

Poojan Agrawal



Title

Can uncertainties in the evolution of massive stars explain properties of gravitational wave progenitors?

Abstract

Massive stars play a critical role in the evolution of galaxies and star clusters. Recent observations of the latter have highlighted the need for systematic studies dedicated to probing the impact of massive stellar evolution on the properties of stellar populations. While the use of fitting formulae to stellar tracks remains a popular choice for modelling stellar evolution in population synthesis codes, these formulae are not adaptable to changes. In this talk, I will discuss and present results from an alternative approach, one that is more adaptable: Method of Interpolation for Single Star Evolution (METISSE). It can readily make use of stellar models computed with different stellar evolution codes and compare their predictions for populations of stars. Using METISSE with data from different stellar evolution codes, I will show how various physical ingredients used in the evolution of massive stars, such as the treatment of their radiation dominated envelopes, can lead to differences in their evolutionary properties. I will discuss the implications of these differences on the evolution and interaction of stars in binaries, and how they can impact compact binary mergers and the properties of gravitational wave events.

Poojan Agrawal | Curriculum Vitae

Centre for Astrophysics and Supercomputing – Swinburne University of Technology
Hawthorn, VIC 3122, Australia. ✉ poojanagrawal7@gmail.com

RESEARCH INTERESTS

Stellar and binary evolution, Massive stars, Stellar dynamics, Star clusters, Stellar remnants, Stellar rotation and magnetic fields, Gravitational waves

EDUCATION

- Oct 2017 **PhD** in Astrophysics *Swinburne University of Technology, AUS*
– PRESENT Thesis Title: *Role of massive stars in stellar population studies*
Supervisors: Prof. Jarrod Hurley, Dr. Simon Stevenson, Dr. Dorottya Szécsi
- 2014-2016 **MSc** in Physics *Savitribai Phule Pune University¹, IN*
Thesis title: *Evolution of the magnetic field of the neutron stars*
Supervisor: Prof. Dipankar Bhattacharya
- 2011-2014 **BSc** in Physics, Mathematics and Astronomy *University of Lucknow, IN*

COMPUTER SKILLS

- Expertise Modern Fortran, Python, L^AT_EX, Git, Markdown
Workable Fortran 77, C++, Bash, Slurm
Knowledge
Software Packages MESA, SSE, BSE, COMPAS

AWARDS AND FELLOWSHIPS

- 2019 **Director's Outreach Excellence** *Centre for Astrophysics and Supercomputing*
2019 **Outreach Superstar** *ARC Centre of Excellence for Gravitational Wave Research (OzGrav)*
2019 **Travel grant** *Giant Magellanic Telescope Community Science Meeting*
2018 **Prof. W.M. Dabodghav Gold Medal** *Savitribai Phule Pune University*
2017–PRESENT **Swinburne University Postgraduate Research Award** *Centre for Astrophysics and Supercomputing*
2016 **Prof. S.S. Joshi Prize** *Department of Physics and Department of Chemistry, Savitribai Phule Pune University*

MENTORING AND SUPERVISION

- 2020 Supervised a group of five highschool students as a part of online work experience program at Centre for Astrophysics and Supercomputing.
2019-2020 Online Mentor for highschool students with In2Science-STEM peer mentoring in schools.
2018-2019 Co-supervised a student for her undergraduate research project as part of the course 'From Stars to Black Holes'.

CONTENT CREATION

- 2020 **Press article** for OzGrav, titled '*Scientists develop a new tool 'METISSE', offering new insights into the lives of massive stars*'.
- 2020 **Online module**, '*A day in the lives of stars*' for work experience students at Centre Astrophysics and Supercomputing.

¹Formerly University of Pune

LEADERSHIP ROLES

- 2018–PRESENT Member of the **OzGrav Early Career Researcher Committee** responsible for organising an annual workshop for ECRs.
- 2019 Organised **Women in CAS lunch** at the Centre for Astrophysics and Supercomputing.
- 2019 **Session Chair** at the Annual Scientific Meeting of the Astronomical Society of Australia.
- 2018–2019 Co-organizer of **Astro-ph Journal Club** at Centre for Astrophysics and Supercomputing.
- 2018 **Session Chair** at the OzGrav Early Career Researcher Workshop.
- 2013 Part of the **Local Organising Committee** for the Astronomy Awareness Camp for College Students, IN.

