

# CURRICULUM VITAE

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Nikolaos Karnesis

## PERSONAL DATA

**Date of Birth:** 1985

**Address:** Aristotle University of Thessaloniki University Campus, 54124, Greece

**Phone:** (+30) 2310998173

**Email:** [karnesis@auth.gr](mailto:karnesis@auth.gr), [karnesis.nikos@gmail.com](mailto:karnesis.nikos@gmail.com)

## EDUCATION

- 2011 - 2015 | **Ph.D. Studies**  
Institut d'Estudis Espacials de Catalunya, Barcelona, Spain.  
*Thesis:* "Bayesian Data Analysis for LISA Pathfinder"  
*Supervisors:* Dr. C. F. Sopena and Dr. M. Nofrarias  
*Brief Summary:* The LISA Pathfinder mission was the first step to detecting Gravitational Waves from space. Its primary aim was to test key technologies for future observatories, as well as provide a detailed noise budget model of the local disturbances. In my thesis I explored the different designs for experiments to be performed on-board the satellite, while at the same time I developed the data analysis pipeline aimed to analyze those experiments. The main software products of this thesis were directly used during mission operations, while the different noise models are now being used to enhance our search for Cosmological Gravitational Wave signals with future space observatories.
- 2003 - 2010 | **Diploma on Applied Mathematical and Physical Sciences**  
National Technical University of Athens, Greece.  
*Diploma thesis:* "Study of the MICROMEAS detector and the MICROMEAS Time Projection Chamber detector. Construction and preliminary data analysis"  
*Brief Summary:* We have built an early version of the MICROMEAS detector, which operates as a time projection chamber. The proof-of-principle structure was calibrated and tested in different settings, and a data analysis code was written in C++ in order to visualize the tracks and the energy of the detected particles (products of Cf-252). This work was performed in collaboration with [Democritus Research Facility](#).

## PROFESSIONAL EXPERIENCE

- 2023 | **MSCA Fellow**  
Aristotle University of Thessaloniki, Thessaloniki, Greece.
- 2021 - 2022 | **Post Doc Position - ESA Prodex**  
Aristotle University of Thessaloniki, Thessaloniki, Greece.
- 2020 | **CNRS Fellow**  
Laboratoire AstroParticule et Cosmologie (APC), Paris, France.
- 2018 - 2019 | **CNES Fellow**  
Laboratoire AstroParticule et Cosmologie (APC), Paris, France.
- 2015 - 2017 | **Post Doc Position**  
Institut für Gravitationsphysik der Leibniz Universität (AEI), Hannover, Germany.
- 2016 - 2017 | **ESA LISA Pathfinder Mission Operations**  
Scientist on duty, data analyst.

## RESEARCH INTERESTS

My research revolves mainly around Gravitational Wave physics, astrophysics, cosmology, and data analysis. This includes both pure science and data analysis aspects, such as binary population properties or compact binaries parameter estimation, but also projects focusing on instrument calibration and data pre-processing. I am quite interested in investigating solutions for the data analysis problems that future observatories are going to face, which are mostly caused by the vast number of Gravitational Wave sources that are going to be overlapping in their data streams.

In particular, in recent years we have been developing our version of a *Global Fit* data pipeline proposal for recovering the multiple signals in the data of future Gravitational Wave detectors. Our pipeline solution is designed by combining **stochastic algorithms**, paired with acceleration methods based on Graphics Processing Units (GPUs) and Machine Learning techniques. This allows us to extract the signatures of different types of Gravitational Wave sources efficiently, using an acceptable volume of computational resources. This endeavor was partially funded by the **ESA Prodex** program.

Our data analysis tools are extremely useful in order to search and extract the numerous sources from the data. This means that we can perform studies on the underlying population properties of the different objects that have been recorded. We can do this by combining information from the stochastic Gravitational Wave signal and the resolvable sources, and by employing hierarchical Bayesian models. This methodology can be used to reveal the properties of the population of the Ultra Compact Galactic Binaries (mostly White Dwarf binaries) in the vicinity of our own Galaxy. This means that we can unlock information about our Galaxy (*i.e.* the formation history, the binary fraction, and the overall mass) using only Gravitational Wave signals. The same can be applied to stellar-mass Black Hole binaries; We can combine information from ground and space-based observatories in order to build more accurate models for their mass and spin distributions across very high redshifts  $z$ .

In recent years, I have been very interested to the emergent field of *multi-messenger astronomy*. The prime example of such a detection was the GW170817 measured by the LVK collaboration. The richness in science, just by only one event, justifies the need for developing methods that will allow us to swiftly turn our optical telescopes towards the correct sky position, after detecting an inspiraling binary with our future Gravitational Wave observatories. This fact acted as inspiration for my MSCA funded project, aimed to generate early triggers by searching in a signal-dominated observatory scenario. For our pipeline proposal we utilize a combination of Bayesian methods and Machine Learning Techniques.

I have also been a member of the **LISA Consortium** since its founding. Within the Consortium, I have been contributing to the development of the ESA LISA mission, which is going to fly in the early 2030s, and is going to be the first Gravitational Waves observatory in space. In more details, I have been leading, or being a member, of different working groups focusing on different aspects of the mission. These include the science, data analysis, and instrument calibration. Finally, I am aiding to the formulation of the science objectives and capabilities of the mission, by leading or participating to different Task Forces, and communicating the results with ESA and the Consortium.

In the past, I have been heavily involved in the ESA LISA Pathfinder mission (LPF). The LPF was launched in 2015 with the aim of testing key technologies for future space-borne gravitational-wave detectors. Before launch, I have been developing the data analysis tools in order to analyze the data almost in real time during mission operations. I have been actively participating in mission operations, by serving as *Scientist On Duty* or as *Data Analyst*. Finally, I have developed the final data calibration pipeline, which produced the main scientific data products of the LPF mission, used in all of the collaboration publications.

