Victoria Fawcett

Title

How are red and blue quasars different?

Abstract

An important fraction of quasars are red at optical wavelengths, indicating (in the vast majority of cases) that the accretion disc is obscured by a column of dust which extinguishes the shorter-wavelength blue emission. In recent work by our group, we have shown fundamental differences in the radio properties of SDSS optically selected red quasars, which cannot be explained with a simple viewing angle hypothesis (Klindt et al. 2019, Fawcett et al. 2020, Rosario et al. 2020, Rosario et al. 2021). In our latest work, we use VLT/X-shooter spectroscopy of a sample of red and typical quasars to gain insight into these differences. We confirm that dust reddening is the main cause of the red colours and explore the emission line properties of our sample. We confront our spectra against accretion disc models and confirm that red quasars are powered by standard thin-disc accretion, finding tentative evidence that red quasars have higher Eddington ratios for any given black hole mass. These results suggest that dusty winds could be driving the fundamental differences in red quasars, and so they may represent an important phase in galaxy evolution. Using DESI spectra, we can now push to more extinguished, lower luminosity systems, which will test whether these results extend to more extreme reddened systems.
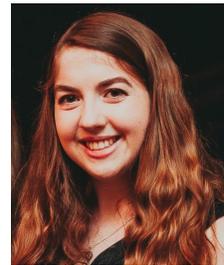
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Research experience

Durham University	Durham, UK
Astronomy PhD, Supervisors: Prof. David Alexander, Prof. Peder Norberg, and Dr David Rosario	2018–Current

- Thesis: *"Understanding the role of red quasars in galaxy evolution"*
- Reduced, analysed and fitted optical-near infrared spectroscopic data of quasars: SDSS, VLT/X-shooter, DESI
- Analysed a variety of radio datasets: FIRST, LoTSS DR1, VLA Stripe 82, VLA COSMOS 3GHz, TGSS, NVSS, VLASS
- Developed various Python codes: radio stacking, spectral emission line, accretion disc and dust extinction fitting, spectral composite stacking, machine learning morphology classifier

University of Warwick	Coventry, UK
Astronomy Masters project, Supervisor: Dr. Peter Wheatley	2017-2018

- BSc MMathPhys, First class (Hons)
- Thesis: *"The X-ray Irradiation and Evaporation of Exoplanets"*
- Investigating the X-ray irradiation of exoplanets and star-planet interactions
- Analysed X-ray data of stars in the Praesepe Cluster using XSpec, Python, R

University of Warwick	Coventry, UK
Astronomy Undergraduate Research Summer Scheme, Supervisor: Prof. Danny Steeghs	Summer 2017

- Project: *"Optimising the GOTO data analysis"*
- Worked on the Gravitational-wave Optical Transient Observer analysing optical data using Topcat, DS9 and Python

Publication Summary, ORCID: 0000-0003-1251-532X

1. G. C. Petter, R. C. Hickox, D. M. Alexander, J. E. Geach, A. D. Myers, D. J. Rosario, **V. A. Fawcett**, L. Klindt, and K. E. Whalen, "Host Dark Matter Halos of SDSS Red and Blue Quasars", ApJ, *submitted*

2. **V. A. Fawcett**, D. M. Alexander, D. J. Rosario, L. Klindt, E. Lusso, L. K. Morabito, and G. Calistro Rivera, "Fundamental differences in the properties of red and blue quasars: an X-shooter insight into dust-reddened quasars", MNRAS, *submitted* **https://drive.google.com/file/d/1DtlTUe3WYUyGd0W_45dWZAO2zy-FqNoN/view?usp=sharing**

3. **V. A. Fawcett**, D. M. Alexander, D. J. Rosario, and L. Klindt, "How are red and blue quasars different? The radio properties", MDPI, Galaxies, vol. 9, no. 107, **https://www.mdpi.com/2075-4434/9/4/107**

4. D. J. Rosario, D. M. Alexander, J. Moldon, L. Klindt, A. P. Thomson, L. Morabito, **V. A. Fawcett**, and C. M. Harrison, "Fundamental differences in the radio properties of red and blue quasars: kiloparsec-scale structures revealed by e-MERLIN", *MNRAS*, vol. 505, no. 4, pp. 5283–5300, Aug. 2021. arXiv:2106.02646

5. G. Calistro Rivera, D. M. Alexander, D. J. Rosario, C. M. Harrison, M. Stalevski, S. Rakshit, **V. A. Fawcett**, L. K. Morabito, L. Klindt, P. N. Best, M. Bonato, R. A. A. Bowler, T. Costa, and R. Kondapally, "The multiwavelength properties of red QSOs: Evidence for dusty winds as the origin of QSO reddening", *A&A*, vol. 649, A102, A102, May 2021. arXiv: 2103.02610

6. **V. A. Fawcett**, D. M. Alexander, D. J. Rosario, L. Klindt, S. Fotopoulou, E. Lusso, L. K. Morabito, and G. Calistro Rivera, "Fundamental differences in the radio properties of red and blue quasars: enhanced compact AGN emission in red quasars", *MNRAS*, vol. 494, no. 4, pp. 4802–4818, Apr. 2020. **https://arxiv.org/abs/2004.01197**

7. D. J. Rosario, **V. A. Fawcett**, L. Klindt, D. M. Alexander, L. K. Morabito, S. Fotopoulou, E. Lusso, and G. Calistro Rivera, "Fundamental differences in the radio properties of red and blue quasars: insight from the LOFAR Two-metre Sky Survey (LoTSS)", *MNRAS*, vol. 494, no. 3, pp. 3061–3079, Mar. 2020. arXiv:2004.01196

