Abstract

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Title of Thesis: Characterization of Wormholes and Cosmological Consequences: The Emergent Scenario

Wormholes, which are extraordinary occurrences originating from the principles of General Relativity, provide theoretical pathways across the fabric of spacetime, potentially enabling journeys between remote areas or even different universes. The recent groundbreaking finding of shadows cast by supermassive black holes and the direct observation of gravitational waves have sparked increased curiosity in pinpointing other extraordinary objects and entities that might imitate black holes, thus underscoring the significance of wormholes in contemporary astrophysics. Recent investigations have notably delved into the domain of wormholes composed of non-exotic matter, leading to a thorough exploration of their navigability and the nature of material at their entrances. This inquiry indicates a considerable likelihood of non-exotic matter wormholes with some transitioning from non-exotic to exotic matter as time progresses.
On the other hand, traditional big bang cosmology is confronted with challenges similar to those observed at the event horizon of a black hole, encompassing issues related to the horizon and singularity. Therefore, there exists a considerable interest in exploring cosmological hypotheses that do not exhibit these deficiencies. Ellis and Marteens introduced a model, the Emergent Universe (EU), which effectively tackles the singularity issue inherent in the framework of Einstein's general relativity.

Hence, this thesis explores the mathematical analysis of potential existence of wormhole solutions in different cosmological theories, investigating their viability and stability. Wormholes can also act as Closed timelike curves(CTC), hence , we also explore the particle motion and confinements in the context of cylindrical wormholes admitting to the presence of CTCs. Moreover, wormholes are free of singularity, so, the viability of dynamical wormholes in the context of Emergent Universe is also studied. Through rigorous derivations and analysis, it delves into the theoretical framework underpinning wormholes, shedding light on their physical properties, their validity of energy conditions and implications within the context of general relativity and modified theory of gravity.

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