Rajika Kuruwita

Title

Accretion behaviour during binary star formation

Abstract

I present theoretical work done using the AMR MHD code FLASH on the formation of binary stars and the evolution of their discs in these systems. I simulated the collapse of molecular cores until the formation of protostars and followed the early evolution of these systems. I investigated the influence that binarity has on the global evolution of a young stellar system, including looking at mechanisms such as accretion of material, jets and outflows, and dynamical interactions. I find that while in some scenarios binary stars may produce hostile environments for planet formation via the destruction of circumstellar discs, the formation of large circumbinary discs is possible. This can lead to the formation of planets around binary stars to be just as likely as the their formation around single stars. I also observe a dependence of accretion on episodic accretion, independent of separation. I will also present preliminary work on reproducing observed statistics of protostellar binary separations, and what it means for understanding binary formation pathways.

Rajika Kuruwita

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Research Interests: Star formation, binary and multiple star systems, protoplanetary disks and planets in binary star systems, MHD simulations, software development.

Education

Australian National University, Canberra, Australia **February, 2015 - January, 2019**

PhD

- Thesis Topic: "The formation, evolution, and survivability of discs around young binary stars"
- Primary Supervisor: Dr Christoph Federrath
- Secondary Supervisor: Associate Professor Michael Ireland

Macquarie University, Sydney, Australia **February, 2010 - January, 2015**

MRes. Physics and Astronomy

- Thesis Topic: "Fallback disks and the end of the common envelope phase"
- Primary Supervisor: Professor Orsola De Marco
- Secondary Supervisor: Assistant Professor Jan Staff

BSc. Astronomy and Astrophysics

Work and Academic Experience

University of Copenhagen, Copenhagen, Denmark
Post-doctorate researcher (European Union INTERACTIONS fellow) **April, 2019 - Present**
Research the formation of binary and multiple star systems via numerical simulations.

Australian National University, Canberra, Australia
Research Assistant **February, 2019 - April, 2019**
Research binary star formation and publish work on episodic accretion and turbulence.
Outreach Assistant **December, 2015 - April, 2019**
Organise and run outreach observing and site tours for the public, school and scout groups, as well as private groups, as well as design activities for the observatory visitor centre.

Macquarie University, Sydney, Australia
Laboratory Demonstrator **February, 2014 - January, 2015**
Taught lab experiments for undergraduate students. This also involved marking lab books.
Observatory and Planetarium Supervisor **February, 2010 - January, 2015**
Coordinated groups, created tours and presentations, operated observatory and planetarium.
Vacation Scholarship Researcher **December, 2012 - February, 2013**
Simulated light curves to understand the influence of exoplanets on the asteroseismological pulsation spectrum of stars.
Vacation Scholarship Researcher **January, 2012 - February, 2012**
Carried out research on nanowires using white light interferometry.

Telescope Time Awarded

Australian National University 2.3m Telescope

- **PI**: Building a Census of Protoplanetary Disks in Binary Star Systems (4 nights)
- **PI**: Building a Census of Circumbinary Protoplanetary Disks (3 nights)
- **PI**: Building a Census of Circumbinary Protoplanetary Disks (6 nights)
- **PI**: Building a Census of Circumbinary Protoplanetary Disks (7 nights)

Talks

Distorted Astrophysical Discs **May, 2020 (Postponed due to Covid-19)**
Contributed Talk Cambridge, UK

Ramses User Meeting **September, 2019**
Contributed Talk Copenhagen, Denmark

Annual Danish Astronomy Meeting **May, 2019**
Contributed Talk Nyborg, Denmark

Niels Bohr Institute **January, 2019**
Invited Talk Copenhagen, Denmark

Sutherland Astronomical Society Incorporated **September, 2018**
Invited Talk Sydney, Australia

Greenlight for Girls National Science Week **August, 2018**
Invited Talk Canberra, Australia

University of Tübingen **May, 2018**
Astronomy Seminar Tübingen, Germany

Heidelberg Institute for Theoretical Astrophysics **May, 2018**
Astronomy Seminar Heidelberg, Germany

Max Planck Institute for Astronomy **May, 2018**
Planet and Star Formation Seminar Heidelberg, Germany

Hamburg Observatory **May, 2018**
Astronomy Seminar Hamburg, Germany

Annual Scientific Meeting of the Astronomical Society of Australia **June, 2018**
Contributed Talk Melbourne, Australia

Planets in Perculiar Places **April, 2018**
Contributed Talk Sydney, Australia

International Women's Day Science in the Pub **March, 2018**
Invited Talk Canberra, Australia

12th ANITA Theory Workshop **February, 2018**
Contributed Talk Perth, Australia

Franco-Australian Astrobiology and Exoplanet School and Workshop **December, 2017**
Contributed Talk Canberra, Australia

Annual Scientific Meeting of the Astronomical Society of Australia **July, 2017**
Contributed Talk Canberra, Australia

11th ANITA Theory Workshop **February, 2017**
Contributed Talk Hobart, Australia

Mt Stromlo Students Seminars **December, 2016**
Contributed Talk (Awarded Best Theme Talk) Canberra, Australia

6th Australian Exoplanet Workshop **November, 2016**
Contributed Talk Melbourne, Australia

