

EDUCATION

UNIVERSITY OF CAMBRIDGE Institute of Astronomy, Cambridge, UK

October 2022 - Present

PhD in Astronomy

Thesis title: ‘Baryonic Feedback: the Impact of Galaxy Formation Physics on Cosmology’

Supervisors: Prof. Debora Sijacki & Dr. Alexandra Amon

DURHAM UNIVERSITY Durham, UK

October 2018 - July 2022

MPhys Physics and Astronomy: First Class Honours

Level 4 project: ‘Discerning the Real Universe from the Matrix with the DESI Bright Galaxy Survey’

Supervisors: Prof. Shaun Cole & Dr. Michael Wilson

Level 4 modules:

Theoretical Astrophysics, Advanced Astrophysics, Particle Theory

Level 3 modules:

Planets & Cosmology 3 (91%), Foundations of Physics 3A (88%), Foundations of Physics 3B (83%),

Theoretical Physics 3 (81%), Computing Project (74%), Advanced Laboratory (83%)

Overall Score: 83.3%

Level 2 modules:

Stars & Galaxies (86%), Theoretical Physics 2 (88%), Mathematical Methods in Physics (73%),

Laboratory Skills & Electronics (81%), Foundations of Physics 2A (83%), Foundations of Physics 2B (84%)

Overall Score: 82.5%

DAME ALICE OWEN’S SCHOOL Potters Bar, UK

October 2011 - June 2018

A-Levels: Physics (A*), Chemistry (A*), Mathematics (A*), Further Mathematics (A*)

GCSEs: 11 at grade A*, including Mathematics, English and Triple Science.

RESEARCH EXPERIENCE - UNIVERSITY OF CAMBRIDGE

Supervisors: Dr. Alexandra Amon Prof. Debora Sijacki

October 2022 - Present

‘Towards an Understanding of Baryonic Feedback: Deciphering the Impact of Galaxy Formation Physics on Cosmology’

Extracting accurate cosmology from weak lensing surveys requires accurate modelling of the matter power spectrum, including the non-linear scales which are affected by baryonic processes. Hydrodynamical simulations have demonstrated that energetic feedback processes, arising predominantly from AGN, suppress the non-linear matter power spectrum. However, the amplitude, redshift and scale dependence of this suppression remains largely unknown. A more complete understanding of baryonic feedback processes and its degeneracies with cosmological parameters is therefore crucial to make progress in the field. My work explores baryonic feedback from two viewpoints. I make the case that it is possible to realise more extreme power suppression with modifications to the AGN feedback model in hydrodynamical simulations, using FABLE as a test bed. In particular, I discuss this in the context of a solution to the S8 tension. The second project assesses standard and new methods of mitigating for baryonic feedback in cosmic shear analyses using the Dark Energy Survey Y3 cosmic shear dataset. I compare of the approaches by considering the impact on the cosmological parameters and the constraints on the power spectrum suppression. Finally, I am also demonstrating that the kinematic Sunyaev-Zel’dovich (kSZ) effect provides a promising avenue for understanding baryonic feedback in a new regime and can be effectively utilised in a joint shear+kSZ analysis to better constrain feedback parameters.

RESEARCH EXPERIENCE - SUMMER PROJECTS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, Massachusetts, USA

Supervisor: Dr. Anna-Christina Eilers

July 2021 - Present

‘Evidence for Episodic Black Hole Growth of Reionization-Era Quasars observed with Magellan/FIRE’

Using new infrared spectroscopic data from FIRE at the 6.5m Magellan telescopes in Chile, I expanded the current sample of characterised high-redshift quasars. I determined the masses of the central black holes and the sizes of quasars ‘proximity zones’: ionised regions around quasars that are sensitive to their lifetimes. My analysis provided new evidence that the active accretion of mass onto the black hole is episodic. The first author paper based on this work has been submitted to the Monthly Notices of the Royal Astronomical Society.

UNIVERSITY OF ST. ANDREWS St. Andrews, UK

Supervisor: Dr. Juan Venancio Hernandez Santisteban

August 2020 - September 2020

'Quiescent Properties of V1838 Aql' (in prep)

The cataclysmic variable (CV) V1838 Aql has been observed in quiescence, but previous work has been unable to characterise the donor star of the system. Using time-resolved spectroscopy from the X-Shooter at the Very Large Telescope, I fit a multi-component model to the near-infrared section of the spectrum and determined the mass and type of the donor, which will be crucial to improve theoretical models of accretion in CVs. My collaborators and I are currently preparing the work to submit to the Monthly Notices of the Royal Astronomical Society in early 2022.

RESEARCH EXPERIENCE - DURHAM UNIVERSITY

Supervisors: Prof. Shaun Cole & Dr. Michael Wilson

October 2021 - July 2022

'Discerning the Real Universe from the Matrix with the DESI Bright Galaxy Survey'

I am building mock galaxy catalogues for the Dark Energy Spectroscopic Instrument Bright Galaxy Survey with the greatest realism to date, which include the imprint of observational systematic effects and will be crucial to validate the scientific analyses. To ensure the resulting mocks are sufficiently realistic, I am investigating multiple metrics to test for agreement between the mock and observed data, including both one-point and two-point clustering statistics.

