Philippa Hartley

Title

Cosmic telescopes: witnessing the emission mechanism of radio quiet quasars

Abstract

The quasar model has reached relative maturity: we know that light is emitted at great power across the electromagnetic spectrum from the active nuclei of distant galaxies, where violent accretion processes release huge amounts of energy from gravitational stores. We observe that, in some quasars, matter falling onto the central black hole is funnneled into dramatic jets, emitting radio light across galactic distances. Over cosmic history the quasar population peaked in unison with star formation activity, leading us to suspect the role of quasars in the quenching of star-formation. Missing from the picture, however, is a full understanding of how such feedback processes manifest in the vast majority of quasars: those objects with very little radio emission. In these 'radio-quiet' quasars, jets appear to be absent, and it is possible that the faint radio signal that we do detect is the result either of smaller-scale AGN activity, of continued star formation, or of both. Only by undestanding the source of this very faint emission can we fully understand the quasar stage of galaxy evolution. This talk presents findings using strong gravitational lenses as 'cosmic telescopes' that magnify distant source structure, allowing us to resolve these intriguing objects to the sub-parsec scale.

Philippa Hartley

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RESEARCH INTERESTS

Strong gravitational lensing · AGN · galaxy evolution · dark matter substructure · radio interferometry · machine learning

PROFESSIONAL EXPERIENCE

Square Kilometre Array Organisation 2019–present
Postdoctoral Fellow

Co-coordinator of the SKA Science Data Challenges: preparing the community for SKA data
· Promotion of the Challenges and their outcomes
· Preparation of large simulated data products
· Partnership with global HPC facilities to provide challenge platform for data processing
· Working with a range of collaborators, both internal and external

Independent research
· Radio interferometry observation and modelling of strong gravitational lens systems
· Interferometric data modelling using machine learning

Square Kilometre Array Organisation 2019–2019
Research Assistant

Precise imaging with SKA-MID
· Radio interferometry simulations to evaluate SKA image fidelity
· Signal processing analysis to quantify environmental effects on telescope dishes

EDUCATION

Jodrell Bank Centre for Astrophysics, University of Manchester 2013–2019
PhD, Astronomy and Astrophysics (part-time)

Thesis: Finding and looking through strong gravitational lenses
Supervisor: Neal Jackson
· Using strong lenses as cosmic telescopes to understand the radio emission mechanisms of quasars
· Machine learning to find strong lenses in large datasets

Jodrell Bank Centre for Astrophysics, University of Manchester 2010–2012
MSc by Research, Astronomy and Astrophysics (part-time)

Thesis: Modelling Observations for Radio Weak Lensing
Supervisor: Richard Battye
Taught courses: Gravitation, Early Universe, Galaxy Formation
· Simulations of the extragalactic radio sky for weak lensing studies

University of Liverpool 2000–2002
BSc, Physics: First Class

TEACHING EXPERIENCE

Co-supervisor, MPhys project, University of Manchester   2020-present
  Abigail Morris and Arthur Farr, *"Interferometric modelling using machine learning"*

Peer mentor, MSc project training and support, JBCA   September 2017–September 2018
  David Whitworth, *"Simulation of joint optical and SKA detections of strong gravitational lenses"*

Contributor, Machine Learning Group, JBCA   December 2017
  "Support vector machine formalism"

Contributor, JBCA Autumn Computing Sessions   October 2017
  "Machine learning best practice"

SCIENTIFIC ACTIVITIES AND MEMBERSHIPS

Member, SKA Continuum Working Group   2021 - present

Member, SKA Regional Centre Steering Committee: Compute Working Group   2020 - present

Referee, MNRAS and PASA   2016 - present

Team member, International Space Science Institute (ISSI)   February 2017–present

Junior associate, Large Synoptic Survey Telescope (LSST) Corporation   May 2016–present

Member, Euclid Consortium   September 2013–present

ADDITIONAL RESPONSIBILITIES

Co-chair, SKA-JBCA Machine Learning Group   2020-present

Co-coordinator, SKA science data challenges   2019-present

Member, Equality, Diversity and Inclusion Working Group, SKAO   2020-present

SOC member, ESCAPE Data Science Summer School   2020 (postponed)

Co-founder and organiser, Machine Learning Lunch, JBCA   November 2017–July 2018

Organiser, Hack Night series, JBCA   August 2017–July 2018

Chair, Internal Seminar series, JBCA   September 2015–September 2016

Host and organiser, JBCA film club   2012–2014

PUBLIC OUTREACH

Media content for the SKA Comms team   2019-present

Guest blog and interview for Abandon Normal Devices   2018

Scientific advisor for the COSMOS artist commission at Bluedot   2018

Invited talk to industry at MancML data science series   Manchester, February 2018

Invited talk for women and girls at the Jodrell Bank Discovery Centre   Jodrell Bank, December 2014

