

# Meridith Joyce, PhD

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## Research Interests & Areas of Expertise

**Stellar evolution codes:** MESA developers team; MIST, DSEP, GYRE, YREC, Monash

**Theoretical and computational astrophysics:** stellar structure and evolution, stellar age determinations, stellar interiors, convection and mixing, stellar pulsations, stars across the mass and evolutionary spectra (late-stage, high-mass, young, disk-hosting, etc.), asteroseismology, numerical methods, astronomy software development.

**Optical astronomy:** variable and oscillating stars, low-metallicity stars, globular clusters.

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## Research Positions and Fellowships

Marie Skłodowska-Curie Actions Individual Fellowship, Widening Fellowship — 2021-2022 round

Lasker Data Science Fellowship — Space Telescope Science Institute, June 2021–present

Modules for Experiments in Stellar Astrophysics (MESA) developers team, September 2019–present

RSAA Postdoctoral Fellow — Australian National University, September 2018–June 2021

Visiting Astronomer — Konkoly Observatory, January 2018–present

Visiting Astronomer — University of Cape Town, June 2017–January 2019

Postgraduate Research Assistant (pre-doc) — South African Astronomical Observatory, June–November 2017

Research Assistant — Dartmouth College, September 2013–July 2018

Research Assistant — Massachusetts Institute of Technology, June–August 2015

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## Education

Ph.D. Physics and Astronomy — Dartmouth College, 2018 — Prof. Brian Chaboyer, adviser

*On the Scope and Fidelity of 1-D Stellar Evolution Models*, PhD Thesis

B.Sc. Mathematics, B.Sc. Physics — Bucknell University, 2009–2013

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## Grants and Funding Secured

### Principal Investigator

- \* **€151,850.88** – Marie Skłodowska-Curie Actions (MSCA) Widening Fellowship, European Union, 2021-2022 round, with a proposal score of 91 in the physics category; over 2 years
- \* **\$48,000 (USD)** – Lasker Data Science Fellowship, Space Telescope Science Institute, February 2021; discretionary research spending
- \* **\$4,000.00 (AUD)** – RSAA Distinguished Visitors Program, *Seismic Evolution of Variable Stars*, March 2020; to fund the travel, housing, and research expenses of Dr László Molnár while in Australia for collaboration with me on proposed project. Highly competitive program awarded to only two researchers per year
- \* **\$1,000.00 (USD)** – Research Grant from the Neukom Institute for Computational Science, December 2017; Awarded to only three graduate students per year across all computational disciplines

### Co-Investigator with substantial knowledge contribution

- \* **\$405,459.00 (USD)** – NASA Astrophysics Theory Program (ATP) Proposal, Co-I (PI: Jamie Tayar), *Modeling Red Giants: A Fundamental Diagnostic for Ages Across the Universe*; over 3 years
- \* **299 800 000 HUF (approx. \$946,000.00 USD)** – Asteroseismic Laboratories (*SeismoLab*) Élvonal Research Excellence Program, Hungarian Research, Development and Innovation Office, Co-I (PI László Molnár); over 5 years

### Under consideration

- ERC Synergy Proposal *The chemical foundations of rocky exoplanets around Sun-like stars*, Co-I (PI Steve Mojzsis)
- NSF Proposal *Collaborative Research: A Panchromatic Survey of the Galactic Bulge*, Co-I (PI Christian Johnson)

- DDRF-JDF (STScI) *Investigating the Controversial Age Distribution of Galactic Bulge Stars*, Co-I (PI Christian Johnson)

### Highly ranked but unsuccessful

- European Research Council Starting Grant *Asteroseismology and mapping with cosmic lighthouses*, Co-I (PI László Molnár )
- Australian Data Partnerships Grant ADP20E-757 *Building a National Data Asset with The Australian Astronomical Theory Hub* Simon O'Toole, Ashley J. Ruiter, **Meridith Joyce (Co-I)**, Amanda Karakas, Timothy R. Bedding
- National Science Foundation proposal *The Constellation network of networks*, AccelNet, Co-I (PI Frank Timmes)

