

## Doctor Luke J. Shingles

### Skills and interests

I am a scientist and software engineer focused on using software to solve complex problems on high-performance computers. Through my training in Software Engineering and experience in scientific research, I have been able to apply high-performance algorithms and data structures to build astrophysical simulations, while also developing skills in data analysis, visualisation, and technical communication through papers and presentations.

Some my highlights have included writing high-performance parallel code to numerically solve systems of differential equations (e.g., to model chemical enrichment of stellar clusters and high-energy particle interactions), using matrix-based methods for solving large systems of linear equations (to determine atomic level populations), and applying Monte Carlo techniques to simulate photon interactions (radiative transfer) in three dimensions within material ejected from supernova explosions. The analysis of my theoretical simulations running on thousands of CPU cores and the comparison to real-world observations has led to research insights that have been published in peer-reviewed scientific journals.

From my interest in parallel algorithms, I have naturally become excited about the use of GPUs to accelerate numerical problem-solving. My own experiments with NVIDIA CUDA have found that large performance benefits can be gained quickly, and even greater benefits can be achieved through further optimisation and a deeper understanding of the hardware. I am also interested in machine learning and computer vision, and look for opportunities to work with these technologies, to solve problems by developing optimised code for CPUs and GPUs, and to keep up with latest developments in parallel and heterogeneous computing.

[LinkedIn Profile](#)

### Email

[l.shingles@qub.ac.uk](mailto:l.shingles@qub.ac.uk)

### Citizenship

Australia, Ireland

### Languages

English (native), Portuguese (basic), Mandarin Chinese (basic)

### Address

Astrophysics Research Centre,  
School of Mathematics and Physics,  
Queen's University Belfast  
Belfast, Co. Antrim, BT7 1NN  
Northern Ireland, United Kingdom

### Programming experience

C, Fortran, Python (numpy/pandas/matplotlib), parallelism with CUDA, MPI, and OpenMP. Most of the scientific simulation codes I have worked on are not publicly available. However, some [plotting and analysis tools](#) I developed for the radiative transport code and the [Fortran/OpenMP chemical evolution code](#) are public on my [GitHub Profile](#).

## Education and recent experience

*Postdoctoral Research Fellow*, Queen's University Belfast, Aug 2015–present  
Scientific research into Type Ia supernovae and development of a massively-parallel simulation of radiative transfer using Monte Carlo methods. Other skills and experience include giving technical presentations, coauthoring of grant applications, reports, and papers, supervision of Masters students, and volunteering as the Postdoctoral Representative for the School of Mathematics & Physics.

*Doctor of Philosophy (Astrophysics)*, Australian National University, 2012–2015  
Thesis: '[Neutron-Capture Nucleosynthesis and the Chemical Evolution of Globular Clusters](#)'

Department: Research School of Astronomy & Astrophysics

*Bachelor of Science with Honours (First Class)*, Australian National University, 2008–2011  
Honours Thesis: 'The Sulfur Anomaly in Planetary Nebulae and Post-AGB Stars'

Department: Research School of Astronomy & Astrophysics

Honours grade: 86%

Undergraduate Majors: Astronomy & Astrophysics, Theoretical Physics, Mathematics

Course grade average: 80% (High Distinction)

Selected course results:

- MATH2301 Games Graphs and Machines (85% High Distinction)
- MATH2305 Maths Methods 1 Honours: Ordinary differential equations and advanced vector Calculus (85% High Distinction)
- MATH2406 Maths Methods 2 Honours: Partial differential equations, Fourier analysis, and complex analysis (78% Distinction)
- PHYS3001 Theoretical Physics (87% High Distinction)
- MATH3104 Applied Algebra 1 Honours: Groups, rings, and advanced linear algebra (78% Distinction)
- MATH3301 Number theory and cryptography (83% High Distinction)

*Bachelor of Information Technology*, Queensland University of Technology, 2003–2007

Major: Software Engineering

## Awards and Scholarships

RSAA Alex Rodgers Travelling Scholarship, 2014

Astronomical Society of Australia Travel Assistance, 2014

RSAA Honourable Mention for Best Student Paper Prize, 2013

IAU Travel Grant for IAUS298, 2013

Australian Postgraduate Award, 2012-2015

International Year of Astronomy Honours Scholarship, 2011

RSAA Summer Research Scholarship, 2010

## Service and Committees

QUB School of Maths and Physics Postdoctoral Society Representative, Jan 2016–present

