PEDRO A. C. CUNHA

Junior Researcher in Astronomy and Astrophysics

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RESEARCH INTERESTS

Keywords: Galaxies; Active Galactic Nuclei (AGN); Machine Learning; Deep Learning; SED fitting; Spectroscopy; Photometry; Data Analysis; Statistical Modeling;

Main research interest: Development of novel machine learning architectures for analysing large astronomical datasets (SDSS, WISE, and Euclid), from imaging to spectroscopy. Studying the AGN-host galaxy co-evolution. Particular focus on the detection and characterisation of obscured Type II Quasars, using SED fitting and machine learning tools.

Programming: Python; SQL; R; C; Matlab; Bash; Git; Linux

Languages: Portuguese (Native); English (Fluent); Italian (Basic).

EDUCATION

University of Porto, Porto, Portugal

PHD IN ASTRONOMY AND ASTROPHYSICS, 2021-2025

Host institution: *Instituto de Astrofísica e Ciências do Espaço (IA) & Centro de Astrofísica da Universidade do Porto (CAUP)*
Scholarship: *FCT PhD Research Studentship*
Dissertation: *Classification and Characterisation of Galaxies using Novel Machine Learning Methods.*
Advisors: *Andrew Humphrey, Jarle Brinchmann*

University of Porto, Porto, Portugal

MASTER’S DEGREE IN ASTRONOMY AND ASTROPHYSICS, 2019-2021

Optional courses: *"Data Mining II" and "Mathematical and Computational Methods applied to Physics".*
Dissertation: *Investigating Obscured Quasars at High Redshift using Machine Learning.*
Advisors: *Andrew Humphrey*

University of Minho, Braga, Portugal

BACHELOR OF SCIENCE IN PHYSICS, 2015-2019

Optional course: *Introduction to Astronomy and Cosmology.*
Dissertation: *Study on vacancies in 2D hexagonal Boron Nitride.*
Advisor: *Ricardo Ribeiro*

University of Porto, Porto, Portugal

BACHELOR OF SCIENCE IN MATHEMATICS, 09/2012-INTERRUPTED

Graduation not completed. Changed to pursue a degree in Physics.

REFEREED PUBLICATIONS

Lead author

- **Cunha, P. A. C**. and Humphrey, A., *"Photometric redshift-aided classification using ensemble learning"*, A&A, vol. 666, Art. no. A87, 2022. doi:10.1051/0004-6361/202243135
- **Cunha, P. A. C.** and 11 other authors, *"MAXI GRB 221006A: Redshifts of the possible host galaxies"*, GCN.32742, 2022.
- **Cunha, P. A. C.** and 7 other authors, *"Identifying type II quasars at intermediate redshift with few-shot learning photometric classification"*, A&A, vol. 687, Art. no. A269, 2024. doi:10.1051/0004-6361/202346426.
- **Cunha, P. A. C.** and 6 other authors, *"Exploring the physical properties of Type II Quasar candidates at intermediate redshifts with CIGALE"*, accepted for publication on A&A.