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## List of Publications

### First Authorships & Co-leads

1. **Meridith Joyce**, Shing-Chi Leung, László Molnár, Michael J. Ireland, Chiaki Kobayashi, Ken'ichi Nomoto *Standing on the shoulders of giants: New mass and distance estimates for Betelgeuse through combined evolutionary, asteroseismic, and hydrodynamical simulations with MESA*, ApJ, October 2020
2. Simon J. Murphy, **Meridith Joyce**, Timothy R. Bedding, Timothy R. White, Mihkel Kama *A precise asteroseismic age and metallicity for HD 139614: a pre-MS  $\lambda$  Boo star with a protoplanetary disk in Upper-Centaurus Lupus*, MNRAS, January 2021 (**lead: modeling**)
3. **M. Joyce**, L. Lairmore, D. J. Price, S. Mohamed, T. Reichardt *Density Conversion between 1-D and 3-D Stellar Models with <sup>1D</sup>MESA2HYDRO<sup>3D</sup>*, ApJ, September 2019
4. **Meridith Joyce** *Asteroseismic Binaries as non-Solar Mixing Length Calibrators*, Proceedings of the conference Stars and their Variability Observed from Space, Vienna, Austria, August 2019
5. L. Molnár, **M. Joyce**, L. Kiss *Stellar Evolution in Real Time: Models Consistent with Direct Observation of a Thermal Pulse in T Ursae Minoris*, ApJ, July 2019 (**joint first and corresponding author**)
6. **M. Joyce** and B. Chaboyer *Classically and Asteroseismically constrained 1D Stellar Evolution Models of  $\alpha$  Centauri A & B using Empirical Mixing Length Calibrations*, ApJ, September 2018
7. **M. Joyce** and B. Chaboyer *Not All Stars Are the Sun: Empirical Calibration of the Mixing Length for Metal-Poor Stars Using 1-D Stellar Evolution Models*, ApJ, March 2018
8. **M. Joyce** and B. Chaboyer *Investigating the Consistency of Stellar Evolution Models with Globular Cluster Observations via the Red Giant Branch Bump*, ApJ, December 2015

### Substantial contributions not led by students

9. Amanda Karakas, Giulia Cinquegrana, **Meridith Joyce** *The most metal-rich asymptotic giant branch Stars*, MNRAS, November 2021

### Publications led by my students

10. Jianling Tang & **Meridith Joyce** *Revised Best Estimates for the Age and Mass of the Methuselah Star HD 140283 Using MESA and Interferometry and Implications for 1D Convection*, RNAAS, May 2021 (**honours student**)
11. Yixiao Zhou, Thomas Nordlander, Luca Casagrande, **Meridith Joyce**, Yaguang Li, Anish Amarsi, Martin Asplund, Henrique Reggiani *The relationship between photometric and spectroscopic oscillation amplitudes from 3D stellar atmosphere simulations*, MNRAS, January 2021 (**PhD student**)
12. Yixiao Zhou, Martin Asplund, Remo Collet, **Meridith Joyce** *Convective excitation and damping of solar-like oscillations*, MNRAS, May 2020 (**PhD student**)

### Publications led by other students

13. Yaguang Li, Timothy R. Bedding, Simon J. Murphy, Dennis Stello, Yifan Chen, Daniel Huber, **Meridith Joyce**, and 9 co-authors *Identifying post-mass-transfer helium-burning red giants using asteroseismology*, submitted to Nature Astronomy, November 2021
14. Adam D. Rains, Maruša Žerjal, Michael J. Ireland, Thomas Nordlander, Michael S. Bessel, Luca Casagrande, Christopher A. Onken, **Meridith Joyce**, Jens Kammerer, Harrison Abbot *Characterization of 92 southern TESS candidate planet hosts and a new photometric [Fe/H] relation for cool dwarfs*, MNRAS, July 2021
15. Margaret Streamer, Michael J. Ireland, **Meridith Joyce**, Simon J. Murphy, Maruša Žerjal *RZ Mic: Identified modes in an Algol-type eclipsing binary with a  $\delta$  Sct component*, submitted to MNRAS, January 2021