QUB School of Maths and Physics Athena SWAN committee for gender equality, Jan 2016–present

QUB ARC Supernova Journal Club coordinator, Oct 2015–Oct 2016

ANU RSAA Stellar Lunch coordinator, Feb 2014–Nov 2014

ANU RSAA Computer Committee, Oct 2013–Apr 2015

## Technical Presentations

Plenary talk, Supernova Workshop at Heidelberg Institute of Theoretical Studies, Heidelberg, Germany, December 2019  
Contributed talk, The extragalactic explosive Universe: the new era of transient surveys and data-driven discovery, Garching, Germany, September 2019  
Contributed talk, Workshop on Radiative Transfer in Supernovae, Garching, Germany, August 2019  
Contributed talk, XIXth Workshop on Nuclear Astrophysics, Ringberg, Germany, March 2019  
Invited Colloquium, ASTRON Institute for Radio Astronomy, Dwingeloo, Netherlands, November 2018  
Contributed Talk, Radiation Transfer and Explosive Thermonuclear Burning in Supernovae, Rehovot, Israel, June 2018  
Poster Presentation, Supernovae From Simulations to Observations and Nucleosynthetic Fingerprints, Bad Honnef, Germany, January 2017  
Contributed Talk, Supernovae: The Outliers, Garching, Germany, September 2016  
Contributed Talk, RAS National Astronomy Meeting, Nottingham, UK, July 2016  
Contributed Talk, 18th Workshop on Nuclear Astrophysics, Ringberg, Germany, March 2016  
Group Talk at Stars Meeting, Institute of Astronomy, Cambridge, UK, Nov 2015  
Seminar, QUB, Belfast, UK, Oct 2015  
Contributed Talk, ASA AGM, Perth, Australia, July 2015  
Contributed Talk, ANITA Workshop, Canberra, Australia, Feb 2015  
Contributed Talk, Mount Stromlo Student Christmas Seminars, Canberra, Australia, Nov 2014  
Group Talk at Stars Meeting, Institute of Astronomy, Cambridge, UK, Sept 2014  
Contributed Talk, Nucleosynthesis in AGB Stars, Bad Honnef, Germany, July 2014  
Contributed Talk, Overcoming Great Barriers in Galactic Archaeology II, Palm Cove, Australia, 2014  
Group Talk at Stellar Lunch, ANU RSAA, Australia, August 2013

## Teaching Experience

*Level Four MSci Project*

Queen's University Belfast  
Sept 2017 – Jan 2018

Co-supervised two MSci students with projects on positron emission from Type Ia supernovae and high-mass stellar evolution with helium-rich abundances.

*PHY1001 Foundation Physics*

Queen's University Belfast  
Oct 2017

Presented lectures on circular motion and simple harmonic oscillators.

*ANU-ASTRO2x Exoplanets*

Australian National University  
Jun–Sep 2015

Teaching assistant for edX online course run by Brian Schmidt and Paul Francis on exoplanet search techniques – pulsar timing, radial-velocity variations, transits, microlensing, and direct imaging with adaptive optics.

*ANU-ASTRO1x Greatest Unsolved Mysteries of the Universe,*  
University

Australian National

Mar–Jun 2015

Teaching assistant for edX online course run by Brian Schmidt and Paul Francis covering the expanding universe, dark energy, dark matter, and gamma-ray bursts.

*ASTR3007 From Stars to Galaxies*

Australian National University  
Feb–Jun 2013 and May–Jun 2014

Teaching assistant for the third-year course on stellar evolution & nucleosynthesis, galactic structure & dynamics, and introductory computer programming. Duties included marking assignments and answering student questions in the classroom.

*PHYS1201 Physics 2*

Australian National University  
Jul–Nov 2012 and Jul–Nov 2013

Teaching assistant for first-year course covering introductory special relativity, electromagnetism, waves & optics, and thermodynamics. Duties included marking assignments and answering student questions in the classroom.

