

# Balu Sreedhar

## Curriculum vitae

Room D5.14, Facultad de Físicas, Universidad de Sevilla  
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Research interests Epoch of reionization (EoR); 21-cm signal from the EoR; high redshift galaxy formation and evolution;  $N$ -body simulations of large-scale structure formation; first stars and galaxies.

### Education

- 2020 – 2024 **Ph.D. in Astrophysics**, *University of Melbourne, Australia*  
Submitted: 5<sup>th</sup> January 2024; Awarded: 24<sup>th</sup> April 2024  
Supervisors Prof. Stuart Wyithe & Dr Bradley Greig  
Thesis *Hydrogen in the first billion years: a study of the 21-cm signal from the high-redshift Universe*
- 2014 – 2019 **Integrated Masters in Physics**, *Pondicherry University, India, CGPA: 9.3/10*  
Supervisor A/Prof. B. Muthukumar  
Thesis *On the Path-Integral Approach to Quantum Mechanics*

### Awards/Scholarships/Grants

- 2024 **Albert Shimmins Award**, *University of Melbourne writing-up grant*, AUD 3,000  
2023 **Student Travel Grant**, *Astronomical Society of Australia*, AUD 1,500  
2023 **Laby Travelling Scholarship**, *University of Melbourne*, AUD 3,000  
2020 – 2024 **Melbourne Research Scholarship**, *University of Melbourne*, AUD 32,000/yr + Fee offset  
2017 – 2019 **Postgraduate Merit Scholarship**, *Pondicherry University*  
2014 – 2017 **Merit Scholarship**, *Pondicherry University*
- 2024 **5M SU as Co-PI**, *From Darkness to Light: Tracking the remnants of the first galaxies with the SOLAS Simulations*, Gadi, National Computational Infrastructure (NCI), Australia  
2022 **5.2M SU as Co-PI**, *FENICE - The First galaxies and ENvironment In Cosmological simulations of Early universe*, Gadi, National Computational Infrastructure (NCI), Australia

### Research Experiences

- 2019 – 2020 **Visiting Student**, *Raman Research Institute, Bangalore*  
Supervisors Prof. Ravi Subrahmanyam & Prof. N. Udaya Shankar  
Title Secondary Science with PRATUSH
- 2018 **Summer intern**, *Indian Institute of Astrophysics, Bangalore*  
Supervisor A/Prof Maheswar Gopinathan

Title Determination of Diffuse Interstellar Bands in LAMOST spectra

2017 **Summer intern**, *Indian Academy of Sciences Summer Research Fellow*

Supervisor Prof. Sukalyan Chattopadhyay, *Saha Institute of Nuclear Physics, Kolkata*

Title Introduction to Relativistic Heavy-Ion Collisions

2016 **Summer intern**, *Indian Institute of GeoMagnetism, Puducherry*

Supervisor Dr Anil Iype

Title Principles of Observatory Magnetometry

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## Workshops & Training

2020, 2021, 2022 Harley Wood schools of Astronomy

2016 Physics Training and Talent Search, *Regional Institute of Education, Mysore*

2019 Advanced SITARE workshop, *IUCAA, Pune*

2018 Indian Institute of Astrophysics Summer School, *Kodaikanal Solar Observatory*

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## Professional Activities

2022 **Panelist**, *Diversity and Inclusion Seminar Series: How to Reach 50/50 Gender Representation: Strategies from the ASTRO3D Centre of Excellence*, Faculty of Science Diversity and Inclusion Committee

2021 **Local Organising Committee**, *Harley Wood School of Astronomy*

2021 – 2022 **Organiser**, *Weekly Astrophysics group meeting*, University of Melbourne

2021 – 2023 **Student Representative**, *ARC Centre of Excellence for All Sky Astrophysics in 3D (ASTRO3D)*, University of Melbourne node

2021 – 2023 **Equity, Diversity & Inclusion Committee**, *ASTRO3D*, University of Melbourne node

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## Selected Talks & Posters

Online participations are marked with a †

2024 **Contributed Talk**, *Hydrogen in the first billion years: simulating the epoch of reionisation*, Nagoya University, Nagoya, Japan

2023 **Invited Talk**, *Hydrogen in the first billion years: simulating the epoch of reionisation*, Mt. Stromlo, RSAA, Australian National University, Canberra

2023 **Invited Talk**, *Fisher matrix forecasts on the astrophysics of galaxies during the EoR*, Centre for Computational Astrophysics (CCA), Flatiron Institute

2023 **Invited Talk**, *The epoch of reionisation*, West Virginia University

2023 **Contributed Talk**<sup>†</sup>, *Global 21-cm signal with MERAXES*, 6<sup>th</sup> Global 21-cm workshop

