnet gravity is described. We studied the horizons structure of the solution, the solution has only one horizon. In addition, a detailed study of the black hole thermodynamics and stability of the solution is also discussed. We calculated Hawking temperature, entropy, and the heat capacity for the black hole solution. We examined the effect of the Gauss-Bonnet parameter α and the quintessence parameter ω on the thermodynamical quantities. It is demonstrated that there arise phase transitions while we discuss the specific heat. It is noted that due to the presence of Gauss-Bonnet parameter the Hawking temperature of the solution is not diverge rather than it gives finite value.

• We proposed a rotating counterpart of Dymnikova black hole that has an additional parameter b. We calculated the curvature invariants and the weak energy condition for the metric. The calculation of curvature invariants reveals that it is regular, everywhere, but it violates the weak energy condition but in a very small amount. We studied the horizons, static limit surfaces, and the structure of ergosphere of rotating Dymnikova black hole. Further, we investigated the effect of parameter b on the ergoregion. It is found that the ergoregion of the rotating Dymnikova black hole increases with an increase in parameter b.