## Refereed Journal Articles

### **Monte Carlo radiative transfer for the nebular phase of Type Ia supernovae**

**L. Shingles**, S. A. Sim, M. Kromer, K. Maguire, M. Bulla, C. Collins, C. P. Ballance, A. S. Michel, C. A. Ramsbottom, F. K. Röpke, I. R. Seitenzahl, N. B. Tyndall  
*Monthly Notices of the Royal Astronomical Society, Volume 492, Issue 2, p.2029-2043 (2020).*

### **A year-long plateau in the late-time near-infrared light curves of Type Ia supernovae**

Or Graur, Kate Maguire, Russell Ryan, Matt Nicholl, Arturo Avelino, Adam G. Riess, **Luke Shingles**, Ivo R. Seitenzahl, and Robert Fisher  
*Nature Astronomy, Advanced Online Publication (2019).*

### **Using late-time optical and near-infrared spectra to constrain Type Ia supernova explosion properties**

K. Maguire, S. A. Sim, **L. Shingles**, J. Spyromilio, A. Jerkstrand, M. Sullivan, T.-W. Chen, R. Cartier, G. Dimitriadis, C. Frohmaier, L. Galbany, C. P. Gutiérrez, G. Hosseinzadeh, D. A. Howell, C. Inserra, R. Rudy, J. Sollerman  
*Monthly Notices of the Royal Astronomical Society, Volume 477, Issue 3, p.3567-3582 (2018).*

### **A kilonova as the electromagnetic counterpart to a gravitational-wave source**

S. J. Smartt, T.-W. Chen, A. Jerkstrand, M. Coughlin, E. Kankare, S. A. Sim, M. Fraser, C. Inserra, K. Maguire, K. C. Chambers, M. E. Huber, T. Krühler, G. Leloudas, M. Magee, **L. J. Shingles**, and 107 additional authors  
*Nature, Volume 551, Issue 7678, pp. 75-79 (2017)*

### **Multi-messenger Observations of a Binary Neutron Star Merger**

Joint-authored by several collaborations including ePESSTO (including **L. J. Shingles**)  
*The Astrophysical Journal Letters, Volume 848, Issue 2, article id. L12, 59 pp. (2017).*

### **A chemical signature from fast-rotating low-metallicity massive stars: ROA 276 in omega Centauri**

David Yong, John E. Norris, Gary S. Da Costa, Laura M. Stanford, Amanda I. Karakas, **Luke J. Shingles**, Raphael Hirschi, Marco Pignatari  
*The Astrophysical Journal, Volume 837, Issue 2, article id. 176, 8 pp. (2017).*

### **Evolution and nucleosynthesis of helium-rich asymptotic giant branch models**

**Luke J. Shingles**, Carolyn L. Doherty, Amanda I. Karakas, Richard J. Stancliffe, John C. Lattanzio, Maria Lugaro  
*Monthly Notices of the Royal Astronomical Society, Volume 452, Issue 3, p.2804-2821 (2015).*

### **Iron and s-element abundance variations in NGC 5286: comparison with anomalous' globular clusters and Milky Way satellites**

A. F. Marino, A. P. Milone, A. I. Karakas, L. Casagrande, D. Yong, **L. Shingles**, G. Da Costa, J. Norris, P. B. Stetson, K. Lind, M. Asplund, R. Collet, H. Jerjen, L. Sbordone, A. Aparicio, & S. Cassisi  
*Monthly Notices of the Royal Astronomical Society, Volume 450, Issue 1, p.815-845 (2015).*

### **The s-process enrichment of the globular clusters M4 and M22**

**Luke J. Shingles**, Amanda I. Karakas, Raphael Hirschi, Cherie K. Fishlock, David Yong, Gary S. Da Costa, & Anna F. Marino  
*The Astrophysical Journal, Volume 795, Issue 1, article id. 34, 12 pp. (2014).*

**Iron and neutron-capture element abundance variations in the globular cluster M2 (NGC 7089)**

David Yong, Ian U. Roederer, Frank Grundahl, Gary S. Da Costa, Amanda I. Karakas, John E. Norris, Wako Aoki, Cherie K. Fishlock, A. F. Marino, A. P. Milone, & **Luke J. Shingles**  
*Monthly Notices of the Royal Astronomical Society, Volume 441, Issue 4, p.3396-3416 (2014).*

**Augmented reality in astrophysics**

Frédéric Vogt & **Luke J. Shingles**

*Astrophysics and Space Science, Volume 347, Issue 1, pp.47-60 (2013).*

**Is the sulphur anomaly in planetary nebulae caused by the s-process?**

**Luke J. Shingles** & Amanda I. Karakas

*Monthly Notices of the Royal Astronomical Society, Volume 431, Issue 3, p.2861-2871 (2013).*