Supervisor: Prof. Mark Swinbank

October 2020 - May 2021

'Characterising the Risk to Earth of Potentially Hazardous Asteroids'

By making astrometric measurements on a series of observations, I determined the orbital parameters of three potentially hazardous asteroids (PHAs). I predicted the targets' close approaches with Earth until 2121 and assessed the risk they pose to Earth using the Torino scale. By performing aperture photometry with parallax observations taken with the pt5m telescope at the Roque de los Muchachos Observatory on La Palma, I calculated the maximum impact energy of a target. My conclusion that it was capable of causing regional damage highlighted the importance of monitoring PHAs.

Supervisor: Prof. Peder Norberg

October 2020 - May 2021

'Tests of Λ CDM Cosmology using Type 1a Supernovae and Predictions of the Universe's Fate'

I used a Markov chain Monte Carlo method to constrain cosmological models using the Supernova Cosmology Project 'Union2.1' Compilation of 580 Type 1a supernovae, incorporating priors from other probes. I found best-fit parameters which were consistently within the one-sigma constraints determined by the initial analysis of this dataset in literature, which used an alternate method to fit the cosmology. I therefore demonstrated the reproducibility of finding Λ CDM to be the concordance model of cosmology and characterised the evolution of a Λ CDM Universe.

Supervisor: Prof. Mark Swinbank

January 2020 - May 2020

'Determinations of the Mass-to-Light Ratio in M82 by CCD Photometry'

The starburst galaxy M82 has a Keplerian rotation curve; theorised to be the result of a dark matter stripping interaction with the neighbouring galaxy M81 which triggered its high star formation rate. I provided evidence for this model by using CCD observations to measure the mass-to-light ratio of the galaxy, theorising that the high value is a result of dust extinction in the interstellar medium, and used H- α band-filters to detect the starburst activity.

OBSERVING EXPERIENCE

Magellan/FIRE (remote) (1 night)

July 2021

Observing quasars at redshift ~ 6 with the infrared spectrometer FIRE for the 6.5m Magellan telescopes.

Durham University/AstroLab (15 nights)

January 2020 - November 2020

Observations of the galaxy M82 for photometry and asteroids for astrometry, with 14 and 16 inch telescopes.

TEACHING EXPERIENCE

Natural Sciences supervisor

October 2023

I supervised undergraduate students in Natural Sciences during the Gonville & Caius Bridging Week at the University of Cambridge. I delivered several academic skills lectures and supervised a short research project.

Module demonstrator

October 2021 - July 2022

Demonstrator in problem solving workshops of the Level 2 module Stars and Galaxies 2 at Durham University.

Private tutor

October 2017 - Present

One-on-one GCSE and A-Level tutoring in mathematics, physics and chemistry.

OUTREACH & CONFERENCES

Cambridge-LMU Cosmology Meeting	December 2023
Talk title: ‘Baryonic Feedback: the Impact of Galaxy Formation Physics on Cosmology’.	
‘Levelling Up: Aspire Higher’ physics mentor	March 2021 - July 2021
I ran workshops for sixth form students on topics such as minority representation in STEM, the university application process and how to acquire research experience in physics.	
Contribution of articles for the astrophysical literature journal ‘Astrobites’	
‘Characterising the Risk to Earth of Potentially Hazardous Asteroids’	September 2021
‘Investigating the Dark Matter in M82 using the Mass-to-Light Ratio’	November 2020
Conference for Undergraduate Women in Physics	
Presented the poster ‘Predicting the Universe’s Fate using Type 1a Supernovae’	March 2021

AWARDS & FUNDING

D. A. Wright Prize	July 2022
Awarded annually by the Board of Examiners in Physics for outstanding performance by a candidate for Final Honours in the MPhys degree in Physics and Astronomy at Durham University.	
Durham Physics Award for Outstanding Achievement	July 2022
Awarded for achieving an overall weighted mean mark greater than 80% (ranking in the top 5% of the Level 3 cohort).	
Level 4 Prize for Theoretical Astrophysics	July 2022
Awarded for achieving the highest annual mark in the Level 4 module Theoretical Astrophysics at Durham University.	
Durham Physics Award for Outstanding Achievement	July 2021
Awarded for achieving an overall weighted mean mark greater than 80% (ranking in the top 5% of the Level 3 cohort).	
John Simpson Greenwell Memorial Fund	April 2021
£1000 grant awarded to support the summer research project supervised by Dr. Anna-Christina Eilers.	
Durham Physics Award for Outstanding Achievement	July 2020
Awarded for achieving an overall weighted mean mark greater than 80% (ranking in the top 3% of the Level 2 cohort).	
John Simpson Greenwell Memorial Fund	April 2020
£1000 grant awarded to support the summer research project supervised by Dr. Juan Venancio Hernandez Santisteban.	

SKILLS

Programming:

Python (including Markov chain Monte Carlo methods, `astropy` and handling FITS files), \LaTeX , Linux

Observational astronomy:

Independent running of the Durham University/AstroLab telescopes, observing remotely with Magellan/FIRE, astrometry and photometry.