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## Research Interests

I am interested in understanding black hole accretion, spin and perform tests of General Relativity through direct modeling of supermassive black holes. I am also keen to understand how relativistic jets are launched and how the accretion disk connects to the relativistic jets. To understand these problems, I am interested in developing and using tools that use machine learning, Bayesian inference, to measure physical properties of black holes and jets through mm-VLBI observations (eg. Event Horizon Telescope).

## Education

**Instituto de Astrofísica de Andalucía (IAA-CSIC)** Nov 2022–Aug 2025 (expected)  
*Doctoral Programme in Physics and Space Sciences* Granada, Spain  
 PhD Thesis: Inferring Black Hole Physics through Image and Video Reconstructions with the Event Horizon Telescope  
 Supervisor: [Dr. José L. Gómez](#)

**Indian Institute of Science Education and Research Kolkata** Aug 2017–Jul 2022  
*Bachelor and Master of Science in Physical Sciences* GPA: 9.52/10.0  
 MS Thesis: [Magnetic Fields of Relativistic Jets of Supermassive Black Holes](#)  
 Supervisor: [Dr. José L. Gómez](#)

## Research and Teaching Experience

**Member, Event Horizon Telescope Collaboration** Jun 2022–present  

- Core contributor of imaging, modeling and feature extraction efforts
- Led four projects leading to three first author papers (two in prep)

**PhD Candidate, Instituto de Astrofísica de Andalucía** Sept 2022–present  

- Supervisor: [Dr. José L. Gómez](#)
- Focused on developing Bayesian modeling and testing theory of general relativity
- Led three EHT Collaboration papers: 1) Origin of ring ellipticity in black hole images of M87\* (*submitted*) 2) Evaluating the first videos of black hole SgrA\* (*in prep*) 3) Geometric modeling of SgrA\* dynamics to understand accretion mechanisms (*in prep*)

**Visiting Scholar** Jul–Aug 2024  
**Black Hole Initiative, Harvard** (Supervisor: [Dr. Paul Tiede](#)) Cambridge, USA  
**MIT Haystack Observatory** (Supervisor: [Dr. Kazu Akiyama](#)) Westford, USA

- Project: Time and frequency resolved Bayesian imaging with `Comrade.jl`
- Added auto-differentiable NFFT for images at different times and/or frequency
- Optimized the code for time ( $\mathcal{O}(N)$  but can be parallelized) and memory allocations
- Added unit tests for the new code and had a [code review](#)
- Working on adding a spatio-temporal Gaussian Random Field (GRF) prior
- GRF will be a solution of a stochastic PDE which outputs video and the velocity profile

**Master Thesis Student, Instituto de Astrofísica de Andalucía** Oct 2021–Jun 2022  

- Supervisor: [Dr. José L. Gómez](#)
- Mapped the 3D structure of magnetic fields in blazar jets of supermassive black holes to understand jet launching

 Granada, Spain

## Graduate Teaching Assistant, IISER Kolkata

Aug 2020–Jul 2021  
Kolkata, India

- Autumn 2020: Mathematical Methods for Physics
- Autumn 2020: Mechanics I
- Spring 2021: Electricity and Magnetism

## Research Intern, University of California, Santa Barbara

May–Jul 2019  
Santa Barbara, USA

- Published a paper on Extended Radio Emission in Narrow-line Seyfert 1 Galaxies with JVLA, supervised by Dr. Emilia Järvelä
- Worked on the Lyman Edge Polarisation of QSO PG 1630+377 using Hubble, supervised by Prof. Robert Antonucci

## Honors and Awards

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### ”la Caixa” Doctoral INPhINIT Fellowship

Sep 2022 - Aug 2025

*Fundación ”la Caixa” - Instituto de Astrofísica de Andalucía (IAA-CSIC)*

- 35 fellowships (from  $\sim 1000$  candidates) are awarded to pursue PhD studies in research centres accredited with the Spanish Seal of Excellence Severo Ochoa in STEM disciplines
- Duration: 3 years and Total grant: €122,592

### JAE Intro 2021 Scholarship

Oct 2021 - Jun 2022

*Consejo Superior de Investigaciones Científicas (CSIC), Spain*

- 250 scholarships (from  $\sim 3000$  candidates) offered to undergraduate students
- Total grant: €5,400 for nine months. Used for the Master Thesis at IAA-CSIC

### INSPIRE Scholarship

Aug 2017 - Jul 2022

*Department of Science and Technology (DST), India*

- Offered to top 1% students in 12th grade exams, undertaking Bachelor and Masters level education in the Natural Sciences. The scholarship amounts to 400,000 INR ( $\sim €4,500$ ) for 5 years