Awards and Prizes

- Durham Castle College award for outstanding leadership   Jun 2021
  - Awarded for my leadership as President of my college during the pandemic
- IOP Early Career Physics Communicator, commissioning prize   Mar 2021
  - Awarded to early career Physicists for a 500 word piece on their experience with Physics
- STEM for Britain silver award in Physics   Feb 2021
  - UK scientific poster competition run by the Parliamentary and Scientific Committee
- Elsevier Research Prize in Physics   Jun 2019
  - Best first year PhD across all Physics research areas (astronomy; condensed matter; instrumentation; particle physics; quantum light and matter) at Durham University, based on research and outreach output

Programming experience

- PYTHON: *advanced*, PhD, Masters
  - PyQSOFit, Astropy, Kmpfit, Matplotlib
  - Jupyter notebooks
- Topcat: *advanced*, PhD

- LaTeX: *advanced*, PhD
- R: *familiar*, Masters
- C: *familiar*, University course
- Xspec: *beginner*, Masters

Observing and Proposal Experience

- **DESI data quality scientist**, 4 nights (*remote observer*)   Nov 2021
- **ESO X-shooter** (*proposal, PI*)   Aug 2021
  - "Unveiling the nature of red QSOs with X-shooter", Run ID: 108.22PV.001, Hours: 8.4
- **DESI data quality scientist**, 3 nights (*remote observer*)   Feb 2021
- **DESI secondary target** (*proposal, PI*)   Oct 2020
  - "Observing the obscure: a DESI survey of dust-reddened quasars", on going program
- **GMRT**, 4 nights (*observing, Pune, India*)   Feb 2020
- **GMRT** (*proposal, PI*)   Jul 2019
  - "Investigating the evolutionary scenario for red quasars using GMRT radio spectral energy distributions", Program ID: 37_064, Hours: 23

Conference and seminar highlights

Invited conference talks: **2**
- **American Astronomical Society (AAS) 239th Meeting** (Salt Lake City, Utah)   Jan 2022
  The Diversity of DESI QSOs
- **DESI Meeting** (remote)   Dec 2021
  A DESI survey of dust-reddened quasars

Contributed conference talks: **10**, including:
- **Black hole accretion disc winds** (Durham University)   Sept 2021
  An X-shooter Insight into Dust-Reddened QSOs
- **The Past, Present and Future of the VLA: celebrating 40 years** (remote)   Aug 2021
  The Peculiar Radio Properties of Red Quasars
- **National Astronomy Meeting (NAM)** (University of Bath, remote)   Jul 2021
  Observing the obscure: a DESI survey of dust-reddened quasars
- **Extragalactic Spectroscopic Surveys: Past, Present and Future of Galaxy Evolution** (remote) Apr 2021
  An X-shooter insight into dust-reddened quasars
- **A new window on the radio emission from galaxies, clusters and cosmic web (RGCW)** (remote) Mar 2021
  The peculiar radio properties of red quasars
- **Durham-Edinburgh eXtragalactic (DEX-XVII)** (University of Edinburgh, remote, best student long talk) Jan 2021

An X-shooter insight into dust-reddened quasars
- **Durham-Edinburgh eXtragalactic (DEX-XVI)** (Durham University, commended long talk)　Jan 2020
  Focussing in on the fundamental differences between red and normal quasars

Seminars: **10** (+2), including:
- **Oxford University** (remote)　Feb 2022
  How are red and blue quasars different?
- **Leiden University** (remote)　Nov 2021
  How are red and blue quasars different?
- **University of Cambridge** (remote)　Nov 2021
  How are red and blue quasars different?
- **Newcastle University**　Nov 2021
  How are red and blue quasars different?
- **MIT** (remote)　Nov 2021
  How are red and blue quasars different?
- **DESI Atlantic Forum** (remote)　May 2021
  Exploring the diversity of SV1 quasars

Outreach and public engagement highlights

Summary: (brackets indicate future events)

School (ages 4–18) talks and workshops: **6**
Public Astronomy talks: **5** (+2)
University Astronomy talks: **7**
Science festivals/events: **9**

Highlights:
- **STEMFest in Space** (*live talk, workshop, remote*)　Oct 2020, 2021
  - Live talk and Q&A about black holes and quasars (2021), Video workshop on building a black hole (2020)
- **Durham book festival** (*video workshop*)　Sept 2021
  - Created a video workshop about the moon for the Durham Little Read
- **Levelling Up: Aspire Higher Physics Durham University** (*talk, remote*)　Jul 2021
  - Presentation about Astronomy and higher education to A level students
- **STEM Ambassador, North East**　Apr 2021–
- **Newcastle Pint of Science** (*talk, Newcastle*)　Sept 2019
- **Durham schools science festival** (*demonstration, Durham*)　Apr 2019
- **Changing Cosmic Perceptions** (*workshops, Durham University + schools*)　2018–2019
  - Three astronomy-art workshops at local North East UK schools

Teaching and Leadership Experience

- **DESI Early Career Scientist (ECS) committee member**　Jan 2020–Current
  - Run ECS meetings and co-organise DESI research forum
- **Level 4 project co-supervisor (*Durham University*)**　2018–2021
  - Assisting the supervision of 3 integrated masters Astronomy students
- **Physics Postgraduate Student-Staff representative** (*Durham University*)　Oct 2020–Current
- **President** (*Durham University, University College*)　Jun 2020–May 2021
  - Co-organised Castle conference and Castle Charity Ball
- **AGN group journal club organiser** (*Durham University*)　Oct 2019–Jun 2021
- **Coronavirus Tutoring Initiative, Year 9 Maths tutor** (*remote*)　Jan 2021–Jun 2021
- **Postgraduate mentor** (*Durham University, University College*)　Oct 2019–Apr 2021
- **Python level 1 demonstrator** (*Durham University*)　Oct 2018–Jun 2020