Adam Carnall

Title

The Star Formation Histories of Massive Quiescent Galaxies

Abstract

The properties of the most massive galaxies in the Universe provide fundamental constraints on both galaxy evolution physics and cosmology. However, extracting subtle physical properties, such as galaxy star formation histories (SFHs) and metallicities, from observations is highly challenging, owing to the age-metallicity-dust degeneracy in galaxy spectral shapes and the challenges involved in obtaining high-SNR, well calibrated spectroscopy.

I will discuss past, present and future efforts to constrain the physical properties of massive quiescent galaxies, and what these tell us about galaxy evolution. In particular I will present results from the VANDELS ESO Public Spectroscopic Survey (arXiv:1903.11082), reporting the analysis of 75 high-SNR rest-UV spectra for massive quiescent galaxies at $1.0 < z < 1.3$ to extract detailed SFHs using a sophisticated Bayesian statistical approach. I will then discuss ongoing efforts to constrain the stellar metallicities of these galaxies with rest-optical KMOS observations, allowing us to probe the evolution of the stellar mass-metallicity relation across 9 Gyr of cosmic history.

Finally, I will discuss the prospects for furthering our understanding with upcoming instrumentation. The Multi-Object Optical and Near-infrared Spectrograph (MOONS) for the VLT will provide a million high quality spectra at $z\sim1$, and I am heavily involved in preparations for the ~200 night extragalactic GTO survey MOONRISE. I will also discuss our first steps towards learning about the earliest quiescent galaxies at $z > 3$ (arXiv:2001.11975), a field that will be revolutionised by the upcoming James Webb Space Telescope.

Adam Carnall

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2021 - 2024 **Leverhulme Early Career Fellow – Royal Observatory Edinburgh**

2019 - 2021 **Postdoctoral Research Assistant – Royal Observatory Edinburgh**

2015 - 2019 **PhD Astrophysics – Edinburgh University**
Thesis: The star-formation histories of massive quiescent galaxies
Supervisors: Prof. Ross McLure and Prof. James Dunlop

2011 - 2015 **MPhys Physics and Astronomy – Durham University**
Thesis: A new search for high-redshift quasars – Supervisor: Prof. Tom Shanks
First class honours: final mark 82% (top 1%)

2009 - 2011 **A-Levels – Thirsk School and Sixth Form College**
A*A*A*A* – Physics, Chemistry, Maths and Further Maths

RESEARCH INTERESTS

Galaxy formation and evolution; quiescent galaxies; quenching mechanisms; star-formation histories; spectral energy distribution fitting; spectroscopic surveys; dust attenuation; UVJ diagnostics; software development and distribution; Bayesian statistical methods and their implementation; high performance computing in astronomy.

PUBLICATION STATISTICS (ADS 16/12/2020)

- Publications: 22 (19 accepted, 2 submitted and 1 technical note), with 6 as first author, 2 as second author
- Citations: 471, of which 204 as first author
- First-authored peer-reviewed publications: 5, with 177 citations
- h-index: 12

PUBLICLY RELEASED SOFTWARE

BAGPIPES Python software for galaxy spectral fitting (used in 29 publications to date)
https://github.com/ACCarnall/bagpipes

SPECTRES Python software for resampling spectral data (used in 28 publications to date)
https://github.com/ACCarnall/spectres

ACCEPTED TELESCOPE PROPOSALS

2019 **The stellar mass-metallicity relation for massive quiescent galaxies at $1.0 < z < 1.5$**
PI, 64 hours, ESO P104, VLT KMOS, 0104.B-0885

2015 **Probing the epoch of reionisation with two bright quasars at $z > 6$ from VST ATLAS**
Co-I (PI: T. Shanks), 2 hours, ESO P94, VLT X-SHOOTER, 294.A-5031

AWARDS AND PRIZES

2020 Selected to attend the 70$^{\text{th}}$ Lindau Nobel Laureate Meeting

2019 Winton Astronomy Thesis Prize

2018 International Astronomical Union travel bursary: £1200

2018 Scottish Universities Physics Alliance PECRE Bursary: £1500 travel funding

2015 Durham University J. A. Chalmers Prize in Experimental Physics

2012 - 2015 Durham Physics Award for Outstanding Achievement: Years 1 - 4

2015 Durham University Summer Research Bursary: £1500 funding for 6 week project

2014 Institute of Physics Top 50 Award: £2000 funding for 8 week project at Southampton University

2013 Oxford University Summer Research Bursary: £1500 funding for 8 week summer project

2013 Leicester University SURE Bursary: £2000 funding for 6 week summer project

SELECTED PRESENTATIONS

Sep 2020	Talk	Epoch of galaxy quenching conference, Cambridge University, UK
Jun 2020	Talk	European Astronomical Society meeting, Leiden, Netherlands
Jun 2020	Invited talk	Oxford galaxy evolution seminar, Oxford University, UK
Feb 2020	Talk	Quenching throughout cosmic time, Aspen Center for Physics, CO, USA
Jan 2020	Invited talk	The growth of galaxies in the early Universe VI, Sexten, Italy
Nov 2019	Talk	The art of measuring galaxy physical properties, INAF, Milan, Italy
Jul 2019	Talk	Galaxy evolution session, National Astronomy Meeting, Lancaster, UK
Jul 2019	Talk	MOONS session, National Astronomy Meeting, Lancaster, UK
May 2019	Invited talk	Lega-C team meeting, Ghent, Belgium
Mar 2019	Talk	Geneva Observatory, Switzerland
Jan 2019	Invited talk	The growth of galaxies in the early Universe V, Sexten, Italy
Nov 2018	Talk	International Astronomical Union Symposium 341: Challenges in panchromatic galaxy modelling with next generation facilities, Osaka University, Japan
Oct 2018	Talk	University of St Andrews, UK
Apr 2018	Invited talk	The art of measuring galaxy physical parameters, UC Riverside, CA, USA
Jan 2018	Invited talk	The growth of galaxies in the early Universe IV, Sexten, Italy
Nov 2017	Talk	Royal Society of Edinburgh Cormack Meeting, Edinburgh, UK
Jun 2017	Invited talk	Advances in galaxy evolution with surveys, Ringberg Castle, Germany

TEACHING AND SUPERVISION EXPERIENCE

2019 - 2023	STFC PhD Studentship: Massissilia Hamadouche Project: The physics of high redshift star-forming galaxies with VANDELS and JWST
2019 - 2021	Edinburgh University BSc Project supervisor
2019	Edinburgh Physics Summer Scholarship: Sam Walker Project: Finding the first quiescent galaxies
2018	Edinburgh University Numerical Recipes Course: guest lecture on MCMC methods
2018	St. Andrews University Research Methods Course: guest lecture on star-formation histories
2018	Edinburgh Physics Summer Scholarship: Jamie Yellen Project: Advanced Bayesian methods for galaxy spectral fitting
2017	Royal Society of Edinburgh Cormack Scholarship: Joe Cairns Project: SCUBA-diving into the deep universe: the origins of massive galaxies
2015 - 2019	Edinburgh University Teaching Assistant: supervised a variety of tutorials and labs

OUTREACH AND PUBLIC ENGAGEMENT

2018 - 2019	Royal Observatory Edinburgh open days: organised activity stall explaining spectroscopic surveys using Sloan Digital Sky Survey plate, fairy lights and portable spectrograph
2018	Royal Observatory Edinburgh open days talk: how many stars are there in the Universe?
2017	Royal Observatory Edinburgh open days talk: astronomical archaeology: how did galaxies form?
2015	Teeside skeptics in the pub talk: what are dark matter and dark energy?