

Editorial to the Special Issue “Quantum Cosmology”

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Some time ago, when I first inquired as to ‘what quantum cosmology is about’, I did approach the hall with a combination of caution as well as eagerness. At my earnest, I was proceeding within what one could label as *festina lente*¹, i.e., albeit going broad and wide, also proceeding serenely as much and as well I could. I wanted eventually to contribute somehow, if possible in a worthy manner. Plus, I had to find and properly study the footsteps previously carved by grand researchers in order to follow them, learn from them and then venture myself.

This Special Issue (SI) also took a while to emerge as we come across several difficulties during the pandemic years ranging from 2020 to 2022. However, we managed to gather a set of diverse and focused contributions, surveying a considerably wide range of topics that represent the main current avenues, as well as the potential for either new and/or still open routes to further explore. Of course, the SI is not exhaustive and plenty other directions remain to be mentioned and further addressed. The main point is that we (i.e., myself and those that added to the SI) (co-)wrote review papers promoting those lines such that eager (young) minds would feel challenged. Then, they can explore ‘seas ruled by uncharted trade winds’ (cf. https://en.wikipedia.org/wiki/Trade_winds#History, accessed on 15 June 2022). If we were successful, someone will have been influenced and will make a significant addition, after having read selected reviews from this SI. This will mean an unequivocal positive output. This will mean our effort was worthy and, furthermore, it will mean we did convey some kind of legacy from our own work (or part of it), herewith presented.

This SI contains sixteen review papers, each of about 20 pages, with 50 to 100 references each. Some overlapping exists and this is most welcome: quantum cosmology is very much multi-(sub)disciplinary; in particular, progress has been made when immersing oneself within methods from other domains. However, some routes do cross or border each other, so that some references or ingredients emerge ‘here, there, somewhere’, in one or two (or even more) reviews alike, as expected in a young domain of exploration. In spite of the challenges, quantum cosmology may well be the area that makes progress in this century, in the next decades. To this, we bequeath the content of this SI.

One of the themes is as follows. Reviews herewith did consider several settings for quantum cosmology probing, explanations and promotion, mostly building from General Relativity (GR) as the classical onset. However, then, wider scopes were appraised and discussed. Concretely, in [1] a (super)string setup was presented. Related to it, non-commutative properties were described in [2]. Within frameworks that encompass GR as the specific limit, the review in [3] brought Brans-Dicke context and content, whereas [4] took $f(R)$ and [5] stretched modified gravity up to affine geometries. In a different use of observables, refs. [6,7] plus [8] as well as [9], each differently in either focus or tools, imported from loop quantum gravity. Within a broader coordinatization of space, supersymmetry was employed in [2,10].

However, this was not all. Besides the prospecting line above mentioned, we have other reviews that instead probed the fitting and realism (i.e., if quantum cosmology can be cast as to match either (i) real observed physics in some (semi)classical domain or (ii) known methodologies of well-established field theories): in [11], the issue of third quantization was imported and appraised; likewise present in [1]. Recently, the ‘landscape’ feature



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from string and alike settings has been a frequent ‘participant’ in discussions. In [12], this is taken in a sincere appraisal concerning a specific (now iconic) solution for the universe in quantum cosmology. The fulcrum of ‘time’ was amply debated through [13,14]. Finally, a majestic review was provided in [15] (if I can put it that way) bringing us into a grand perspective of quantum cosmology. It also conveys our attention to the issue of back-reaction (which is something [4,16] also captivate into).

It may be also of relevance to associate reviews with additional thematic issues. More specifically, in [3,13] the de Broglie–Bohm interpretation of quantum mechanics was employed whereas in [14] the Montevideo interpretation was taken for discussion. Furthermore, the issue of a ‘bounce’ (and somewhat of an alternative for the very early universe paradigm) at the creation event was used in [9,13]. Although a feature not yet fully elaborated in quantum cosmology, (quantum) entanglement may become primordial and [16] elaborated upon it, besides on back-reaction. Though not yet something, either methodically or thoroughly incorporated in quantum cosmology, chaos was mentioned in [9,15]. Within this domain, providing a contribution for effects created and then eventually causing change, particle creation is important to be considered; see [7]. Another feature not often widely discussed, are symmetries (within the Noether framework) in quantum cosmology; see [5]. Moreover, the fundamental crucible of a singularity is unavoidable and in reference [4] an opportunity was provided to discuss on a particular case. Still elusive but a most important ‘grail’ in quantum cosmology is to retrieve direct, unequivocal observational evidence of quantum gravity; Furthermore, in reference [6] a discussion about the topic is brought to the literature.

In summary, the above-cited review articles reflect the present state of the art, regarding either already resolved or still unresolved problems. The Guest Editor of this Special Issue does hope that it will be useful to stimulate subsequent new research routes in quantum cosmology. The primordial baseline to embrace is that, beyond the mere ‘longitudinal’ effort, adding just an incremental borderline result, it is ‘transversal’ questioning that is now much required (meaning, taking from some quantum cosmology mainstream issues and then formulating them in a new unexpected format and/or move one or two steps away from the current known footsteps).

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Note

¹ cf. Festina lente—Wikipedia: https://en.wikipedia.org/wiki/Festina_lente, accessed on 15 June 2022.

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Short Biography of Author



Paulo Vargas Moniz is a full professor at UBI (Portugal). He graduated from Lisbon and then moved to DAMTP, Cambridge for some years. He has been occasionally returning ever since and is also a life member at Clare Hall (college). He has been at the Editorial Board and then Advisory Board at CQG. The author of several books and several (much) more research papers, supervised students and post-docs, research visitor at many places, several times. Prof. Moniz has been serving at conferences committees, notably the MG series. Once a vice-rector, as such has been a representative at several EU (and affiliated) agencies, too. He received several science prizes. His research interest is on SUSY quantum cosmology (mostly the DAMTP ‘eigen’line). More about quantum cosmology is also shared, idiosyncratically and at times, in <http://www.dfis.ubi.pt/~pmoniz/> and somewhat update in <https://www.linkedin.com/in/pvmoniz/>.