Co-author

- O'Rourke Brogan, R., **Cunha, P. A. C.**, Ma, G., and Thoene, C. C., *"Afterglow limits of GRB 221006A from OHP"*, GCN.32710, 2022.
- Humphrey, A., and 7 other authors including **Cunha, P. A. C.**, *"Machine-learning classification of astronomical sources: estimating F1-score in the absence of ground truth"*, MNRAS, vol. 517, no. 1, OUP, pp. L116–L120, 2022. doi:10.1093/mnrasl/slac120.
- Humphrey, A., Bisigello, L., **Cunha, P. A. C.**, and 233 other authors, *"Euclid preparation. XXII. Selection of quiescent galaxies from mock photometry using machine learning"*, A&A, vol. 671, Art. no. A99, 2023. doi:10.1051/0004-6361/202244307.
- Humphrey, A., **Cunha, P. A. C.** and 6 other authors, *"Improving machine learning-derived photometric redshifts and physical property estimates using unlabelled observations"*, MNRAS, vol. 520, no. 1, OUP, pp. 305–313, 2023. doi:10.1093/mnras/stac3596.
- Carvajal, R., and 14 other authors including **Cunha, P. A. C.**, "Selection of powerful radio galaxies with machine learning", A&A, vol. 679, Art. no. A101, 2023. doi:10.1051/0004-6361/202245770.
- Mellier, Y., and 1195 authors including **Cunha, P. A. C.**, "Euclid. I. Overview of the Euclid mission", arXiv e-prints, Art. no. arXiv:2405.13491, 2024. doi:10.48550/arXiv.2405.13491, Accepted for publication in the A&A special issue `Euclid on Sky'.
- Bisigello, L., and 256 other authors including **Cunha, P. A. C.**, "Euclid preparation: XLIX. Selecting active galactic nuclei using observed colours", A&A, vol. 691, Art. no. A1, EDP, 2024. doi:10.1051/0004-6361/202450446.
- Enia, A., and 294 other authors including **Cunha, P. A. C.**, "Euclid preparation: LI. Forecasting the recovery of galaxy physical properties and their relations with template-fitting and machine-learning methods", A&A, vol. 691, Art. no. A175, EDP, 2024. doi:10.1051/0004-6361/202451425.
- Humphrey, A., **Cunha, P. A. C.**, and 259 other authors, "Euclid preparation. Estimating galaxy physical properties using CatBoost chained regressors with attention", submitted to A&A.

SCIENTIFIC COMMUNICATIONS

Oral Presentations

Pedro A. C. Cunha, A. Humphrey, J. Brinchmann. “Unveiling the Physical Properties of Type II Quasar Candidates in the Redshift Desert: Galaxy and AGN Co-Evolution”.
2023/09/07. Presented in XXXIII National Meeting of Astronomy and Astrophysics (ENAA).

Pedro A. C. Cunha, A. Humphrey, J. Brinchmann. “Few-shot learning photometric classification for the identification of Type II Quasars at intermediate and high-redshift”. (ePoster + Flash talk)
2023/07/13. Presented in European Astronomical Society Annual Meeting 2023.

Pedro A. C. Cunha, A. Humphrey, J. Brinchmann. “SpecSound: a sonification approach to astronomical spectroscopic analysis using machine learning”.
2023/06/26. Presented in the special event Student Think Tank @ ICAD 2023: Sonification for the Masses.

Pedro A. C. Cunha, A. Humphrey. “Investigating obscure Quasars at high redshift using Machine Learning”.
2021/09/08-10. Presented in XXXI National Meeting of Astronomy and Astrophysics (ENAA) (Virtual).

Posters

Pedro A. C. Cunha, A. Humphrey, J. Brinchmann. “Unveiling the Physical Properties of Type II Quasar Candidates in the Redshift Desert: Galaxy and AGN Co-Evolution”.
2023/07/12. Presented in European Astronomical Society Annual Meeting Meeting 2023.

Pedro A. C. Cunha, A. Humphrey, J. Brinchmann. “SpecSound: a sonification approach to astronomical spectroscopic analysis using machine learning”.
2023/06/29. Presented in ICAD 2023: Sonification for the Masses.

Pedro A. C. Cunha, A. Humphrey, J. Brinchmann. “Unveiling the Physical Properties of Type II Quasar Candidates in the Redshift Desert: Galaxy and AGN Co-Evolution”.
2023/06/19. Presented in Euclid Consortium Meeting 2023.

Pedro A. C. Cunha, A. Humphrey. “*Selection of obscured quasars with Machine Learning at high redshift*”.
2021/06/21-23. Presented in Massively Parallel Large Area Spectroscopy from Space (Virtual).

Pedro A. C. Cunha, A. Humphrey. “*Investigating obscure Quasars at high redshift using Machine Learning*”.
2021/05/05-07. Presented in IJUP (Virtual).

