



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study : Ph.D.
Thesis Title: Asymptotic symmetry and its role in black hole thermodynamics
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Thesis Submitted to the Department/ Center : Physics
Date of completion of Thesis Viva-Voce Exam : 21.06.2022
Key words for description of Thesis Work : Asymptotic symmetries, charged null surface, thermal nature of the Black hole , rotating black hole, timelike hypersurface.

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The astonishing connection between the asymptotic symmetries and the thermodynamics of the black hole was realized by the scientific communities about forty years ago. One of the unsolved tasks in the study of the black hole thermodynamics is to uncover and understand the microscopic degrees of freedom which are responsible for the entropy of the black hole. In this context, the Noether charges and current related to the asymptotic symmetries play a pivotal role in resolving this issue. In 1962, surprisingly, an infinite-dimensional group of symmetries near null infinity of the asymptotically flat spacetime was discovered as the asymptotic symmetry group (BMS), which has the flat space Poincaré group as the subgroup. Initially, it was revealed that the asymptotic symmetry analysis near null boundaries could shed light on the gravitational scattering phenomena, but later the symmetry analysis was well extended to the near-horizon region of the black hole. In the present thesis, we investigate the various aspects of the asymptotic symmetries in gravitational theories. At first, we try to analyze the asymptotic symmetries and the conserved charges near a generic null hypersurface having electromagnetic charge, in higher-order theory of gravity with the presence of the non-linear gauge field. We hope that this result will illuminate the physical importance of the charges in a more general context. However, by these lines of work, consequently, it is found out that the supertranslation and superrotation parameters modify the macroscopic parameters of the black hole. We argue that this can be treated as the breaking of the symmetry of the arbitrariness of the solutions, by the black hole backgrounds. In Rindler and Schwarzschild black hole backgrounds, we study the Lagrangian dynamics of the Goldstone modes and interestingly the Fourier modes of the supertranslation parameter come out to be the unstable ones. In the semi-classical regime, we found that this instability can lead to the thermalization of the horizon. Next, the same analysis is further performed in the rotating black hole background. Finally, We investigate the asymptotic symmetries near a timelike hypersurface at a finite distance outside the horizon of the black hole, following the standard procedure.