Joan Alcaide-Núñez

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Website — LinkedIn — GitHub

Languages: English, German, Spanish, Catalan (basic Italian)

Personal Statement

I am Joan Alcaide Núñez (he/him), a BSc Physics student at LMU Munich with a strong interest in observational and multi-messenger cosmology. My research focus lies in combining electromagnetic and gravitational-wave observations to constrain cosmological parameters and probe the nature of dark energy, with particular interest in the late-time evolution and fate of the Universe.

Between 2023 and 2025, I pursued a series of summer research projects centered on the cosmic distance ladder, recomputing the Hubble constant using Cepheids and then Type Ia Supernovae. Building on this foundation, I recently began to work with multi-messenger approaches, exploring how gamma-ray bursts (GRBs) and gravitational wave observations can jointly constrain cosmological models independently of, and complementary to, standard probes. These projects introduced me early to research-level data analysis and strengthened my mathematical, programming and statistical skills early beyond the high school curriculum.

After the Youth & Science fellowship, I have continued to develop my research interests in dark energy and multi-messenger cosmology, extending my previous work and deepening my training. In particular, I have focused on applying Bayesian inference with Monte Carlo (extending from χ^2 minimization), while learning about the theoretical foundations of dark energy models and alternatives to ΛCDM. I am now seeking opportunities to further develop these skills collaboratively within an active research environment.

Research Experience

GRB cosmography with empirical energy relations June-July 2025

Osservatorio Astronomico di Brera (OAB-INAF) 5 weeks

Supervisor: Dr. Giancarlo Ghirlanda, Dr. Om Sharan Salafia (High-Energy Astrophysics Group)

• Applied GRB empirical relations to constrain cosmological parameters $(\Omega_m, \Omega_\Lambda)$ via chi-squared minimization.
• Combined GRB results with binary neutron star (BNS) simulated population (Einstein Telescope).
• Received one-to-one mentoring on relativistic effects and high-energy astrophysics, including theoretical foundations relevant to GRB cosmology.
• Engaged in weekly journal clubs, discussions, and visiting researchers talks, gaining early experience and exposure to other aspects of astrophysics.
• Project's code repository

CAPIBARA Collaboration lead 2024-present

CAPIBARA Collaboration

• CAPIBARA is a group of high-school and university students aiming to research the high-energy cosmos. It comprehends two missions (short-term pathfinder, long-term transient observatory) focusing on both engineering and scientific research.
• Established strategical partnerships with PLD Space & OBA Space among others.

• Leading one of the research initiatives to use Gamma-Ray Burst data from the CAPIGX mission to constrain cosmological parameters and study the Universe at high redshift.
• CAPIGX also should be a useful resource for electromagnetic counterpart follow-ups in the multi-messenger era (2030s)
• Status: Year 1 Collaboration Status Report on July 2025

Student Internship at German Space Agency September 2024
Institute for Remote Sensing - German Aerospace Center (IMF-DLR) 2 weeks

• Week 1: Worked with the Experimental Methods Department (hyperspectral imaging), outdoor field measurements, drone-boat experiment. Visited the German Space Operation Center (GSOC), where both satellite and human spaceflight are guided; the Earth Observation Center (EOC).
• Week 2: Worked with the Photogrammetry and Image Processsing Department, analyzed data using QGIS software and GDAL Python library using Landsat 8 satellite thermal imaging data. Visited the Galileo Competence Center (GK).

Supernova Distance Ladder June-July 2024
Institute of Space Sciences (ICE-CSIC-IEEC) 2 months
Supervisor: Dr. Lluís Galbany (Supernova and Stellar Transients Group)

• Computed Type Ia SNe distances using infrared and optical photometry data from ESO (SOFI instrument), ATLAS and ZTF.
• Fitted cosmological parameters to the distance results, including the Hubble constant.
• Leveraged skills on object-oriented programming and astronomy related Python libraries, data analysis, aperture photometry.
• Engaged in journal clubs, weekly seminars, group meetings.

