ON THE THERMODYNAMIC ASPECTS OF GRAVITY

Abstract

To begin with we have examined the validity of a gravitational entropy proposal in the context of accelerating black hole solutions. Here the Weyl curvature hypothesis is examined using the gravitational entropy. We have considered the family of C-metric to represent various accelerating black holes and evaluated their corresponding gravitational entropy and the gravitational entropy density. The merits and demerits of such an analysis were also commented with possible resolutions. Then we studied the entropy of the free gravitational field in some isotropic and anisotropic cosmologies utilizing the definition of gravitational entropy proposed by Clifton, Ellis and Tavakol, where the Bel-Robinson tensor is used to determine the energy momentum tensor of the free gravitational field. We checked whether in the vicinity of the initial cosmic singularity, the ratio of the energy density of free gravity to that of matter density goes to zero or not, examining the Penrose's conjecture on Weyl curvature. We showed that whenever this is true, the gravitational entropy increases monotonically with the structure formation of the universe and discussed the conditions for which the Weyl curvature hypothesis is valid or otherwise. Subsequently the next part of the thesis deals with the validity of two different proposals of gravitational entropy (GE) in the context of traversable wormhole solutions and argued that for any traversable wormhole to be physically realistic, it should have a viable GE. We found that the GE proposals do provide us a consistent measure of GE in several of wormhole solutions. In the later portion of the thesis, we examined the validity of the generalized second law of thermodynamics (GSLT) in an expanding Friedmann Robertson Walker universe filled with different variants of the Chaplygin gas and analyzed the validity of the GSLT on the cosmological horizons. We found that for the cosmological apparent horizon, some of these models always obey the GSLT but on the cosmological event horizon it depends on the free parameters of the respective models. Lastly, we studied the evolution of the FRW universe in presence of the variable modified Chaplygin gas. We have obtained its temperature as a function of the redshift. Then the relevant parameters like the Hubble parameter, the equation-of-state parameter etc. are obtained in terms of the redshift. Subsequently we calculated the temperature of decoupling. Finally, we concluded our thesis and discussed our thoughts on it.