## Contributing author publications

16. Molnár, László; Bódi, Attila; Pál, András; Bhardwaj, Anupam; Hamsch, Franz-Josef; Benkó, József M.; Derekas, Aliz; Ebadi, Mohammad; **Joyce, Meridith**; and 19 co-authors *First results on RR Lyrae stars with the TESS space telescope: untangling the connections between mode content, colors and distances*, MNRAS (in press), November 2021
17. Murphy, Simon J.; Bedding, Timothy R.; White, Timothy R.; Li, Yaguang; Hey, Daniel; Reese, Daniel; **Joyce, Meridith** *Five young  $\delta$  Scuti stars in the Pleiades seen with Kepler/K2*, submitted to MNRAS, November 2021
18. Yang, Tao-Zhi; Zuo, Zhao-Yu; Li, Gang; Bedding, Timothy R.; Murphy, Simon J.; **Joyce, Meridith** *TIC 308396022: a  $\delta$  Scuti- $\gamma$  Doradus hybrid with large-amplitude radial fundamental mode and regular g-mode period spacing*, A&A, October 2021
19. Zinn, Joel C. et al., including 31 co-authors (**Meridith Joyce** at position 22) *The K2 Galactic Archaeology Program Data Release 3: Age-abundance patterns in C1-C8, C10-C18*, ApJ, August 2021
20. Lorenzo Spina, Yuan-Sen Ting, Gayandhi M. De Silva, Neige Frankel, Sanjib Sharma, Tristan Cantat-Gaudin, **Meridith Joyce** and 24 others from the GALAH collaboration *The GALAH survey: a comprehensive study of Open Clusters in the era of Gaia and large spectroscopic surveys*, MNRAS, February 2021
21. Michael Hayden et al., including 30 co-authors (**Meridith Joyce** at position 24) *the GALAH Survey: Chemical Clocks*, submitted to MNRAS, May 2020
22. Daniel L. Holdsworth, H. Saio, D.M. Bowman, D.W. Kurtz, R. R. Sefako, **M. Joyce**, T. Lambert, B. Smalley *Suppressed phase variations in a high amplitude rapidly oscillating Ap star pulsating in a distorted quadrupole mode*, MNRAS, January 2018

## Summary of Publications

**22 total papers**, nearly all (19) in one of the two highest-impact astronomy journals (ApJ, MNRAS) or better (Nature Astronomy). Among these: **8 first author or equivalent**

Current h-index: 9

Another 4 first author papers are in preparation with expected submission timescales of less than 6 months. Upcoming contributions are to include the 6th [MESA](#) instrument paper and the second MIST paper (citations > 1000)

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## Teaching

### Supervision of higher degree research

**External co-supervisor** of Monash University Ph.D. student Giulia Cinquegrana, August 2020–present

**Primary supervisor** of RSAA Summer Scholar and Honours student Jianling Tang, November 2020–June 2021

**Primary supervisor** of RSAA Ph.D. student Yixiao Zhou, March 2020–January 2021

### Lecturing and workshops

IAU Symposium 336 Special Skills Training Session — Instructor, *Using MESA for teaching and research*

[MESA](#) Summer School — Teaching assistant, August 2021

RSAA Summer Scholars Program — Advisor, November 2020–January 2021; **resulted in student's publication**

Australian National University — **Full Lecturer, Astronomy 3007: Stars**, February–June 2020

University of Cape Town — Teaching assistant & contributing lecturer, computational astrophysics, February–April 2018

University of Cape Town — Guest lecturer, undergraduate astronomy year 3, March 2018

South African Astronomical Observatory — Guest Lecturer, NASSP Summer School, South Africa, January–February 2018

University of Cape Town via Dartmouth College — Teaching assistant, Dartmouth Foreign Studies Program, Cape Town, South Africa, January–March 2017

Dartmouth College — Teaching assistant, September 2013–July 2018

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## Talks and Public Profile

### Invited Colloquia and Seminars

1. Yale (host: Sarbani Basu), November 2020
2. Northwestern University (host: Kerry Patterson), November 2020
3. Florida Institute of Technology, (host Saida Caballero-Nieves), November 2020
4. University of Hertfordshire (host: Chiaki Kobayashi), November 2020

5. UC Santa Cruz (host: Josiah Schwab), November 2020
6. Space Telescope Science Institute, (host: Kornpob Bhirombhakdi), November 2020
7. MPA Heidelberg (host: Hans-Walter Rix), October 2020
8. University of Birmingham (host: Guy Davies), October 2020
9. KIPAC Stanford (host: Alex Amon0, October 2020)
10. University of Auckland (host: Jan Eldridge), October 2020
11. UW Madison (host: Rich Townsend), October 2020
12. KITP/UC Santa Barbara (host: Lars Bildsten), October 2020
13. Aarhus University (host: Victor Silva Aguirre), September 2020
14. Harvard (host: Selma de Mink), September 2020
15. Harvard Center for Astrophysics (host: Charlie Conroy), September 2020
16. UT Austin (host: Craig Wheeler), September 2020
17. Flatiron (host: Dan Foreman-Mackey), September 2020
18. University of Sydney (host: Tim Bedding), February 2020
19. University of Tokyo (host: Ken'ichi Nomoto), January 2020
20. University of New South Wales (host: Sarah Martell), October 2020
21. Radboud University (host: Onno Pols), October 2020
22. Heidelberg Institute for Theoretical Studies (host: Saskia Hekker), October 2020
23. Macquarie University (host: Orsola De Marco), March 2019
24. Monash University (host: Amanda Karakas), November 2018
25. Rome Observatory (host: Paolo Ventura), 2018
26. Belgrade Observatory (host: Monika Jurkovic), 2018
27. Konkoly Observatory (hosts: Maria Lugaro, Robert Szabo, Laszlo Molnar), 2018
28. University of Cape Town (host: Shazrene Mohammed), 2017
29. KU Leuven (host: Conny Aerts), 2017

