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Editorial

Post-Editorial of the Special Issue "Estate Quantistica Conference—Recent Developments in Gravity, Cosmology, and Mathematical Physics"

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This editorial summarizes the contributions presented during the Estate Quantistica 2018 and published in a special issue of *Universe*. This edition of Estate Quantistica was dedicated to Richard Kerner on the occasion of his 75th birthday, to Winfried Zimdahl on the occasion of his 70th birthday and to Júlio Fabris on the occasion of his 60th birthday.

The study of the physical aspects of the evolution of the universe is the perfect playground for joining physicists and mathematicians putting together quantum and classical physics in the same context. From the initial inflationary expanding phase, in which quantum fluctuations represent the initial seeds for large-scale structure formation, to the current mysterious dark energy domination, there exists a large number of open questions on which researchers with different technical backgrounds have worked together.

It is evident that quantum mechanics is one of the most intriguing areas of physics and is highly important to our understanding of the primordial universe. Jérôme Martin's contributions to this Special Issue [1] highlight whether astrophysical observations could unambiguously reveal the quantum origin of the universe by borrowing ideas from quantum information theory. He argues that some of the tools needed to carry out this task have been discussed long ago by J. Bell. A very interesting review of Bell's contribution to the field is presented, advocating that cosmology and cosmic inflation represent the most interesting frameworks to apply the concepts that J. Bell investigated.

The primordial universe is also the main motivation of Patrick Peter's contribution to this issue [2]. He presents an overview of quantum cosmology and shows how one can turn to the trajectory approach of quantum mechanics to provide an effective mean of deriving physical consequences not reached in the context of standard quantum mechanics interpretation.

Once more in the quantum physics realm, Richard Kerner, one of those honored by this event, discussed the quantum nature of Lorentz invariance [3]. He argues that the transformation of physical quantities in the macroscopic observed world are the result of the averaging of symmetry groups acting in the Hilbert space of quantum states of elementary constituents of which classical material bodies are formed. In doing so, he presents an elegant discussion on the topic yielding a proposal of a ternary generalization of Dirac's equation.

The delicate threshold between gravity and quantum mechanics was introduced by Jan Willem van Holten in his *The Gravity of Light-Waves* [4]. He presents exact solutions of the Einstein–Maxwell equations and provides and interesting discussion of the dynamics of classical particles and quantum fields in gravitational and electromagnetic backgrounds.

Stemming from works by Y. Nambu on a generalization of the Poisson bracket by ternary brackets, a generalization to n-ary brackets attracted a lot of attention after L. Takhtajan formalized the notion of Nambu–Poisson brackets. The paper by Viktor Abramov deals with a generalization of Nambu–Poisson structures to superspaces [5]. Moreover, in their contribution, Viktor Abramov,

Olga Liivapuu, and Abdenacer Makhlouf introduce q-deformations of (σ, τ) differential graded Lie algebras, a generalization of differential graded algebras obtained by introducing a twist by maps σ and τ [6].

In a general relativistic description of the universe, dark matter and dark energy are mandatory components of the cosmic energy budget. Together, they represent $\sim$95% of the current cosmic energetic inventory. However, we face a profound lack of knowledge about their microscopic nature, leading to many approaches aiming to describe their dynamics. Winfried Zimdahl, Hermano Velten and William Algoner discuss how to implement the description of large scale cosmological structure formation adopting nonstandard cosmic fluids possessing intrinsic viscous properties [7]. This is a step beyond the standard dark matter description based on perfect relativistic fluids. Prof. Zimdahl is a world expert on the application of non-equilibrium relativistic thermodynamics in the cosmological background.

Our standard description of gravitational phenomena is based on general relativity. However, there are many attempts to extend it and to find out a new theory able to circumvent some of the open issues in the study of the universe. Regarding non-general relativistic theoretical proposals, two contributions are presented in this issue. Breno Giacchini and Tibério de Paula Netto study gravitational theories with more than four derivatives and their features at Newtonian level by discussing the limiting Newtonian potential and related singularities in such theories [8]. Another contribution in the field of extended gravity theories is performed by Fulvio Sbizà in his Degravitation and the Cascading DGP model [9]. He presents solutions of the 6D Cascading DGP model, a braneworld model which is a promising candidate to realize the phenomenon of the degravitation of vacuum energy, where the induced metric on the codimension-2 brane is of the de Sitter form.

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