## Selected Scientific Talks

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### Invited Talks

- [1] Origin of the Ring Ellipticity in the Black Hole Images of M87\* 2 Dec 2024  
*2024 EHT Virtual Collaboration Meeting* [Presentation](#)
- [2] Full Stokes Radio Interferometric Imaging and Instrument Modeling 1-2 Oct 2024  
with `Comrade.jl`  
*European Radio Interferometry School 2024, Granada, Spain*
- [3] New EHT Results of the M87\* Shadow: 1 Jul 2024  
Observations, Imaging, and Analysis from Multiple Years [Presentation](#)  
*European Astronomical Society Annual Meeting 2024, Padova, Italy*
- [4] 2018 M87\* Ring Ellipticity 12 Dec 2023  
*2023 EHT Virtual Collaboration Meeting* [Presentation](#)

### Contributed Talks

- [1] Full Stokes Bayesian Modeling and Imaging of VLBI data 2 Jul 2024  
with `Comrade.jl` [Presentation](#)  
*European Astronomical Society Annual Meeting 2024, Padova, Italy*
- [2] Measuring the Ring Ellipticity of M87\* using 2018 the EHT data 24 May 2024  
*EHT Collaboration Meeting Summer 2024, Mexico City, Mexico* [Presentation](#)
- [3] Full Stokes Snapshot Modeling with `Comrade.jl` 27 Feb 2024  
*SgrA\* Dynamics Workshop, Granada, Spain* [Presentation](#)

[4] Measuring the Ring Ellipticity of M87* using 2018 the EHT data <i>EHT Collaboration Meeting 2023 Summer, Taichung, Taiwan</i>	27 Jun 2023 <a href="#">Presentation</a>
[5] A Bayesian Approach to Imaging Supermassive Black Holes and Relativistic Jets <i>Doctoral Conferences (Jornadas de Doctorado), IAA-CSIC</i>	17 May 2023 <a href="#">Presentation</a>
[6] Accelerating Bayesian Imaging with Comrade.jl <i>2022 EHT Winter (Virtual) Collaboration Meeting</i>	15 Dec 2022 <a href="#">Presentation</a>
[7] Accelerating Bayesian Imaging with Comrade.jl <i>Resolve Workshop 2022, MPIfR, Bonn, Germany</i>	26 Oct 2022 <a href="#">Presentation</a>

## Accepted Proposals & Observations

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<b>2023.1.01244.V: The Multi-frequency Horizon-scale View of M87</b> <i>Led the Event Horizon Telescope ALMA Cycle 10 Proposal</i> <i>Observed at the IRAM-30m Telescope for the 2024 EHT Observation Campaign</i>	Apr 2024
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## Outreach

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<b>Official Press Release of the EHT for the 2018 M87* Paper I</b> <i>M87* One Year Later: Proof of a persistent black hole shadow</i>	18 Jan 2024
<b>Official Press Release of IAA-CSIC for the 2018 M87* Paper I</b> <i>English version: M87* One Year Later: Proof of a persistent black hole shadow</i>	18 Jan 2024
<b>Managing Social Media and Website of VLBI Group at IAA</b> <i>X.com, Instagram, Threads, Website</i>	May 2022 - present

## Skills

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**Imaging:** Comrade.jl, eht-imaging

**Programming:** Julia, Python, Git, Bash

**Languages:** English (native), Marathi (native), Hindi (native), Spanish (A2)

## References

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### Dr. José L. Gómez

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Granada, Spain  
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### Prof. Peter Galison

Professor at Harvard University  
Director at Black Hole Initiative  
Cambridge, MA, United States  
[Webpage](#)  
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### Dr. Kazu Akiyama

Research Scientist  
MIT Haystack Observatory  
Westford, MA, United States  
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### Prof. Aviad Levis

Assistant Professor at Department of CS  
University of Toronto  
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## First Author Papers

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[1], [2], [3] are Event Horizon Telescope Collaboration Official Papers. [1] is under internal review of the Collaboration. [2] and [3] are in preparation. [4] has equal contribution first authors where I did half of the analysis and paper writing.

- [1] **R. Dahale** and the Event Horizon Telescope Collaboration, “Origin of the ring ellipticity in the black hole images of M87\*,” (*submitted*), 2024.
- [2] **R. Dahale** and the Event Horizon Telescope Collaboration, “Validation and evaluation of the first video reconstructions of the black hole SgrA\* with the Event Horizon Telescope,” (*in prep*), 2024.
- [3] **R. Dahale** and the Event Horizon Telescope Collaboration, “Bayesian full Stokes geometric snapshot modeling of the black hole SgrA\* with the Event Horizon Telescope,” (*in prep*), 2024.
- [4] Järvelä, E., **R. Dahale**, L. Crepaldi, *et al.*, “Unravelling the origin of extended radio emission in narrow-line Seyfert 1 galaxies with the JVLTA,” *Astronomy & Astrophysics*, vol. 658, A12, A12, Feb. 2022. DOI: [10.1051/0004-6361/202141698](https://doi.org/10.1051/0004-6361/202141698).

## Event Horizon Telescope Collaboration Papers

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Significant contribution to [1]. I led the Bayesian imaging and analysis and wrote the corresponding part in the paper.

