The orbital evolution of planets orbiting ageing stars

A Data Management Plan created using DMPonline.be

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Project abstract:

Some 95% of all stars in the galaxy have an initial mass lower than 8 solar masses; it is now thought that the majority of them has at least one planetary companion. During the post-main-sequence evolution, these stars go through giant phases characterized by significant mass loss, large stellar radii, strong pulsations, and extreme luminosities. These changes in stellar characteristics may completely transform a planetary system: the stellar wind, star-planet tides, planet accretion or loss rates, and drag forces drive the orbital evolution of the giant star-planet system and establish whether the planet survives the star’s giant phases or not.

But, at present time, the orbital evolution of planets orbiting giant stars is only addressed at the level of the stellar equilibrium tide, with mass-loss rates and mass-transfer efficiencies now thought to be highly inaccurate. Here we take a radically different approach by constructing models that include all relevant ingredients and are based on unprecedented calculations. We will extend the tidal formalism with pioneering calculations of dynamical tides in giant stars and will include spin-orbit coupling, wind Roche Lobe overflow, gravitational and frictional drag forces, novel planet accretion and loss rates and a new wind mass-loss rates. That way, this project will lead to a new quantitative metric for predicting the fate of planets orbiting ageing stars, including that of the Solar system planets orbiting the ageing Sun.

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FWO DMP (Flemish Standard DMP)

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, .cvs,.pdf, .txt, .rtf, .dwg, .gml, … • NA	*Please choose from the following options:* • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA	
D1	tidal dissipation factors	new	digital	Other (theoretical description) Software	.txt, .csv python code/Jupyter notebooks	<50TB	
D2a	confront predictions with observations	reuse	digital	Observational/Simulation Software	.txt, .csv, .dat python code/Jupyter notebooks	<50TB	
D2b	resonance formulae	new	digital	Other (theoretical derivation) Software	.txt, .csv python code/Jupyter notebooks	<1GB	
D3a	mass-loss related relations	new	digital	Simulation/theoretical derivation Software	.txt, .csv python code/Jupyter notebooks	<25TB	
D3b	model grids	reuse	digital	Simulation	.txt, .csv	<50TB	
D4a	model predictions	new	digital	Simulation/theoretical derivation Software	.txt, .csv python code/Jupyter notebooks	<5TB	
D4b	MESA simulations	new	digital	Simulation data Software	.dat python code/Jupyter notebooks	<5TB	

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:

For Deliverable 2 we will confront new simulations with existing observations, published in Gális et al. 199, A&A 348, 533 (https://articles.adsabs.harvard.edu/pdf/1999A%26A...348..533G); and Soszyński et al. 2021, ApJL 911, L22 (https://iopscience.iop.org/article/10.3847/2041-8213/abf3c9);
For Deliverable 3 we will use model grids which are currently being run in-house by PhD students Jolien Malfait and Silke Maes. These model grids will be ready by the start of the work package.

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

The limited use of existing data (observation/models) should not cause issues as all used results are publicly available to the scientific community.
Existing software tools such as MESA (https://docs.mesastar.org/en/release-r22.11.1/) and GYRE (https://gyre.readthedocs.io/en/stable/) will be used to calculate model simulations. These codes can be freely used as long as the necessary citations/acknowledgements are given.

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).

Detailed description of the full scientific process (theoretical derivations, model development and setup, scientific deliverables) will be documented in text files, PDFs and digital notebooks in the working directories of the host institute and published in regular scientific publications.

Software code/tools and Jupiter notebooks/scripts will include readme files on Github and will be commentated inline in the code to describe the aim of the code and details on the input/out variables. All modelling output will be saved in a well-documented local directory structure with readme.txt files.

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

- Data bases of model output will come with model specific metadata information on parameter space setup.
- Journal publications will use dedicated journal standards (e.g. keywords) to identify research context.

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

Where will the data be stored?

Locally (personal device+institute servers+backups)

- Newly-made simulations and theoretical derivations
- Models, parameters and retrievals
- Analysis tools/software codes

Externally:

- Original observations (archival database of different observatories and the CDS database http://cdsweb.u-strasbg.fr/about)
- Software codes and tools (Github)
- Scientific publications (journal websites, KU Leuven Lirias)

How will the data be backed up?

