Luke Shingles, PhD

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Personal Statement

I am an experienced researcher with skills in scientific software development, data analysis, and visualisation. I would be particularly interested in opportunities to apply GPU hardware, image processing, and machine learning algorithms.
Some of 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. My 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.

I have:

- Over four years full-time paid experience developing numerically-intensive software for scientific research (C/C++)
- Expertise with multithreading and parallel algorithms (OpenMP, MPI, and CUDA)
- Expertise with debugging, performance profiling, and optimisation (gdb, perf)
- Experience with collaborative development using version control (Git), continuous integration, and automated testing
- Over eight years experience in scientific research with publications in peer-reviewed journals
- Expertise building tools to process and visualise large data sets to extract meaningful insights (Python with numpy, pandas, and matplotlib)
- Expertise in statistics, differential equations, and linear algebra (machine learning fundamentals)

Education and Employment

Aug 2015 - Mar 2021 **Postdoctoral Researcher**
Queen's University Belfast, Northern Ireland

- Lead developer on a radiative transfer code for large-scale simulations (∼50k core-hour) and an associated set of analysis/plotting tools for use by a group of researchers.
- Implemented several matrix-based numerical solvers and Monte Carlo statistical estimators to model the relevant plasma conditions and radiation transport physics.
- Developed an initial port of the simulation to GPU-accelerated CUDA C++ that resulted in 4-5x speedup.
- Other tasks included giving conference presentations and lectures, writing research papers, reports, and grant applications, supervision of Masters and PhD students, and volunteering as the Postdoctoral Representative for the School of Mathematics & Physics.

Technologies: C/C++, Git, Python (Numpy/Pandas/Matplotlib), OpenMP, MPI, CUDA

2012-2015 Doctor of Philosophy (Astrophysics)
Australian National University

Thesis: Neutron-Capture Nucleosynthesis and the Chemical Evolution of Globular Clusters
Primary Supervisor: Dr. Amanda Karakas

- Computed numerical simulations of low-mass stars on Linux-based high-performance compute clusters (NCI Raijin system).
- Developed Fortran/OpenMP code to solve a system of differential equations to model chemical production in galaxies.
- Published insights from simulation results in peer-reviewed journals with implications for the evolution of low-mass stars and the origins of chemical elements in the universe.
- Paid work as teaching assistant for courses on first-year physics, third-year astrophysics, and online courses on cosmology and exoplanets.

Technologies: Fortran, OpenMP, Git, Python (Matplotlib), Mathematica

2008-2011 Bachelor of Science with Honours (First Class)
Australian National University

Honours Thesis: The Sulfur Anomaly in Planetary Nebulae and Post-AGB Stars
Honours grade: 86% (First Class)
Majors: Astronomy & Astrophysics, Theoretical Physics, Mathematics
Course grade average: 80% (High Distinction)
Selected results:

Games, Graphs, and Machines	85% High Distinction
Maths Methods 1 Honours: Ordinary differential equations and advanced vector calculus	85% High Distinction
Maths Methods 2 Honours: Partial differential equations, Fourier analysis, and complex analysis	78% Distinction
Theoretical Physics	87% High Distinction
Applied Algebra 1 Honours: Groups rings, and advanced linear algebra	78% Distinction
Number theory and cryptography	83% High Distinction

2003-2007 **Bachelor of Information Technology**
Queensland University of Technology
Major: Software Engineering

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, Australian National University
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

- **Nebular [Fe II] emission as a constraint on Type Ia supernova progenitors**
  L. Shingles, Stuart Sim, Andreas Floers, et al.
  Monthly Notices of the Royal Astronomical Society, (2020, in preparation).

- **The influence of line opacity treatment in STELLA on supernova light curves**
  A. Kozyreva, **L. Shingles**, Alexey Mironov, Petr Baklanov, Sergey Blinnikov
  Monthly Notices of the Royal Astronomical Society, (2020, in review).

- **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).