2023 **Contributed Talk**<sup>†</sup>, *Fisher matrix forecasts on the astrophysics of galaxies during the Epoch of Reionisation*, 16<sup>th</sup> GECO-16 conference: Shedding new light on the first billion years of the Universe

2023 **Poster**, *What can you learn about the galaxies during the Epoch of Reionisation from the 21-cm power spectra?*, Astronomical Society of Australia Science meeting, Sydney

- 2023 **Contributed Talk**, *Fisher matrix forecasts on the astrophysics of galaxies during the Epoch of Reionisation*, Reionisation in Summer conference, Heidelberg
- 2023 **Invited Talk**, *Simulations of the Epoch of Reionisation*, Cosmic DAWN Institute, Copenhagen
- 2023 **Invited Talk**, *Simulations of the Epoch of Reionisation and forecasting the galaxy properties*, Scuola Normale Superiore, Pisa
- 2023 **Contributed Talk**, *Fisher matrix forecasts on the astrophysics of galaxies during the EoR*, ASTRO3D Annual Science Meeting, Perth
- 2023 **Invited Talk**, *Constraining astrophysics using the 21-cm power spectra from the Epoch of Reionisation*, 8<sup>th</sup> Southern Regional Astronomy Meeting, Cochin
- 2023 **Contributed Talk**<sup>†</sup>, *What can we learn from the 21-cm power spectra from the Epoch of Reionisation?*, 16<sup>th</sup> The Australian National Institute of Theoretical Astrophysics (ANITA) Workshop
- 2022 **Contributed Talk**<sup>†</sup>, *Thermal and Reionisation History within a Large-Volume Galaxy Formation Simulation*, International Workshop on Galaxy Formation And Evolution Across The Cosmic Time (GFEACT-2022)
- 2022 **Invited Talk**<sup>†</sup>, *21-cm Predictions for the Epoch of Reionisation*, Kapteyn Institute colloquium
- 2022 **Contributed Talk**, *21-cm Predictions for the Epoch of Reionisation*, ASTRO3D Annual Science Meeting, Melbourne
- 2022 **Invited Talk**, *21-cm Predictions for EoR using Semi-Analytic Galaxy Formation applied to GENESIS+*, International Centre for Radio Astronomy Research (ICRAR), University of Western Australia, Perth
- 2022 **Contributed Talk**, *Exploring the Effects of Mass Resolution in Cosmological Simulations on EoR Statistics*, 15<sup>th</sup> The Australian National Institute of Theoretical Astrophysics (ANITA) Workshop, Sydney
- 2022 **Contributed Talk**<sup>†</sup>, *Monte-Carlo Augmentation applied to N-Body Simulations for Semi-Analytic Modelling*, SAZERAC Sip
- 2021 **Poster**<sup>†</sup>, *A computationally cheap trillion particle N-body simulation*, ACAMAR7: Australia-China Workshop on Astrophysics
- 2021 **Contributed Talk**<sup>†</sup>, *Impact of Galaxy Formation on 21-cm Global Signal*, 4<sup>th</sup> Global 21-cm Workshop
- 2021 **Contributed Talk**<sup>†</sup>, *Semi-Analytic Galaxy Formation Applied to the Epoch of Reionisation*, 7<sup>th</sup> Regional Astronomy Meeting 2021
- 2021 **Poster**, *A computationally cheap trillion particle N-body simulation*, ASA Annual Science Meeting 2021, Melbourne

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## Teaching

- 2023 - **Tutor**, *Art of Scientific Computing (graduate course)*, University of Melbourne
- Graduate level course open to all students from the university (not limited to physics majors). The course introduces students to a wide range of skills that are commonly encountered in the design and construction of computational tools in research applications. I have to date guided  $\sim 15$  students in various one-semester research topics including simulations of traffic analysis, epidemics, forest fires, neural activity, energy states of complex hydrocarbons via Hartree-Fock methods, etc.

2022 - **Demonstrator**, *Laboratory and Computational Physics 3 (undergraduate course)*, University of Melbourne

3rd-year undergraduate physics students take a lab subject as part of their major, which requires taking at least two experimental projects, each of which involves 18 hours of classroom time. I am the instructor for the N-body simulation lab. In 2023, I co-wrote a new version of the observational astrophysics projects where the students submit an observational proposal to observe galaxy clusters, reduce the data, and estimate the Hubble constant.

2023 - **Demonstrator**, *Solar system to cosmos (undergraduate course)*, University of Melbourne

Introductory undergraduate course open to anyone enrolled at the university irrespective of their academic background. I guide students through a set of 8 three-hour sessions that cover diverse topics such as spectra, actual telescope observations & image processing, HR diagram, galaxy classifications, curved spacetime, etc.