- [1] Event Horizon Telescope Collaboration, (**including R. Dahale**), K. Akiyama, *et al.*, “The persistent shadow of the supermassive black hole of M 87. I. Observations, calibration, imaging, and analysis,” *Astronomy & Astrophysics*, vol. 681, A79, Jan. 2024. DOI: [10.1051/0004-6361/202347932](https://doi.org/10.1051/0004-6361/202347932).
- [2] Event Horizon Telescope Collaboration, (**including R. Dahale**), K. Akiyama, *et al.*, “The persistent shadow of the supermassive black hole of M87: II. Model comparisons and theoretical interpretations,” *Astronomy & Astrophysics*, vol. 693, A265, Jan. 2025. DOI: [10.1051/0004-6361/202451296](https://doi.org/10.1051/0004-6361/202451296).
- [3] A. W. Raymond, Event Horizon Telescope Collaboration, (**including R. Dahale**), *et al.*, “First Very Long Baseline Interferometry Detections at 870  $\mu\text{m}$ ,” *The Astronomical Journal*, vol. 168, no. 3, 130, p. 130, Sep. 2024. DOI: [10.3847/1538-3881/ad5bdb](https://doi.org/10.3847/1538-3881/ad5bdb).
- [4] Event Horizon Telescope Collaboration, (**including R. Dahale**), K. Akiyama, *et al.*, “First Sagittarius A\* Event Horizon Telescope Results. VIII. Physical Interpretation of the Polarized Ring,” *The Astrophysical Journal Letters*, vol. 964, no. 2, L26, p. L26, Apr. 2024. DOI: [10.3847/2041-8213/ad2df1](https://doi.org/10.3847/2041-8213/ad2df1).
- [5] Event Horizon Telescope Collaboration, (**including R. Dahale**), K. Akiyama, *et al.*, “First Sagittarius A\* Event Horizon Telescope Results. VII. Polarization of the Ring,” *The Astrophysical Journal Letters*, vol. 964, no. 2, L25, p. L25, Apr. 2024. DOI: [10.3847/2041-8213/ad2df0](https://doi.org/10.3847/2041-8213/ad2df0).
- [6] G. F. Paraschos, Event Horizon Telescope Collaboration, (**including R. Dahale**), *et al.*, “Ordered magnetic fields around the 3C 84 central black hole,” *Astronomy & Astrophysics*, vol. 682, L3, p. L3, Feb. 2024. DOI: [10.1051/0004-6361/202348308](https://doi.org/10.1051/0004-6361/202348308).
- [7] P. Torne, Event Horizon Telescope Collaboration, (**including R. Dahale**), *et al.*, “A Search for Pulsars around Sgr A\* in the First Event Horizon Telescope Data Set,” *The Astrophysical Journal*, vol. 959, no. 1, 14, p. 14, Dec. 2023. DOI: [10.3847/1538-4357/acf4f2](https://doi.org/10.3847/1538-4357/acf4f2).
- [8] F. Roelofs, Event Horizon Telescope Collaboration, (**including R. Dahale**), *et al.*, “Polarimetric Geometric Modeling for mm-VLBI Observations of Black Holes,” *The Astrophysical Journal Letters*, vol. 957, no. 2, L21, p. L21, Nov. 2023. DOI: [10.3847/2041-8213/acff6f](https://doi.org/10.3847/2041-8213/acff6f).
- [9] Event Horizon Telescope Collaboration, (**including R. Dahale**), K. Akiyama, *et al.*, “First M87 Event Horizon Telescope Results. IX. Detection of Near-horizon Circular Polarization,” *The Astrophysical Journal Letters*, vol. 957, no. 2, L20, p. L20, Nov. 2023. DOI: [10.3847/2041-8213/acff70](https://doi.org/10.3847/2041-8213/acff70).

## Other Papers

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- [1] Fuentes, A., J. L. Gómez, (**including R. Dahale**), *et al.*, “Filamentary structures as the origin of blazar jet radio variability,” *Nature Astronomy*, vol. 7, pp. 1359–1367, Nov. 2023. DOI: [10.1038/s41550-023-02105-7](https://doi.org/10.1038/s41550-023-02105-7).
- [2] E. Traianou, T. P. Krichbaum, (**including R. Dahale**), *et al.*, “Lost in the curve: Investigating the disappearing knots in blazar 3C 454.3,” *Astronomy & Astrophysics*, vol. 682, A154, A154, Feb. 2024. DOI: [10.1051/0004-6361/202347267](https://doi.org/10.1051/0004-6361/202347267).
- [3] G.-Y. Zhao, J. L. Gómez, (**including R. Dahale**), *et al.*, “Unraveling the Innermost Jet Structure of OJ 287 with the First GMVA + ALMA Observations,” *The Astrophysical Journal*, vol. 932, no. 1, 72, p. 72, Jun. 2022. DOI: [10.3847/1538-4357/ac6b9c](https://doi.org/10.3847/1538-4357/ac6b9c).