Testing quantum and semi-classical features of the early universe

A Data Management Plan created using DMPonline.be

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Project abstract:

Physics in the twentieth century was marked by the development of both quantum mechanics and general relativity (GR). Despite the extreme level of precision to which these two theories were checked, their unification into a quantum theory of gravity remains elusive. Indeed GR is non-renormalizable and cannot be quantized with the usual quantization scheme that was applied to all other forces of nature. The natural question to ask is then: should gravity really be quantized? Although its quantum nature has not yet been experimentally proven, the initial cosmological singularity predicted by GR motivates us to seek at least a better description for the early universe cosmology. Here we focus on the resolution of this singularity through quantum cosmology. This approach is more accessible than full quantum gravity, as the set-up of the early universe can be simplified to only a few degrees of freedom. In this project we
will improve the understanding of the quantum nature of our early universe and of its gravitational path integral, by using a new semi-classical criterion based on complex metrics and by studying how quantum backgrounds become classical, using decoherence and entanglement entropy. This will also lead to new observational probes of the quantum nature of gravity.

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1. Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

				Only for digital data	Only for digital data	Only for digital data	Only for physical data
Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
		Please choose from the following options: • Generate new data • Reuse existing data	*Please choose from the following options:* • Digital • Physical	*Please choose from the following options:* • Observational • Experimental • Compiled/aggregated data • Simulation data • Software • Other • NA	*Please choose from the following options:* • .por, .xml, .tab, .csv,.pdf, .txt, .rtf, .dwg, .gml, … • NA	*Please choose from the following options:* • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA	
Personal notes on tablet	Handwritten calculations and notes forming the basis of thoughts	New data	Digital	Other	.pdf	<100MB	
LaTeX files	Summary of calculations typed	New data	Digital	Other	.pdf	<100MB	
Mathematica notebooks	Mathematical computations requiring computer power	New data	Digital	Software	.nb	<1GB	
Python jupyter notebook	Numerical computations with comments	New data	Digital	Software	.ipynb / .py	<100MB	
Data files	Data generated by Mathematica and Python notebooks	New data	Digital	Software	.csv	<1GB	

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

N.A.

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, …)? If so, please comment per dataset or data type where appropriate.

- No

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/Data transfer agreements/ research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- No

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

2. Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g., in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, Codebook.tsv etc. where this information is recorded).

The data generated in form of computations will be contained in published papers that will clearly state all necessary steps in order to reproduce the results presented. Furthermore, the data will either be commented directly in file when that is possible, e.g., for Mathematica and Jupyter notebooks, or will be accompanied by README.txt files for format files as .csv containing numerical data sets.

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- No

A README.txt file will be created to accompagny all folders containing notebooks, note files and data set related to a specific calculation or research question, explaining how all data set have been generated and giving precise instructions as to how to use the said data.

3. Data storage & back-up during the research project

Where will the data be stored?

The data will be stored on the shared server of the Theoretical Physics division (Nextcloud), as well as on the personal computer of the PI. When appropriate, some code and data will be published together with papers and made available on online servers associated to journals.

How will the data be backed up?

All the data stored in the university storage system is automatically backed-up.
Researchers in our department have access to a redundant storage system consisting of 12TB of disk space which they can use to store their data on. Data integrity is managed by our disk-to-disk storage solution which takes snapshots for backups every day (7 days) – every week (4 weeks) - every month (3 months) with an offsite backup every month.

Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.
If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.

- Yes

Because of the nature of the data generated by this research, we expect that 10GB is a very large upper bound on the total amount of data that we will need to store and backup. Therefore an ordinary storage capacity is sufficient and will be managed by the IT division.

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

The data generated in this research are not personal or confidential data. The departemental server where the data will be stored and backup are protected by a password.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

Due to the small amount of data that will be generated, there are no specific costs expected to be associated with the data storage and backup. Standard costs of storage are covered centrally by the Theoretical Physics division.

4. Data preservation after the end of the research project

Which data will be retained for at least five years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

All digital data, including draft of published papers, codes, numerical data sets, etc. will be stored for at least the legally required 5 years

Where will these data be archived (stored and curated for the long-term)?

The data will be stored in the backup KU Leuven server for up to 3 years, and then the data will be moved to a cold storage server for 3 additional years.

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

Due to the small amount of data generated, the costs will be negligible and covered centrally by the Theoretical Physics division.

5. Data sharing and reuse

Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.

- Yes, in an Open Access repository

The most relevant computations will be summarised in published papers which will be made available on the online preprint server arxiv.org. In case the computations are very technical, software codes will also be made public on the same platform alongside the published articles (as ancillary files).

If access is restricted, please specify who will be able to access the data and under what conditions.

N.A.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)? Please explain in the comment section per dataset or data type where appropriate.

- No

Where will the data be made available? If already known, please provide a repository per dataset or data type.

The data will be made available on the arxiv.org repository or upon request by email for more detailed aspects of the computations.

When will the data be made available?

The data will be made available upon publication of the corresponding article.

Which data usage licenses are you going to provide? If none, please explain why.

CC BY

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- Yes

All published articles will have a DOI number associated to them.

What are the expected costs for data sharing? How will these costs be covered?

No costs are expected for data sharing.

6. Responsibilities

Who will manage data documentation and metadata during the research project?

The PI (Caroline Jonas) will manage data documentation and metadata during the research project.

Who will manage data storage and backup during the research project?

Data storage and backup will be managed by the IT division of the Physics Department, Natuurkunde en Sterrenkunde ICT.

Who will manage data preservation and sharing?

The PI (Caroline Jonas) will manage data preservation and sharing.

Who will update and implement this DMP?

The PI (Caroline Jonas) will update and implement this DMP.