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Editorial

Post-Editorial of "*Universe*: 5th Anniversary" Special Volume

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As the Editor-in-Chief of *Universe* since its inception in 2015, it is a pleasure and an honor for me to introduce this commemorative Special Issue "*Universe*: 5th Anniversary" for the journal's first five years of life. Popped out in an arena populated by several meritoriously well known and established journals, *Universe* immediately distinguished itself for its exceptional Advisory and Editorial Boards made up of many of the most renowned scientists in the field and for its refusal, right from the start, to make any compromise as regards the quality of the manuscripts to be published. Thus far, that attitude has never weakened, even when author processing charges were gradually introduced. Contrary to other reputable journals, *Universe* always relied on a number of referee reports which have never been smaller than two, being often larger than it. Acceptance of manuscripts was never a mere matter of arithmetics about the positive and negative reports, being, instead, the outcome of a thoughtful judgment pertaining to their content and meaningfulness involving myself, the Academic Editors in charge and the very proactive and competent Editorial Staff. The final decision was not infrequently my prerogative, and it sometimes occurred in these years that I had to override other Editors' choices in order to preserve, in my view, the integrity and the quality of the journal. In some occasions, I had also to face vibrant protests by authors, some of them distinguished scholars belonging to the Editorial Board itself. When in doubt, it has been a privilege for me to be able to rely on the competent advice of eminent and distinguished members of the Advisory Board who have never shied away from giving me their valuable opinions. In this regard, I have to thank the Advisory and Editorial Boards for the trust placed in me so far. I am also grateful to the Publisher and the Editorial Staff for having set up a very agile workflow, with bureaucratic formalities reduced to a minimum.

The response of the scientific community to my invitation to contribute to this Special Issue was commendable, resulting in 6 reviews, 20 research articles and 1 editorial for which I thank all the distinguished contributors. The topics covered are wide, ranging from foundational issues of fundamental theories to classical and quantum aspects of the gravitational interaction, both theoretical and experimental, passing through astrophysics and particle physics.

In his editorial, N. Mavromatos [1] reviews several works that have appeared in *Universe* in the past few years on models for Quantum Gravity, Loop Quantum Cosmology and Black Holes, all topics extensively treated by the other contributors to this Special Issue as well.

Phenomenological/experimental aspects of gravity are dealt with in several papers. G. Schettino et al. [2] look at the opportunity offered by the ongoing space-based mission BepiColombo to Mercury to put constraints to some alternative theories of gravity with torsion in the field of the Sun. After including them in the suite of dynamical models of their orbit determination software to be fit to sets of simulated radiotechnical data from the probe, they estimate, among other things, torsion-related parameters by demonstrating that it is possible to effectively constrain them. Remaining in the Solar System arena, I [3] focus my attention to the past mission, Gravity Probe B (GP-B), in the field of Earth and on the possibility that a reanalysis of its data may allow one to the measure also the general relativistic spin precession induced by the terrestrial quadrupole mass moment J_2 to the first post-Newtonian (pN) order. Indeed, while the experimental accuracy in determining the spin's declination rate amounts to 18.3 milliarcseconds per year $\left(\mathrm{mas\,yr^{-1}}\right)$, the expected pN J_2-driven precession of the spin's declination is of the order of $\simeq$30–40 $\mathrm{mas\,yr^{-1}}$.

Moving to larger distances, L. Acedo [4] deals with the possibility, which recently appeared in the literature, that some binary stars, 0.1 parsec (pc) wide, may exhibit an anomaly in their measured radial velocities analogous to those that, at the scale of galaxies and galactic clusters, led to the Dark Matter (DM) paradigm. Remarking that, this time, the latter could hardly be the solution of such an alleged anomaly, he proposes a non-Newtonian model of gravity that, according to him, may accommodate both the wide binaries issue and the anomalous rotation curves of galaxies as codified by the Tully–Fisher relation. Finally, he calculates some orbital consequences of his model which could be put to the test in the Solar System with future planetary ephemerides. At cosmological scales, T. Faerber and M. López-Corredoira [5] make a compilation of the measurements performed so far in the literature of the amplitude of mass fluctuations σ_8 and of the Hubble parameter H_0 investigating if the reported error bars are truly representative of the dispersion of the measured values of such two cosmological parameters. Their outcome is that the statistical error bars have been underestimated, or systematic errors were not properly taken into account in at least 20% of the measurements analyzed, suggesting that, in the case of the Hubble parameter, this may be the source of the recently observed H_0 tension among different kinds of measurements. C. Sabín [6] explores the possibility of a laboratory tabletop experiment to emulate a spacetime containing a traversable wormhole. The experimental setup consists of two superconducting qubits coupled to a dc-SQUID array embedded into an open microwave transmission line, where an external bias produces the GR-like signal.

