Small extra dimensions and holography: a Swampland expedition

A Data Management Plan created using DMPonline.be

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Funder: Fonds voor Wetenschappelijk Onderzoek - Research Foundation Flanders (FWO)

Template: FWO DMP (Flemish Standard DMP)

Grant number / URL: 11PAA24N

ID: 206111

Start date: 01-11-2023

End date: 31-10-2027

Project abstract:

The Swampland program seeks to study the space of effective low-energy theories which are not compatible with quantum gravity. An obvious property of such low energy theories is the number of visible dimensions. However, a prediction of string theory is the existence of extra dimensions, whose vibrations behave as particles with masses inversely proportional to the size of the extra dimensions. It is therefore crucial to know whether such vibrations can be measured at low energy. This is where the Swampland program comes into play: are low-energy theories with small extra dimensions compatible with quantum gravity? I aim to settle this question by combining techniques from supergravity and holography.

On the gravity side, I will study the backreaction of orientifolds, which is the main source of debate regarding the consistency of string vacua which exhibit small extra dimensions. Once this backreaction is better understood, I will contrast it with a recent mathematical conjecture by Yau et. al., which will either upset the current view on flux compactifications in string theory or provide an interesting counterexample to the conjecture.

On the CFT side, I will investigate how many visible space dimensions holographic CFTs can reconstruct. For instance, a recent connection between the weak gravity conjecture and large extra dimensions will be translated into a CFT statement. This will likely lead to new conjectures on the space of CFTs, which I will then attempt to prove.

Last modified: 02-04-2024

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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.

Dataset Name	Description	New or reused	Digital or Physical	Only for digital data Digital Data Type	Only for digital data Digital Data format	Only for digital data Digital data volume (MB/GB/TB)	Only for physical data Physical volume
Understanding orientifolds backreaction.	Some part of the computation of the backreaction might need to be computed numerically. In this case, numerical results will be stored in csv files arising from a mathematica notebook.	*Please choose from the following options:* Generate new data	*Please choose from the following options:* Digital	*Please choose from the following options:* • Simulation data • Software	*Please choose from the following options:* • .csv,.nb	*Please choose from the following options:* • <100MB	
Future projects	The proposal is in theoretical physics and therefore not data centred. However, the use of the Mathematica software to help with computations is likely to occur. In that case, the relevant Mathematica notebooks will be submitted as ancillary files to the publications.	Generate new data	Digital	Software	.nb	<100MB	

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 generated dataset (mainly Mathematica notebooks) will be made understandable through the use of clear headers and associated README.txt files. Following community standards, these will be understandable together with the accompanying paper (which will be freely available online through arXiv.org).

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.

- Yes

The metadata standard of KU Leuven's Research Data Repository will be used for all generated datasets.

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

Where will the data be stored?

Locally on my KU Leuven work laptop, with copies on the KU Leuven cloud servers (OneDrive).

How will the data be backed up?

The data will be backed up automatically and continuously to the KU Leuven OneDrive.

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

onedrive.kuleuven.be has a storage of over 2 TB, which is more than sufficient for the whole project.

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

Access to the primary data (on my laptop) is obviously limited to me personally through physical access + a unique PIN code that is not shared with anyone.

The backup (onedrive.kuleuven.be) is considered secure enough to be used by KU Leuven and the provided security is deemed sufficient for this project. Access to the data is restricted to a per-invitation basis.

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

This is not applicable since the laptop and the drive are provided by the university (KU Leuven). The small amount of data generated/used with this project is small enough for this to be sufficient.

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 the data described in the table of 1. Research Data Summary will be retained for (at least) 5 years.

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

The generated datasets will be archived in KU Leuven's Research Data Repository.

If Mathematica notebooks are used for a publication, these will be stored on the open-access preprint repository arXiv as ancillary files to the corresponding publications.

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

KU Leuven's Research Data Repository is managed centrally by the KU Leuven. No funding from the current project is required to cover this.

arXiv is managed by Cornell University and they do not charge researchers for their data storage service.

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

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 generated datasets will be made available through KU Leuven's Research Data Repository and relevant Mathematica notebooks through arXiv (see above).

When will the data be made available?

upon publication of research results

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

Data from the project will be made available under the CC-BY 4.0 license.

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

DOIs are generated automatically for arXiv submissions (which might include Mathematica notebooks as ancillary files) and also for KU Leuven Research Data Repository datasets.

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

There is no cost associated to making the data available at neither arXiv nor KU Leuven's Research Data Repository, other than the time required to prepare the files, write the associated documentation etc. This time cost will be borne jointly be the PI and collaborators.

6. Responsibilities

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

The PI bears the overall responsibility for updating & implementing this DM

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

The PI bears the overall responsibility for updating & implementing this DM

Who will manage data preservation and sharing?

KU Leuven, managing the Research Data Repository, and Cornell University, managing arXiv. The PI is responsible for making the datasets available through said repositories.

Who will update and implement this DMP?

The PI bears the overall responsibility for updating & implementing this DM

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