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Extended Abstract

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An interplay between the atomic and high energy physics: An update

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It is well documented that electrons and all particles (even as heavy as fullerenes) produce the same interference patterns as photons in the two-slit experiment. Nevertheless, the description of these patterns remained markedly different thus far. The difference was studied in detail by David Bohm. Recently, Sanz and Miret-Artes were able to squeeze it to zero. Fortunately, they left some room for further improvements. They are going to be presented in the talk. In it, we observe that in the absence of sources the electromagnetic field can be described without loss of generality in terms of the complex scalar field. Previously, the electromagnetic field was described either with help of the massless Dirac-type fields or via complicated matrix (DuffinKemmer) Dirac-like formalism developed by Harish-Chandra. As noticed by Freeman Dyson, such a formalism is useful for description of meson-nucleon interactions in Yukawa-style calculations. Use of new complex field not only simplifies these and other calculations considerably but also allows us to demonstrate field-theoretically its equivalence with the complex scalar field entering the non-relativistic Schrödinger equation. Such a coincidence is not fully unexpected in view of the fact that both the electromagnetic (Maxwell) and the Schrödinger equations are invariant with respect to the action of conformal group O (2, 4). Upon development based on ideas by Nambu, this observation is used for development of the Regge mass spectrum formalism for hadrons.

High energy physics encompasses the study of the fundamental particles and interactions between particles that make up our Universe. This includes dark matter and dark energy. The group at Texas A&M, housed within the Mitchell Institute for Fundamental Physics and Astronomy, consists of theory and experimental groups working on the cutting edge of these questions. Scientists work at the Large Hadron Collider (LHC) as well as on direct and indirect searches for the particles of dark matter with the Super CDMS, LUX and Fermi experiments. This also includes the design and construction of accelerators for use in creating particle collisions. On the other hand, some of our scientists work on the fundamental principles of string theory and gravity, as well as on the interface between cosmology, dark matter, models and phenomenology.
It is challenging to construct explicit and controllable models that realize de Sitter solutions in string compactifications. This difficulty is the main motivation for the Refined de Sitter Conjecture and the Trans-Planckian Censorship Conjecture which forbid stable de Sitter solutions but allow metastable, unstable and rolling solutions in a theory consistent with quantum gravity. Inspired by this, we first study a toy de Sitter No-Scale Supergravity model and show that for particular choices of parameters it can be consistent with the Refined de Sitter Conjecture and the Trans-Planckian Censorship Conjecture. Then we modify the model by adding rolling dynamics and show that the theory can become stable along the imaginary direction, where it would otherwise be unstable. We extend the model to multi-field rolling and de Sitter fields, finding the parameter space where they can be compatible with the Refined de Sitter Conjecture . The modified models with rolling fields can be used to construct Quintessence models to accommodate the accelerating expansion of the Universe. In this paper, we first provide a brief review of the effective dynamics of two recently well-studied models of modified loop quantum cosmologies (mLQCs), which arise from different regularizations of the Hamiltonian constraint and show the robustness of a generic resolution of the big bang singularity, replaced by a quantum bounce due to non-perturbative Planck scale effects. As in loop quantum cosmology (LQC), in these modified models the slow-roll inflation happens generically. We consider the cosmological perturbations following the dressed and hybrid approaches and clarify some subtle issues regarding the ambiguity of the extension of the effective potential of the scalar perturbations across the quantum bounce, and the choice of initial conditions. Both of the modified regularizations yield primordial power spectra that are consistent with current observations for the Starobinsky potential within the framework of either the dressed or the hybrid approach. But differences in primordial power spectra are identified among the mLQCs and LQC. In addition, for mLQC-I, striking differences arise between the dressed and hybrid approaches in the infrared and oscillatory regimes. While the differences between the two modified models can be attributed to differences in the Planck scale physics, the permissible choices of the initial conditions and the differences between the two perturbation approaches have been reported for the first time. All these differences, due to either the different regularizations or the different perturbation approaches in principle can be observed in terms of non-Gaussianities.

High Energy Physics (HEP) explores what the world is made of and how it works at the smallest and largest scales, seeking new discoveries from the tiniest particles to the outer reaches of space. This quest inspires young minds, trains an expert workforce, and drives innovation that improves the nation's health, wealth, and security.

Bottom Note: *This work is partly presented at 3rd International Conference on High Energy Physics, December 11-12, 2017, Rome, Italy*