### **Invited conference talks:**

30. invited panelist on stellar convection, *Probes of Transport in Stars*, KITP UCSB, November 2021
31. invited lecturer, IAU 336 skills session, KU Leuven, November 2021
32. invited speaker to special session on Betelgeuse, 16th Marcel Grossmann Meeting on General Relativity, July 2021
33. invited speaker, Death Throes of Evolved Stars, KU Leuven, April 2021
34. invited speaker, Workshop on Reference Stars, Lund University, March 2021
35. invited speaker, Australian National Institute for Theoretical Astrophysics (ANITA) annual meeting, UNSW, December 2020
36. invited contributor, *Astrophysics of LIGO/Virgo sources in the O3 era*, IPMU University of Tokyo, January 2020
37. session chair and invited speaker, *Stars in Melbourne*, Monash University, December 2019

### **Contributed conference talks:**

38. EAS 2021, session on Betelgeuse, Leiden, June 2021
39. *Stars and their variability, observed from space* Vienna, Austria, September 2019
40. *A Star Has Evolved* Smögen, Sweden, 2019
41. *Time Machine to the First Stars*, IPMU Tokyo, Japan, December 2018
42. *Advances with SALT (South African Large Telescope)*, Pretoria, South Africa, November 2018

## Public Outreach Talks

43. ***Astronomy on Tap*** public lecture, Budapest, Hungary, September 2019  
*From Light to Insight: How computer modeling lets us watch stars die*
44. Public astronomy nights **outreach lecture series**, SAAO, Cape Town, South Africa, February 2018  
*Stellar Stories: Filling in the Observational Gaps with Computer Models of Stars*
45. Special lecture on Betelgeuse at Kamioka neutrino observatory, Japan, April 2021 (paid)
46. Guest on **World Wide AstroFest**, United Kingdom, November 2020 (paid)

## Communications Achievements

- \* Invited speaker to the special session on Betelgeuse, Marcel Grossmann Meeting on General Relativity (MG16), July 2021
- \* winner, European Astronomical Society's Best Poster Competition, *Gaia Revolutions in Milky Way Modeling*, June 2021
- \* American Astronomical Society's Chambliss Graduate Student Poster Competition, Honorable Mention, 2016
- **to feature in BBC science documentary series *Science's Greatest Mysteries***, anticipated release of March 2022
- Television appearance on ABC News, Canberra, Australia
- Guest on popular podcasts, YouTube shows, radio
- Scientific work featured on CNN, Forbes, Newsweek, Astronomy Now, SkyNews, CNET, Phys.org, and others (see website)

## Observing time

- . CHARA Array, 2021A semester, *Angular sizes and oblateness of delta scuti pulsators observed by TESS* Co-I (PI Tim White)
- . SAAO-Sutherland 1.9m, SpUpNIC grating spectrograph, 7 nights, **PI Preliminary Spectra of Metal-Poor Stars with HST Parallaxes**, November 2017
- . SAAO-Sutherland 1.9m, SpUpNIC grating spectrograph, 4 nights, September 2017
- . SAAO-Sutherland 1m, SHOC SAAO CCD, 7 nights, July 2017
- . MDM 1.3m, remote, 1 night, May 2017

## Organizations, Collaborations & Service

### Service

- as a postdoc, I organized an international thesis committee and graduated a PhD student at the Research School of Astronomy and Astrophysics (RSAA) at ANU
- as a postdoc, I served as a full lecturer for Australian National University's stellar astrophysics course when the need unexpectedly arose
- MESA instructor, IAU 336 skills training session
- Referee for *Astrophysics & Space Science*
- teaching assistant for the 2021 MESA Summer School
- ARC Centre of Excellence ASTRO 3D Colloquium Committee, November 2020–May 2021
- RSAA computing time allocation committee, June 2019–May 2021
- RSAA hiring committee