2021 - 2022 **Demonstrator**, *First Year Physics*, University of Melbourne

Advanced undergraduate course for physics majors covering topics including mechanics, fluid dynamics, etc

## Technical Strengths

■ ■ ■ ■ ■	basic knowledge	■ ■ ■ ■ ■	extensive project experience
■ ■ ■ ■ ■	intermediate knowledge with some project experience	■ ■ ■ ■ ■	deepened expert knowledge
		■ ■ ■ ■ ■	expert / specialist

	Level	Skill	Comment
Language:	■ ■ ■ ■ ■	Python	<i>Extensive data analysis and visualisation experience</i>
	■ ■ ■ ■ ■	C	<i>Active developer of MERAXES semi-analytical model</i>
	■ ■ ■ ■ ■	C++, Fortran	<i>Basic understanding</i>
	■ ■ ■ ■ ■	L <sup>A</sup> T <sub>E</sub> X	<i>Expert</i>
OS:	■ ■ ■ ■ ■	Unix	<i>Extensive experience</i>
Methods	■ ■ ■ ■ ■	SLURM, Git, Bash	<i>Extensive</i>

## Languages

- Malayalam Native
- English, Tamil & Hindi Fluent

## References

- Prof Stuart Wyithe  
RSAA, Australian National University  
✉ [stuart.wyithe@anu.edu.au](mailto:stuart.wyithe@anu.edu.au)
  - Prof Chris Power  
ICRAR, University of Western Australia  
✉ [chris.power@uwa.edu.au](mailto:chris.power@uwa.edu.au)
- Dr. Bradley Greig  
School of Physics  
University of Melbourne  
✉ [greigb@unimelb.edu.au](mailto:greigb@unimelb.edu.au)
  - Prof Rachel Webster  
School of Physics  
University of Melbourne  
✉ [r.webster@unimelb.edu.au](mailto:r.webster@unimelb.edu.au)

## Publications List

- [5] J. Cook, **S. Balu**, B. Greig, C. M. Trott, J. L. B. Line, Y. Qin, and J. S. B. Wyithe. *The Impact of ionization Morphology and X-ray Heating on the Cosmological 21cm Skew Spectrum*, in press, Monthly Notices of the Royal Astronomical Society, arxiv: 2402.17254  
I generated a set of seven simulations from  $z = 30$  to  $z = 5$ , varying the halo mass threshold for star formation, the X-ray luminosity per star formation rate, and the minimum energy of X-rays escaping galaxies; implemented the IGM spin temperature field lightcone into MERAXES; significant contribution to the manuscript.
- [4] E. M. Ventura, Y. Qin, **S. Balu**, and J. S. B. Wyithe. *Semi-analytic modeling of Pop. III star formation and metallicity evolution - I. Impact on the UV luminosity functions at  $z = 9 - 16$* , in press, Monthly Notices of the Royal Astronomical Society, arXiv: 2401.07396  
Scientific input; generation of the  $N$ -body simulation and the merger trees; contribution to the manuscript.
- [3] **Sreedhar Balu**, Bradley Greig, and J. Stuart B. Wyithe. *Fisher matrix forecasts on the astrophysics of galaxies during the epoch of reionization from the 21-cm power spectra*, Monthly Notices of the Royal Astronomical Society 525.2 (Oct. 2023), pp. 3032–3047. doi: 10.1093/mnras/stad2552.  
Generation of simulations, analyses of the outputs; manuscript.
- [2] Yuxiang Qin, **Sreedhar Balu**, and J. Stuart B. Wyithe. *Implications of  $z \geq 12$  JWST galaxies for galaxy formation at high redshift*, Monthly Notices of the Royal Astronomical Society 526.1, (Aug. 2023) pp.1324-1342, doi: 10.1093/mnras/stad2448.  
Application of the augmented merger trees generated in [1] to galaxy evolution at high- $z$ ; implementation of IGM ionization field lightcone into MERAXES; contributed to the manuscript.
- [1] **Sreedhar Balu**, Bradley Greig, Yisheng Qiu, Chris Power, Yuxiang Qin, Simon Mutch, and J. Stuart B. Wyithe. *Thermal and reionization history within a large-volume semi-analytic galaxy formation simulation*, Monthly Notices of the Royal Astronomical Society 520.3 (Apr. 2023), pp. 3368–3382. doi: 10.1093/mnras/stad281.  
Augmentation of the merger trees; implementation of the X-rays into MERAXES; analyses and manuscript.