OUTREACH

Public talks

- 2020 **Story of the stars: Celebrities of the night sky** (online) *Astronomy delight series, Scientific Knowledge for Youth Foundation*
- 2019 **Decoding the mysteries of stars** *Mount Burnett Observatory*
- 2019 **Who are the stars in your neighbourhood?** *Physics in the Pub, Melbourne*
- 2019 **Vivid lives of stars** *Swinburne Public Astrophysics Lecture*
- 2018 **Multiple stellar populations in globular clusters** *Astronomical Society of Victoria*
- 2013 **Shape of the solar system and universe around us** *Uttar Pradesh Amateur Astronomers Club*

Science communication

- 2018–PRESENT **SciVR demonstrations** *OzGrav*
- 2018–PRESENT **AstroTour guide** *Centre for Astrophysics and Supercomputing*
- 2019 **Outreach engagement for indigenous students** *Koorie State Netball and Football Carnival, AUS*
- 2019 **Skype a Scientist** *Online*
- 2017–2016 **Demonstration of pulsar model** *National Science Day activities
Giant Metrewave Radio Telescope (GMRT) observatory, IN*
- 2011–2014 **Telescope observing sessions** *Uttar Pradesh Amateur Astronomers Club, IN*

TALKS AND POSTERS

Invited talks

- 2020 **Can uncertainties in the evolution of the massive stars explain EM and GW observations?** (online) *University of Melbourne, AUS*
- 2016 **Evolution of the magnetic field of neutron stars** *'Prof. S.S. Joshi' Award Ceremony*

Contributed talks

- 2020 **Exploring uncertainties in the evolution of massive stars with METISSE** (online) *MOBSTER-1 virtual conference*
- 2020 **Exploring the impact of stellar evolution on the formation of gravitational wave progenitors** *MODEST 20 conference*
- 2018 **Modeling single star evolution in globular clusters** *Annual Scientific Meeting, Astronomical Society of Australia*
- 2015 **Evolution of the magnetic field of neutron stars** *Osaka University, JP*
- 2013 **Life cycle of a star: stellar evolution** (Prize winning) *National Seminar for Popularization of Astronomy, IN*

Posters

- 2019 **Impact of stellar evolution on the formation of gravitational wave progenitors** *Annual OzGrav Retreat*
- 2019 **Method for rapid stellar evolution with METISSE** *Annual Scientific Meeting, Astronomical Society of Australia*

- 2018 **Modeling single star evolution in globular clusters** *Annual GMT Community Science Meeting*
- 2017 **Astrophysical sources of gravitational waves: modelling stellar populations** (Group poster, Prize winning) *Annual OzGrav Retreat*
- 2013 **Radio Astronomy: the study of the invisible universe** *National Seminar for Popularization of Astronomy, IN*

MEMBERSHIPS

- 2018–PRESENT ARC Centre of Excellence for Gravitational Wave Research (OzGrav)
- 2018–PRESENT Astronomical Society of Australia

WORKSHOPS ATTENDED

- 2018 **MESA Summer School** *University of California, US*
- 2018 **Harley Wood Winter School** *Astronomical Society of Australia*
- 2015 **Japan-Asia Youth Exchange Program in Science** (competitively awarded) *Osaka University, JP*
- 2013 **Pulsar Observatory for Students** (competitively awarded) *Radio Astronomy Centre, IN*
- 2012 **Radio Astronomy Winter School** (competitively awarded) *National Centre For Radio Astrophysics, IN*

REFERENCES

- Reference 1 Prof. Jarrod Hurley
Centre for Astrophysics and Supercomputing
Swinburne University of Technology
Hawthorn VIC 3122 Australia.
Email: jhurley@swin.edu.au
- Reference 2 Dr. Simon Stevenson
Centre for Astrophysics and Supercomputing
Swinburne University of Technology
Hawthorn VIC 3122 Australia.
Email: spstevenson@swin.edu.au
- Reference 3 Dr. Dorottya Szécsi
1. Physikalisches Institut
Universität zu Köln
Otto-Fischer str. 14.
Köln, 50674, Germany.
Email: szecsi@ph1.uni-koeln.de

PUBLICATIONS

First or Second Author

- Aug 2020 **The fates of massive stars: exploring uncertainties in stellar evolution with METISSE.**
P. Agrawal, J. Hurley, S. Stevenson, D. Szécsi, C. Flynn
MNRAS, 497, 4549

Co-author

- April 2020 **'Bonn' Optimized Stellar Tracks (BoOST). Simulated populations of massive and very massive stars as input for astrophysical applications.**
D. Szécsi, R. Wünsch, **P. Agrawal**, N. Langer
arXiv:2004.08203
- Sep 2020 **Neutron Star Extreme Matter Observatory: A kilohertz-band gravitational-wave detector in the global network.**
Ackley et al. including **P. Agrawal**
Publications of the Astronomical Society of Australia, 37, e047

Dec 2020 **Population synthesis of accreting white dwarfs: Rates and evolutionary pathways of H and He novae.**

A. Kemp, A. Karakas, A. Casey, R. Izzard, A. Ruiter, **P. Agrawal**, F. Broekgaarden, K. Temmink
Submitted to MNRAS