- Two-time volunteer lecturer and organizer at the National Astrophysics and Space Science Program (NASSP) Summer School, South African Astronomical Observatory & University of Cape Town, South Africa, 2017 and 2018
- President of the Dartmouth chapter of the national organization Graduate Women in Science and Engineering (GWISE) and Dartmouth's representative to the multi-collegiate New England GWISE consortium, 2016–2017

## Equity, Diversity & Inclusion

Every student I have formally supervised is either female, non-White, international, or a combination thereof. Students I have mentored informally span all races, genders, gender identities, ages, locations, and economic circumstances.

I elevate the contributions of female, non-White, non-traditional, LGBTQIA-identifying, and international scientists on my publications, as supported by the author lists.

- \* Organizer of ANU's Black Lives Matter response and discussion group, June 2020
- \* Representative for the RSAA to the *all colleges of science (CoS) Equity and Diversity Committee*
- \* RSAA Inclusion, Diversity, Equity, and Access (IDEA) committee rep, November 2020–April 2021
- \* RSAA cultural reform initiative: **lead**, working group on mental health
- \* volunteer organizer for the National Astrophysics and Space Science Program, Cape Town, South Africa, 2017 & 2018
- \* volunteer women's crisis advocate, ongoing

## Scientific Collaborations

- . MESA developers team, August 2019–present
- . Blanco DECam Bulge Survey (BDBS), August 2021–present
- . *Asteroseismic Laboratories (SeismoLab)* affiliate researcher, Konkoly Observatory, Budapest, Hungary
- . TESS Asteroseismic Science Operations Center (**TASOC**) Working Groups 2, December 2020–present
- . ASTRO3D ARC Centre of Excellence affiliate investigator, October 2019–June 2021
- . GALactic Archaeology with HERMES (**GALAH**) collaboration; August 2020–June 2021
- **Professional Organizations** —
- American Astronomical Society (AAS), 2021–present
- Astronomical Society of Australia (ASA), 2019–2021
- Australian National Institute for Theoretical Astrophysics (ANITA), 2019–2021

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## Workshops & Special Training

- \* **KITP Program *Probes of Transport in Stars***, by invitation, October–December 2021
- \* MESA Summer School, teaching assistant, August 2021
- \* TESS*ninja* 3 data sprint, University of Sydney, Sydney, Australia, February 2020
- \* Astrophysics of LIGO/Virgo sources in O3 era, participation by invitation, University of Tokyo IPMU, January 2020
- \* MESA developers retreat, Santa Barbara, CA, USA, October 2019
- \* Center for Scientific Computing Summer School, Espoo, Finland, Summer 2016
- \* MESA Summer School, student, August 2015

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## Software Development

I am **MESA developer** and [the only junior woman on the team \(2 women total\)](#).

I am the primary author and maintainer of the open-source Python package <sup>1D</sup>MESA2HYDRO<sup>3D</sup>.

I have designed MESA-based exercises for undergraduate astronomy courses and written a range of publicly available visualization tools for stellar structure and evolution and asteroseismic data.

See <https://github.com/mjoyceGR>

**Power user of several stellar evolution and related programs:** MESA, GYRE, MIST, DSEP, YREC, Phantom

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## List of Referees

**(1) Prof. Brian Chaboyer (PhD adviser)**

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Dartmouth College  
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**(3) Prof. Michael J. Ireland**

Research School of Astronomy and Astrophysics  
Mount Stromlo Observatory  
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**(2) Dr László Molnár**

Konkoly Observatory  
Konkoly-Thege Miklós út 15-17  
Budapest, Hungary, 1121  
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**(4) Prof. Richard H D Townsend**

Head, Department of Astronomy  
University of Wisconsin-Madison  
475 N Charter St, Madison, WI 53706, United States  
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## RSAA Testimonials

Prof. Mark Krumholz  
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Prof. Matthew Colless  
Director, Research School of Astronomy and Astrophysics  
Mount Stromlo Observatory  
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## External Scientific Endorsements

Prof. Timothy R. Bedding  
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University of Sydney  
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A/Prof. Amanda Karakas  
School of Physics and Astronomy  
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Prof. Thomas Jarrett  
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Prof. J. Craig Wheeler  
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