Star Formation **August, 2016**
Computational Astrophysics splinter session (Invited) Exeter, UK **Annual Scientific Meeting of the Astronomical Society of Australia** **July, 2016**
Contributed Talk Sydney, Australia

10th ANITA Theory Workshop **February, 2016**
Contributed Talk Melbourne, Australia

5th Australian Exoplanet Workshop **November, 2015**
Contributed Talk Sydney, Australia
9th ANITA Theory Workshop **February, 2015**
Contributed Talk Canberra, Australia

Awards and Honors

- 2020: European Union INTERACTIONS Fellowship
- 2017: Joan Duffield Research Supplementary Scholarship
- 2015: Australian Postgraduate Award
- 2013: Macquarie University Research Training Scholarship
- 2012: Vacation Scholarship (Macquarie University)
- 2011: Vacation Scholarship (Macquarie University)

Teaching and mentoring experience

Computational Astrophysics **November, 2019**
Gave two post-graduate level lectures on computational astrophysics reviewing hydrodynamics and modelling shockwaves. **Graduate Student** **September, 2017 - present**
Mentoring ANU graduate student Eloise Birchall in implementing radiative transfer and tracer particles into my simulations. This is to trace environments within protoplanetary disks to determine certain mineral formation sites.
Mt Stromlo Observatory Summer Research **December, 2017 - February, 2018**
Co-supervised Isabella Gerard (currently a graduate student at Monash University) on a research project on turbulent magnetic fields and star formation. I am currently co-author on the paper she has submitted for publication from this project.
Mt Stromlo Observatory Winter School **June-July, 2017**
Advised undergraduate students Lara Cullinane (currently a graduate student at ANU), Joshua Ho, Lillian Guo and Patrick Armstrong in planning observations and writing telescope proposals.

Computer Skills

- Computing Languages: Python, Fortran and html
- Applications: LaTeX, `yt`, simulation code FLASH, analysis of hdf5 files from hydrodynamic simulations, reducing observational data in fits files, retrieving radial velocities.
- Operating Systems: Unix/Linux, Windows, and Mac.

Other Experience

- Founder of Astronomy on Tap Copenhagen.
- Treasurer of Kvinder i Fysik (the Danish women in physics society)
- Member of the Science Organising Committee for the 2016 Harley Wood Winter School.
- Chair of the Organising Committee for the 2016 Mt Stromlo Student Seminars
- Member of the Local Organising Committee for the 2017 Harley Wood Winter School and Annual Scientific Meeting of the Astronomical Society of Australia.

Referee Details

- Professor Orsola De Marco, Department of Physics and Astronomy, Macquarie University, Sydney NSW 2109, Australia. tel: +61 2 9850 4241 , email: orsola.demarco@mq.edu.au
- Associate Professor Michael Ireland, Research School of Astronomy and Astrophysics, Australian National University, Research School of Astronomy & Astrophysics, Mount Stromlo Observatory, Cotter Road, Weston Creek, ACT 2611, Australia. tel: +61 2 6125 0288, email: michael.ireland@anu.edu.au
- Dr Christoph Federrath, Research School of Astronomy and Astrophysics, Australian National University, Research School of Astronomy & Astrophysics, Mount Stromlo Observatory, Cotter Road, Weston Creek, ACT 2611, tel: +61 2 6125 0217, email: christoph.federrath@anu.edu.au

Refereed Publications

Kuruwita et al., *The dependence of episodic accretion on eccentricity during the formation of binary stars*, 2020, Astronomy & Astrophysics, *Accepted*

- Lead author, and conductor of research and analysis.

Kuruwita & Federrath, *The role of turbulence during the formation of circumbinary discs*, 2019, Monthly Notices of the Royal Astronomical Society, 486, 3647-3663

- Lead author, and conductor of research and analysis.

Kuruwita et al., *Multiplicity of disc-bearing stars in Upper Scorpius and Upper Centaurus-Lupus*, 2018, Monthly Notices of the Royal Astronomical Society, 480, 5099–5112

- Lead author, and conductor of research and analysis.
- Collected the majority of observations.

Kuruwita et al., *Binary star formation and the outflows from their discs*, 2017, Monthly Notices of the Royal Astronomical Society, 470, 1626-1641

- Lead author, and conductor of research and analysis.

Kuruwita et al., *Considerations on the role of fall-back discs in the final stages of the common envelope binary interaction*, 2016, Monthly Notices of the Royal Astronomical Society, 461, 486-496

- Lead author, and conductor of research and analysis.

Gerrard et al., *The role of magnetic field structure in the launching of protostellar jets*, 2019, Monthly Notices of the Royal Astronomical Society, 485, 5532-5542

- Co-supervised Gerrard in running simulations and analysing them

Green et al., *Testing the binary trigger hypothesis in FUors*, 2016, The Astrophysical Journal, 830, 29

- Obtained observational data with Keck and commented on paper drafts.

Childress et al., *The ANU WiFeS SuperNovA Programme (AWSNAP)*, 2016, Publications of the Astronomical Society of Australia, 33, 29

- Obtained observational data with Australian National University 2.3m telescope.

Little et al., *Phase-stepping interferometry of GaAs nanowires: Determining nano-wire radius*, 2013, Applied Physical Letters, 103, 161107

- Obtained experimental data with white light interferometry of nanowires.