The host institute has a well-developed in-house storage and backup system which will allow for continuous data preservation.

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

Necessary additonal storage facilities are calculated in the project budget. If even more storage is needed, these can be taken on by the research group working budget.

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

Raw and processed data are stored on institute network servers and backup following KU Leuven and in-house security standards: all data are secured with access restrictions on file-system level.

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

9200€ for high-speed solid-state drives and 50TB of additional data storage capacity is budgeted in the project. If even more storage is needed, these can be taken on by the research group working budget.

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 original observations and retrievals/results (raw,processed, models, retrievals, publications) will be stored for at least 25 years.

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

All data (data reduction, analysis, model, retrievals, publications) will be stored locally on the servers of the host institute.
All publications will be archived on the website of the scientific journal and the SAO/NASA Astrophysics Data System (https://ui.adsabs.harvard.edu/).

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

Costs for backup and storage on local institute servers has been included in the project budget and the general working budget of the host institute.

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
- Scientific publications with description of the full scientific process, methods and model output parameters will be made available via journal websites and KU Leuven Lirias.
- Software tools and scripts will be made available via Github

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

NA

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.

- Scientific publications with description of the full scientific process, methods and model output parameters will be made available via journal websites and KU Leuven Lirias.
- If necessary (i.e. if not all relevant data can be disseminated via scientific publications due to size/type constraints) deliverables will be made public via a dedicated project website on the host website (but linked in the scientific publication).
- Software tools and scripts will be made available via Github

When will the data be made available?

After publication in the scientific journals.

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

Results and data in scientific journals are published under CC-BY 4.0
Software on Github are published underGPL-3.0 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

Scientific publications will get a DOI assigned as per journal standards.

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

We budget ~1000euro per publication for gold open access. There are no costs associated with Github or other public access repositories such as ArXiv or Lirias.

6. Responsibilities

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

The PI and team members together with assistance from the institute's project coordinator and IT team.

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

The PI and institute's IT team will be responsible for proper working of server storage and backup.

Who will manage data preservation and sharing?

The PI and team members will make sure the data is correctly set up for server storage and open access sharing.

Who will update and implement this DMP?

The PI and institute's project coordinator.

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Application DMP

Questionnaire

Describe the datatypes (surveys, sequences, manuscripts, objects …) the research will collect and/or generate and /or (re)use. (use up to 700 characters)

This project will generate new theoretical (and numerical) descriptions and model simulations. All theoretical results (and hence equations) will be published in open-access journals, Lirias and ArXiv. The output formats of the numerical codes vary between .csv, .txt and .dat files. We will post- process and analyze these by using and developing python scripts and Jupiter notebooks that can be shared via platforms such as GitHub. During this FWO project, we will generate a grid of model predictions that are stored in regular text and binary files and will be made publicly available on a dedicated website.

Specify in which way the following provisions are in place in order to preserve the data during and at least 5 years after the end of the research? Motivate your answer. (use up to 700 characters)

The supervisor and team members will be responsible for the preservation of the data, assisted by the IT team of the Institute of Astronomy (IvS).
The IvS has a well-developed in-house storage and backup system which will allow for continuous data preservation. Funding for the backup and storage servers is foreseen in the project.
All original astronomical observations and metadata are stored on public data repositories of the observatories and publications describing the full scientific method will be available from the respective scientific journals and KU Leuven Lirias.

What’s the reason why you wish to deviate from the principle of preservation of data and of the minimum preservation term of 5 years? (max. 700 characters)

NA

Are there issues concerning research data indicated in the ethics questionnaire of this application form? Which specific security measures do those data require? (use up to 700 characters)

NA

Which other issues related to the data management are relevant to mention? (use up to 700 characters)

NA

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DPIA

DPIA

Have you performed a DPIA for the personal data processing activities for this project?

- Not applicable

The orbital evolution of planets orbiting ageing stars
GDPR

GDPR

Have you registered personal data processing activities for this project?

- Not applicable