EVENT ORGANISATION

Conference
XXXIV Encontro Nacional de Astronomia e Astrofísica
2024/09/12-14, Guimarães, Portugal (Member of the LOC team)

Workshop
Massively Parallel Large Area Spectroscopy from Space,
2021/06/21-23, IA, Portugal (Member of the LOC team)

Masterclass
LHC@ International Masterclass.
2021/02/27, Universidade do Minho, Braga, Portugal (Member of the tutor team)

WORKSHOPS AND SCHOOLS

Observing School
NEON Observing School.
2022/10/2-15, Observatoire de Haute-Provence, France

Workshop
Exploiting Archives for Radio Astronomy in the SKA-era.
2020/11/23-2020/11/25, RadioNet and IA(Virtual)

Workshop
Workshop on Compact Objects, Gravitational Waves and Deep Learning.
2020/09/21-2020/09/25, University of Aveiro, Portugal

Summer Internship @ Critical Software
2019/07-2019/08, Critical Software, Porto, Portugal

Workshop
Introduction to Linux.
2017/02/06-08, LIP-Minho, University of Minho, Portugal

STUDENT SUPERVISION

Summer School
IAstro Summer Internships, supervised and co-supervised 5 projects (~6 students per project).
2024/07, Porto, Portugal

Summer School
IAstro Summer Internships, supervised and co-supervised 3 projects (~5 students per project).
2023/07, Porto, Portugal

Summer School
IAstro Summer Internships, supervised 2 projects (~4 students per project).
2022/07, Porto, Portugal

ADDITIONAL EXPERIENCE

Extracurricular project
“Computational study of the interface heat transport on the boundary between thermoelectric nanoparticles.”
2018/09-2019/02, INL and CFUM, University of Minho, Braga, Portugal
Adviser: Sergey Pyrlin

Extracurricular project
“A vacancy study on 2D hexagonal Boron Nitride ",
2017/02-2017/07, CFUM, University of Minho, Braga, Portugal
Adviser: Ricardo Ribeiro

PROJECT PARTICIPATION

Finding Lyman-alpha emitters through machine learning (FLAEMING)
EXPL/FIS-AST/1085/2021
P.I: Ana S. Paulino Afonso
Date: 2022/01/01-2023/12/31
Contribution: In this project, I was part of the machine learning expert team. My main task was to contribute to the development and validate the machine learning architecture for classification and regression tasks. I helped to implement and optimise algorithms using decision-tree based methods, deep learning, and ensemble models.

Hunting for Obscured Supermassive Black Holes using HPC-Warp speed 2022.75281.CPCA.A0
P.I: Pedro A. C. Cunha
Date: 2023/09/01-2024/03/01
Contribution: In this High-Performance Computing (HPC) project, I was granted (42000 hours of CPU time and 470 hours of GPU time) to run machine learning models for the classification and physical properties estimation of Type II Quasar candidates. My work focused on a multi-input architecture to perform spectroscopic analysis of Type II Quasar candidates identified through a ensemble methodology using photometric data.

Dark matter and metals in galaxies (DarkMAGE)
PTDC/FIS-AST/4862/2020
P.I: Jarle Brinchmann
Date: 2023/12/01-Current
Contribution: As a member of the Euclid collaboration, I contribute to the data analysis, particularly as a machine-learning expert.

AstroLingua: Empowering Inclusive Astronomy through AI
CPCA-IAC/AV/594693/2023
P.I: Ana S. Paulino Afonso
Co-PI: Pedro A. C. Cunha
Date: 2024/02/02-2025/02/01
Contribution: In this project, we were granted computational time and resources from Google Cloud to explore the use of Large Language Models (LLMs) and deep learning classification for inclusivity in astronomy. Our main goal is to provide scientifically accurate and accessible descriptions of astronomical images for visually-impaired citizens and researchers. My role involves training models to generate text descriptions from image features using CNNs and Transformers. I am also working on LLMs to refine these descriptions, ensuring clarity, accuracy, and accessibility. We aim to develop a framework that can automatically generate descriptive text for galaxies images, useful for large surveys such as Euclid.

OBSERVING EXPERIENCE

- **4 nights** - NEON Observing School 2022: In-person observing school hosted by the Observatoire de Haute-Provence.
- **3 nights** - GOODMAN@SOAR: “Studying emission line activity in a sample of machine learning-selected QSO2 in the redshift desert” - Remote observation, collaboration with Rogerio Riffel.