About certain foundational issues of fundamental interactions, B. Mashhoon [7] investigates some new aspects of the acceleration-induced nonlocal electrodynamics. In particular, he removes the original restriction that the theory's kernel has to be linear in the acceleration tensor and, thus, parity-violating, finding that, in principle, it can have linear, quadratic, and possibly higher-order parity conserving terms in it. By focussing on parity-conserving quadratic kernels, he works out some physical consequences of an acceleration-induced nonlocal field theory of electrodynamics for a given kernel. D. Koks [8] studies the roles played by coordinate and proper times in the gravitational redshift. He starts from the Eddington's analysis of the gravitational redshift a century ago examining also other apparently contrasting views such as those by Earman and Glymour, and Schild as well, which all return the same correct result. Then, he moves to adopting the uniformly accelerated frame in flat spacetime as an appropriate basis for discussing the redshift in curved spacetime. M. Rotondo [9] derives the functional Schrödinger equation for quantum fields in curved spacetime in the semiclassical limit of quantum geometrodynamics with a Gaussian incoherent dust acting as a clock field. His main goal is recovering an appropriate semiclassical limit for the dynamics of quantum matter fields, without claiming that it provides a viable definition of time in the quantum gravity regime, nor that such a notion is necessary to begin with.

Quantum Gravity is duly represented in this Special Issue. R. Gambini and J. Pullin [10] review the Montevideo Interpretation of quantum mechanics rooted in the notion that time must be a physical observable, not a classical parameter, and that everything must be quantum in a quantum universe. Adopting new methods based on a framework that recently appeared in the literature to deal with the problem of time in generally covariant systems, they came to a formulation of quantum mechanics without any reference to the classical world and with an intrinsic operational definition of quantum events not needing external observers. M. Bojowald [11] deals with some Black Hole models in Loop Quantum Gravity (LQG). He argues that the underlying geometry of space–time has often been expressed in such a way that most of such constructions would violate general covariance and slicing independence. The only way out would consist of deriving not only modified metric components, but also a new space–time structure that is covariant in a generalized sense. A generic consequence of consistent modifications in effective theories suggested by LQG is signature change at high density. It is an important ingredient in long-term models of black holes aiming at determining what might happen after black hole evaporation. A. Ashtekar and M. Varadarajan [12] look at the field equations of general relativity in the Hamiltonian framework based on a Yang–Mills phase space. By re-examining the gravitational dynamics in such a scenario, they finally come to a geometrical interpretation of the canonical transformation generated by the Hamiltonian constraint on the Yang–Mills phase space which, as far as quantum gravity is concerned, provides a starting point to complete more satisfactorily the Dirac quantization program for general relativity. Other implications and ramifications in classical general relativity and mathematical physics are treated as well.

Astrophysical themes are present as well. K. Franceschetti and L. Del Zanna [13] address the problem of understanding the origin of the extremely strong magnetic fields in neutron stars and magnetars by means of numerical simulations in a non-ideal general relativistic magnetohydrodynamic (GRMHD) regime. In particular, they look at the growth of the magnetic field induced by the action of the mean-field dynamo due to sub-scale, unresolved turbulence. They obtain different growth rates depending on the dynamoc coefficient. L. Foschini [14] critically reviews the literature of recent years on several sources of high-energy gamma-rays such as Narrow-Line Seyfert 1 Galaxies (NLS1s) and other Active Galactic Nuclei (AGN). In particular, he focuses on the paradigm of a central engine powered by a relatively small-mass black hole common to such a variety of objects.