**Keywords:** Gravitational-Waves, compact binaries, stochastic Gravitational-Wave background, Gravitational Wave Astronomy, LISA mission, LISA Pathfinder mission, Bayesian statistics, system calibration, experiment design, parameter estimation, signal analysis, matched filtering, Markov Chain Monte Carlo, Machine Learning.

## GRANTS & FELLOWSHIPS

2022	EMILIA, Marie Skłodowska-Curie Fellowship (HORIZON-TMA-MSCA-PF-EF).
2021	SpaceSHEL (Hellenic Foundation for Research & Innovation).
2020	ESA Prodex funding (PRODEX GR 2019).
2017	2017 DIA-PF CNES Post-doc Fellowship.
2013	2012 BE1 00836. Visiting grant provided by the Generalitat de Catalunya.
2011	FI-DGR 2011. PhD Fellowship provided by the Generalitat de Catalunya.
2008	NTUA Training Grant. INSA Lyon in collaboration with the ESRF.

## RESEARCH PROJECTS

2022 - Present	SpaceSHEL: “Space Stochastic Gravitational Wave Hunt Employing LISA”. Role: PI (HFRI).
2020 - 2022	ESA Prodex: “LISA Stochastic Signals Analysis Pipeline”. Role: Contact person, developer.
2018 - 2020	Spanish Contribution to LISA, the ESA-L3 Mission, ESP2017-90084-P. Role: External collaborator.
2016 - 2018	From LISA Pathfinder to the ESA-L3 mission: Towards Gravitational Wave Astronomy from Space. Ministry of Economy and Competitivity of Spain, ESP2015-67234-P. Role: External collaborator.
2014 - 2017	Development and Exploitation of the LISA[1cm] Pathfinder Mission and Contributions to The Gravitational Universe and STE-QUEST, Ministry of Economy and Competitivity of Spain, ESP2013-47637-P. Role: Full member, Developing Data Analysis Pipelines & methods for the ESA LISA Pathfinder mission.
2014 - 2017	Gravitational Astronomy Group, AGAUR, Catalan Government (2014-SGR-1378). Role: Full member, Developing Data Analysis Pipelines & methods for the ESA LISA Pathfinder mission.
2012 - 2013	Topical Network on Gravitational Waves. Ministry of Science and Innovation of Spain, FIS2011- 15363-E. Role: PhD student, Developing Data Analysis Pipelines & methods for the ESA LISA Pathfinder mission.

## LANGUAGES

Greek	Maternal
English	Fluent (Certificate of Proficiency, IELTS 7.5)
Catalan	Basic

## RESEARCH ACTIVITIES & SCIENTIFIC COMMUNITIES

Scientific Communities	<p><b>LISA Pathfinder:</b> LISA Pathfinder Science Team, LISA Pathfinder Data Analysis Team. LISA Pathfinder Calibration Team.</p> <p><b>European Space Sciences Committee (ESSC):</b> Fundamental Physics Panel</p> <p><b>LISA:</b> LISA Consortium full member, LISA Data Challenges Group, LISA Data Processing Working Group, Cosmology Working Group, LISA Early Career Scientists, LISA Data Policy Group, LISA Data Artefacts Group.</p> <p><b>LISA Consortium Committees:</b> LISA Publication and Presentation Committee.</p> <p><b>ESA:</b> ESA LISA Calibration Group.</p> <p><b>Virgo:</b> Detector Characterization Group, Virgo Early Career Scientists Group.</p> <p><b>Other:</b> Aristotle University of Thessaloniki Gravitational Wave Group.</p> <p><b>Hellenic Society on Relativity Gravitation and Cosmology:</b> Elected as Treasurer.</p>
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## ORGANIZATION OF CONFERENCES AND MEETINGS

	<p>NEB-20, Athens, September 2023. Organization Committee.</p> <p>4th G2Net Training School, 28-31 March 2023. Organization Committee.</p> <p><b>1st LISA in Greece Workshop</b>, Thessaloniki. Organization Committee.</p> <p>COSPAR 2022, Athens. Organization of the E1.13 session of detecting GWs in space.</p> <p>Chairing sessions at the first GWAECs Coordination Meeting (27/9/2021)</p> <p>Chairing sessions at Workshop on Gravitational Wave Astrophysics for Early Career Scientists. Lorentz Center, (3-7 May 2021).</p> <p>LPF Data analysis meetings. Organisation of numerous data analysis meetings (from 2012 to 2015) concerning the study of data analysis challenges for the LISA Pathfinder mission.</p> <p>LPF Operational exercises. There have been several operational exercises (from 2009 to 2015) organised by the ESA and the LPF data analysis team, with the aim of testing the data analysis infrastructure to realistic mission scenarios. Contributing to the preparation and organisation of these events.</p> <p>LPF training (2014). Preparation and organisation of the second LPF training event; Software development, documentation, data generation, and tutoring. Aim of the meeting: Train the scientific personnel to use the dedicated software for the analysis of the LPF mission data.</p>
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## SOFTWARE

- **LTPDA**: LISA Technology Package Data Analysis toolbox.
- **MH MCMC**: A Metropolis-Hastings sampler.
- **GWG**: Estimating the foreground confusion signal due to compact Galactic Binaries.
- **Eryn**: An MCMC sampler on steroids [2303.02164].
- **Spectal**: A basic toolbox for time-series and spectral analyses.
- **LDC1 submission**: Analysis for the stochastic gravitational wave signal **LDC1** data.
- **SBD**: Analytic Bayesian framework for assessing the detectability of a stochastic Gravitational Wave signal with a given observatory.

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Karnesis Nikolaos, Thessaloniki, March 11, 2023