Bounds On The Effective Theory Of Gravity In Models Of Particle Physics And

The study of gravity is crucial for our understanding of the fundamental forces that govern the universe. In the realm of particle physics, various models have been proposed to explain the interactions between particles and the underlying nature of gravity. These models often involve an effective theory of gravity, which aims to describe the behavior of gravitational forces within a specific energy range or length scale.

One of the main challenges in developing an effective theory of gravity is determining the bounds or limitations within which it remains valid. In other words, scientists need to establish the energy range or length scale at which the effective theory accurately predicts gravitational effects. This is particularly important when analyzing the behavior of gravity at extremely high energies or small distances, where quantum effects become significant.

Several theoretical frameworks, such as the Standard Model of particle physics and string theory, provide insights into the effective theory of gravity and its limitations. The Standard Model incorporates three of the fundamental forces: electromagnetic, weak, and strong forces. However, it does not include gravity, which remains a challenge to integrate into the theory successfully.

Bounds on the Effective Theory of Gravity in Models of Particle Physics and Cosmology (Springer Theses) by Michael Atkins(2014th Edition)

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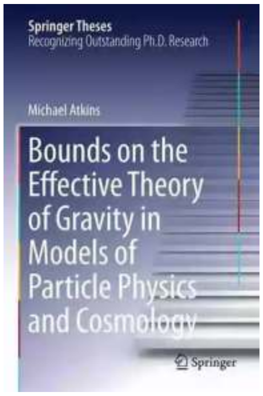
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String theory, on the other hand, is a theoretical framework that combines gravity with quantum mechanics and attempts to provide a unified description of all fundamental forces. It introduces the concept of extra dimensions, beyond the usual three spatial dimensions, to resolve certain inconsistencies in quantum gravity. Within string theory, the effective theory of gravity is constrained by the properties of these extra dimensions.

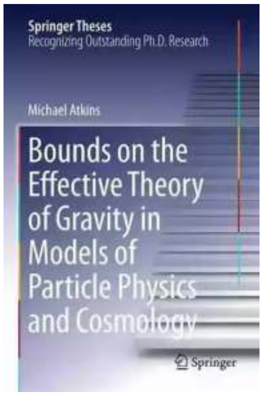
Experimental evidence also plays a crucial role in establishing bounds on the effective theory of gravity. High-energy particle colliders, such as the Large Hadron Collider (LHC),allow scientists to probe increasingly higher energy ranges and test the predictions of various theoretical models. By analyzing the data obtained from these experiments, researchers can derive constraints on the parameters of the effective theory of gravity.

Furthermore, astrophysical observations provide valuable insights into the behavior of gravity on a cosmic scale. Studying the motion of celestial bodies, the expansion of the universe, and the properties of black holes can help establish bounds on the effective theory. For instance, the existence of dark matter and dark energy poses challenges to our current understanding of gravity, indicating the need for a more comprehensive theory.

Recent advancements in gravitational wave astronomy have also contributed to bounding the effective theory of gravity. The detection of gravitational waves, ripples in spacetime caused by massive cosmic events, offers a new avenue for studying gravitational interactions. By analyzing the properties of these waves and comparing them to theoretical predictions, scientists can gain insights into the validity of the effective theory of gravity at different energy scales.

It is worth noting that bound on the effective theory of gravity can differ depending on the considered model or theoretical framework. Each framework has its own assumptions and limitations, leading to variations in the bounds derived from different approaches. Therefore, it is essential for scientists to cross-validate their results using multiple techniques and data sources to ensure the robustness of the obtained bounds.

, understanding the bounds on the effective theory of gravity in models of particle physics is a complex yet crucial endeavor. Through theoretical considerations, experimental data, and astrophysical observations, scientists strive to establish the energy range or length scale at which the effective theory accurately describes gravitational interactions. This knowledge is instrumental in refining our understanding of the fundamental forces and the nature of gravity in the universe.



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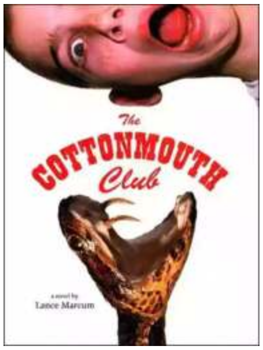
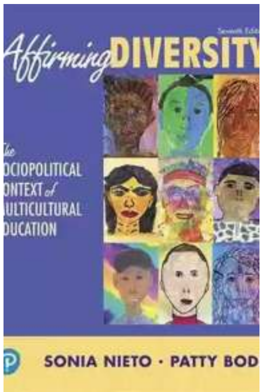
The effective theory of quantum gravity coupled to models of particle physics is being probed by cutting edge experiments in both high energy physics (searches for extra dimensions) and cosmology (testing models of inflation). This thesis derives new bounds that may be placed on these models both theoretically and experimentally. In models of extra dimensions, the internal consistency of the theories at high energies are investigated via perturbative unitarity bounds. Similarly it is shown that recent models of Higgs inflation suffer from a breakdown of perturbative unitarity during the inflationary period. In addition, the thesis uses the latest LHC data to derive the first ever experimental bound on the size of the Higgs boson's non-minimal coupling to gravity.





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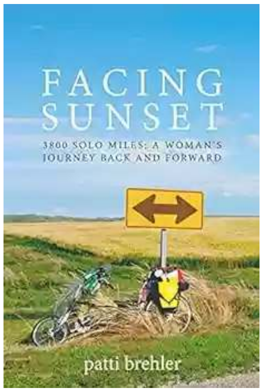

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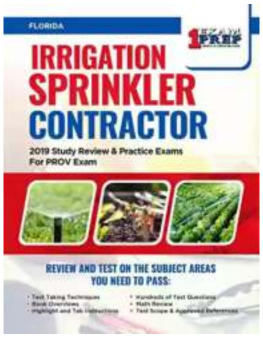

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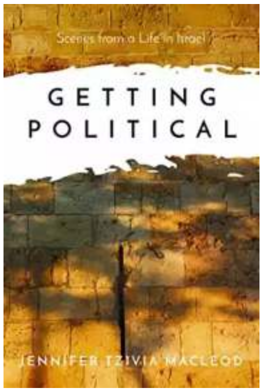

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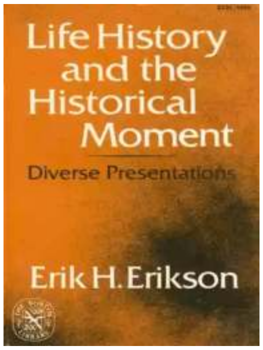

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