In addition, astrobiology enriches this Special Issue. L. N. Irwin and D. Schulze-Makuch [15] explore known and unknown forms of life in a variety of alien habitats such as a rocky planet with an ice-covered global ocean, a barren planet devoid of surface liquid, a frigid world with abundant liquid hydrocarbons, on a rogue planet independent of a host star, on a tidally locked planet, on super-Earths, or in long-lived clouds in dense atmospheres.

Several aspects of General Relativity, both at the level of fundamental formalism and with a closer connection with possible observational aspects are treated in the Special Issue. J.-P. Luminet [16], starting from the seminal model of a rotating universe put forth by K. Gödel in 1949, exposes a historical survey of the discussions concerning the existence of Closed Timelike Curves (CTC) in general relativistic spacetimes, opening the physical possibility of time travel in the past. He critically discusses some issues arising when certain physical mechanisms of chronological protection, yet to be elucidated in detail even when quantum fluctuations near horizons are taken into account, are invoked in order to avoid the causality-violating paradoxical consequences of time travel in the past. I. Dymnikova [17] reviews the many roles played by de Sitter vacuum in fields as disparate as the early and late time accelerated expansion stages in cosmology, black hole physics, and particle physics where it connects the Higgs mechanism with gravity and spacetime symmetry breaking. A. Davidson and T. Ygael [18], taking the field theoretical similarities between Maxwell and Weyl vector fields as starting point, construct a full local scale/gauge invariant Weyl/Maxwell mutual sourcing theory, and explore some of its properties in four dimensions. G. Volovik [19], in the framework of black hole thermodynamics, considers the case in which the Newtonian constant of gravitation G is viewed as a thermodynamic variable. As a result, he calculates the quantum tunneling from black holes to white holes finding that the temperature and entropy of white holes are negative. P. Stavrinos and C. Savvopoulos [20] attempt to geometrize DM into the Riemannian and a Riemann–Sasaki spacetime framework. Among the consequences of their approach treated with the classical Riemannian geometric methods, they deal with the geodesic motion under the influence of DM. H. Hamber et al. [21] study numerically gravitational fluctuations as a possible alternative to cosmic inflation. In particular, they propose to explain the accurate cosmological power spectra data by means of nonperturbative features of the quantum version of Einstein's gravity. As a calculational tool, the authors adopt modified versions of some currently available numerical programs (ISiTGR, MGCAMB and MGCLASS) developed for observational cosmology. H. Velten and T. R. P. Caramês [22] review some non-conservative extended theories of gravity, many of which were proposed in the last few years to describe dark matter and dark energy phenomenology.

In addition, Particle physics is well represented. I. M. Dremin [23] calculates spectra of unbound dielectrons, i.e., electron–positron pairs, and photons from decays of parapositronia produced in ultraperipheral collisions of electrically charged objects. He discusses the role played by such processes in the astrophysical problem of cooling electron–positron pairs and the intense emission of high-energy photons from the Galactic Center. H. Liu and J. Xu [24] investigate the impact of isospin corrections to some statistical properties of net-baryon and net-charge fluctuations in the isospin asymmetric matter produced in relativistic heavy-ion collisions at energies typical of the Beam Energy Scan (BES) Program at the Relativistic Heavy Ion Collider (RHIC), based on a 3-flavor Polyakov-looped Nambu-Jona-Lasinio model. They find notable isospin effects, especially in net-charge fluctuations. J. D. Uribe et al. [25] investigate the phenomenon of neutrino flavor oscillations in a novel astrophysical context, i.e., the neutrino-dominated accretion process around Kerr black holes. Such elusive particles are also the protagonists of the paper by A. Capolupo and colleagues [26], who propose new approaches to distinguish between Dirac and Majorana neutrinos. They make also a phenomenological analysis aimed at highlighting the distinctions between them. N. Magdy et al. [27] investigate some features of ultra-relativistic heavy-ion collisions at the RHIC and the Large Hadron Collider (LHC) in which an exotic state of matter named Quark-Gluon Plasma (QGP) is created. In such a context, identifying the dynamical evolution and the transport properties of the QGP is of the utmost importance. Within this framework, the authors study the elliptic flow fluctuations of identified particles using participant and spectator event planes by using a Multi-Phase Transport (AMPT) model.

Now, the time has come to give the floor directly to the authors, whom I thank once again, and to the readers, who I hope will appreciate the aforementioned works published in this Special Issue.

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