Scientific Paper Writing August-December 2023
Youth and Science Programme
Supervisor: Dr. Ignasi Pérez-Ràfols, Dr. Laia Casamiquela (Youth & Science)

• Computed the Hubble constant employing Hubble's method with modern Cepheid data from the NASA-IPAC NED Database and he Konkoly Observatory.
• First experience with paper reading, astronomical data analysis, paper writing, and the field of cosmology.
• Project's code repository
• Previously: Research stay in astronomy and astrophysics at MonNatura Pirineus, 10-body student group and 4 researchers; introduction to astronomical observations (16" Schmidt-Cassegrain telescope) and following data collection and analysis, astrophysics from star evolution to gravitational waves; practical demonstrations.

Education

Ludwig-Maximilians-Universität (LMU) Munich September 2025 – Present
B.Sc. in Physics

German School of Barcelona September 2017 - May 2025
Dual High School Diploma (Germany + Spain), GPA: 1.0/1.0

Awards

• **Silver Honour and National Award Spain International Astronomy & Astrophysics Competition (IAAC) 2025**, presented for the student with most points in the country, reaching the 7% of ∼12300 students participating worldwide.
• **Physics Distinction for extraordinary grades by the German Physical Society (DPG)**
• **First Prize and Special Award in Scientific Photography in Jugend Forscht Nordrhein-Westfalen 2025**, forwarding to Final round
• **First Prize in Jugend Forscht Iberia 2025**, project title: "Cosmological distance measurements with Type Ia Supernovae"
• **Silver Honour Final Round of the International Astronomy & Astrophysics Competition (IAAC) 2024**
• **Awarding of internship at German Space Agency (DLR) in Jugend Forscht Nordrhein-Westfalen 2024**
• **First Prize in Jugend Forscht Iberia 2024**, Spain + Portugal level, project title: "Recomputing the Hubble constant"
• **Bronze Honour in Final Round and National Award Spain in the International Astronomy & Astrophysics Competition (IAAC) 2023**, presented for achieving the highest nation-wide score in the final round.

Technical Skills

Programming Languages: Python, C++, HTML/CSS/JavaScript
Scientific Libraries: numpy, scipy, pandas, matplotlib, astropy
Tools: Git, GitHub, LaTeX, Markdown
Methods: data analysis, parameter estimation and model fitting, Bayesian inference, mathematical and cosmological functions

Formal Training:

- *Gravity and Black Holes* — Perimeter Institute (GoPhysics!), 2025
- Mathematics, Statistics, and Data Science — Universitat Autònoma de Barcelona (UAB), 2022
- Algorithms and Programming (C++) — Universitat Politècnica de Catalunya (UPC), 2022
- League of Codes (C++) — Harbour Space, 2022–2023

Currently Expanding: emcee, GWTC & gwcosmos, PyTorch

Selected Projects & Outputs

Gen10: Education Tool for Genomics (website) 2023–2025
Developed a Python package and tutorials enabling students to explore basic genomics concepts through hands-on experimentation. *Python, package development, testing, Jupyter notebooks*

28M: Live Local Elections Statistics (GitHub) Apr–May 2022
Built a real-time data collection and visualization tool for local election results in collaboration with a regional radio station. *Python, HTML/CSS, NumPy, xlwings*

Outreach

De l'aula a l'espai: joves, ions i fotons per entendre l'univers d'altes energies (Contributed) March 2025
CosmoXarxa, CosmoCaixa Barcelona's Science Museum
CosmoXarxa is an initiative create by and for Explainers of the science museum (outreach volunteers). I presented the CAPIBARA project, its objectives and status, both technical, scientific and educative, inviting the public to join the efforts. slides

Introduction to Astrophysics (Invited) May/June 2024
German School of Barcelona
Double session (3h) about an naive introduction to astronomy and astrophysics for 11th graders, covered some cosmology (Big Bang theory), star evolution, galaxy morphology and massive bodies (neutron stars and black holes as extreme cases of star evolution). slides

L'Exploració Espacial (Invited) October 2023
Escola Canigó
Presentation to pre-school students about human space travel and solar system exploration. Focused on hands-on learning with models and didactic, entertaining content. slides

Explainers at CosmoCaixa Museum 2022-2023
Volunteered as Explainer at Barcelona's Science Museum explaining demonstrations to visitors on weekends. Participated in events such as Explainers during Winter, Explainers at Barcelona's City Science Fair and CosmoXarxa.

Volunteering & Socials

Cycling Without Age 2024-2025
Accompanying cycling "walks" around the village and enjoying sharing time with elderly.

Music Band 2021-2024
Playing piano in different groups, school events, competitions, and for charity at local children's hospital. Continue playing