**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**
**SHORT ABSTRACT OF THESIS**

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| Programme of Study | : | Ph.D. |
| Thesis Title | : | ASPECTS OF SOME PHYSICAL PROCESSES AROUND COMPACT OBJECTS IN THEORIES OF GRAVITY |
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| Thesis Submitted to the Department/ Center | : | PHYSICS |
| Date of completion of Thesis Viva-Voce Exam | : | 06/05/2025 |
| Key words for description of Thesis Work | : | general relativity, Gauss-Bonnet, quasinormal modes, shadows, naked singularities, echoes, stability |

**SHORT ABSTRACT**

Although Einstein's theory of general relativity (GR) is regarded as one of the most successful theories for comprehending gravity both from an experimental as well as from theoretical perspective, numerous pathologies are known to exist in the theory. A number of alternatives to GR are proposed with a hope to remove such pathologies and to also provide hint about the regimes of spacetimes where physics is not clearly understood at present. Such alternatives are expected to reduce to GR as a low energy effective theory. The Universe provides us with a number of platforms where different theories of gravity can be put to test to check their validity. Among them, black holes (BH) provide a perfect test bed to explore and understand different physical processes as well as different theories of gravity. Other compact objects like naked singularities (NS), wormholes, etc. are also further helpful in carrying out the above investigations. The progress in the observational arena both in the gravitational and electromagnetic channel via the gravitational wave detectors and event horizon telescope (EHT) have provided indirect and direct ways to probe the Universe and has further pushed the frontiers of research in alternative theories and compact objects. The present thesis is aligned with this area and tries to focus in brief to the study of some aspects of the physical processes like shadows, quasinormal modes, superradiance and stability of solutions in two different types of alternative theories of gravity: the novel four dimensional Einstein-Gauss-Bonnet (EGB) gravity and the Loop Quantum Gravity. The former one contains higher order curvature corrections in the action in addition to the Einstein-Hilbert term, while the later was developed with a view to circumvent the loopholes of GR such as singularity by incorporating quantum corrections that gives the spacetime the notion of discreteness thereby rendering the spacetime regular. The QNMs and greybody factors of 4D-EGB BH have been studied by the perturbation technique using test scalar, electromagnetic and Dirac fields. The parameter of the 4D-EGB theory modifies these quantities, thereby providing us with an opportunity to check for these modifications in the observed data and comment on the nature of the compact object or the theory of gravity. The NS solution in this theory has also been explored and its stability was checked. Since it acts as a BH mimicker for various reasons, the thesis discusses the distinguishable features exhibited by the NS in the form of echoes in the time evolution of the test fields against which the response of the background has been studied. Such spacetimes were found to be unstable, thereby respecting the Cosmic censorship conjecture and restricting the parameter space of the Gauss-Bonnet coupling constant. On the other hand in order to understand the implications of quantum parameters on some astrophysical processes, the thesis discussed the shadows and superradiance in a quantum corrected BH in the domain of LQG and found that even if the effects are, at present, not within the domain of any observational techniques, interesting physical insights could still be found to take place at the scale of Planckian regimes, which might help in understanding the primordial BHs. The studies discussed in the thesis are important in understanding the nature of effects due to modifications in the theories of gravity, thereby providing a window to understand the nature of the background spacetime and check for distinctive observational features, if any.