Demonstrations at the Museum of Science and Industry   2012–2014

Presenting and editing the JBCA Jodcast astronomy podcast   2012–2014

PRIZES, AWARDS AND PROPOSALS

Multiple travel awards to attend ISSI, seminars and conferences	2013-present
SKA Exceptional Performance Award	2021
PI, e-MERLIN observing proposal: allocated 34 hours	2020
Co-I, EVLA observing proposal: allocated 32 hours	2020
Co-I, e-MERLIN observing proposal: allocated 34 hours	2018
PI, European VLBI Network observing proposal: allocated 48 hours	2019
STFC Innovation Placement	2019
PI, e-MERLIN observing proposal: allocated 24 hours	2018
Co-I, UoM Investing in Success 2018: awarded £10 000	2018
PI, European VLBI Network observing proposal: allocated 24 hours	2018
Co-I, Rosetrees Interdisciplinary Prize: selected as UoM applicant	2018
First prize in category of false positive rejection, Strong Lens Finding Challenge	2017
Wynn Evans prize for graduating top of year, University of Liverpool	2002

TECHNICAL SKILLS

Telescopes: e-MERLIN, VLA, EVN, LOFAR

Computing: Compilation and installation, data transfer, containerisation, virtual machines, parallel processing

Languages: Python, Fortran, SQL, HTML, git, CUDA, bash

Libraries: Tensorflow, Keras, PyTorch, CuDNN, scikit-image, scikit-learn, pandas, GeoPandas, MULTINEST, astropy, FITSIO, multiprocessing

Astronomy software: AIPS, ParselTongue, CASA, DIFMAP, Miriad, MeqTrees, RASCIL, SoFIA, Carta, DS9

Data analysis: Bayesian inference, dimension reduction, machine learning, deep learning, feature engineering, signal processing, visualisation, optimisation, model selection, clustering

SELECTED TALKS

Hypatia Colloquium, ESO   Online, June 2021
"Cosmic telescopes: witnessing the emission mechanism of radio quiet quasars"

SKA Speaker Series   Online, March 2021
"Cosmic telescopes: using strong gravitational lenses to preview the SKA Universe"

IAU Early Career Astronomer Series (invited)   Online, February 2021
"Preparing for a new era in astronomy"

SKA Pathfinders Radio Continuum Surveys (SPARCS) (invited)   Online, December 2020
"The SKA Science Data Challenges"

SKA-JBCA Machine Learning Club   Online, July 2020
"Using machine learning to find strong gravitational lenses"

A Centenary of Astrophysical Jets   SKA Global Headquarters, July 2019
"Cosmic telescopes: using strong lenses to study radio quiet quasars"

STFC Innovation Placement presentation   Jodrell Bank Observatory, September 2019
"Precise imaging with SKA-MID"

Euclid ML/DL Working Group   Online, November 2019
"Support vector machine classification of strong gravitational lenses"

Euclid Strong Lensing Science Working Group   Paris, September 2019
"Cosmic telescopes: using strong lenses to study radio quiet quasars"

Gravitational Lensing by Galaxies and Clusters   Isle of Skye, June 2019
"Strong lensing reveals jets in a sub-microJy radio quiet quasar"

European Week of Astronomy and Space Science (EWASS)   Liverpool, April 2018
"Support vector machine classification of strong gravitational lenses"

Nice Sophia Antipolis University departmental seminar (invited)   Nice, December 2017
"Strong gravitational lenses and how to find them"

4IR Workshop: Class Imbalance in Machine Learning (invited)   Manchester, November 2017
"Finding rare objects in space"

e-Merlin and EVN in the SKA era   Jodrell Bank Observatory, September 2017
"Cosmic telescopes: using strong lenses to study radio quiet quasars"

Euclid Strong Lensing Science Working Group   Bern, February 2017
"Application of support vector machines to the Strong Lens Finding Challenge"

Euclid:UK meeting   London, December 2016
"Strong lensing science with Euclid"

Euclid Strong Lensing Science Working Group   Toulouse, October 2016
"Finding strong lenses using machine learning"

RAS National Astronomy Meeting poster session   Nottingham, July 2016
"Finding strong gravitational lenses using support vector machines"

Euclid Strong Lensing Science Working Group   Heidelberg, November 2015
"Finding strong lenses using support vector machines"

Internal Seminar   JBCA, October 2015
"Long baseline LOFAR observations of the first lens"

PUBLICATIONS

J. McKean et al., *Gravitational lensing in LoTSS DR2 – Extremely faint 144-MHz radio emission from two highly magnified quasars*, under review, MNRAS

Euclid Strong Lensing Science Working Group white paper, *Euclid Science with Strong Gravitational Lenses*, under review by Euclid editorial board

A. Bonaldi et al., *Square Kilometre Array Science Data Challenge 1: analysis and results*, 2021, MNRAS, 3821–3837

S. Badole et al., *VLA and ALMA observations of the lensed radio-quiet quasar SDSS J0924+0219: a molecular structure in a 3 microJy radio source*, 2020, MNRAS, 496, 138-151

P. Hartley et al., *Strong lensing reveals jets in a sub-microJy radio quiet quasar*, 2019, 485, 3009–3023

B. Metcalf et al., *The strong gravitational lens finding challenge*, 2019, Astronomy & Astrophysics, 625, A119

P. Hartley et al., *Support vector machine classification of strong gravitational lenses*, 2017, MNRAS, 471, 3378-3397

R. Joseph et al., *A PCA-based automated finder for galaxy-scale strong lenses*, 2014, Astronomy & Astrophysics, 566, A63