Alexander Byrne

4th year Astrophysics Student
St Catharine's College, Cambridge
ajnb3@cam.ac.uk • 07391 788913
xbyrne.github.io

Education

University of Cambridge, St Catharine's College **Cambridge, 2019-pres**

- MSci Natural Sciences (Astrophysics) – First Class expected
- Ranked 1st in third year Astrophysics examinations
- Awarded *Winifred Georgia Holgate Pollard Memorial Prize* from the University of Cambridge
- Awarded *John Spencer Wilson Prize in Natural Sciences* and *Skerne (1745) Scholarship* from St Catharine's College

King Edward VI Camp Hill School for Boys **Birmingham, 2012-2019**

- A-levels (all A*): Further Maths, Physics, Chemistry, Maths
- Twelve GCSEs, all at A*/9

Research Experience

Part III (Master's) Project **Cambridge, 2022-23**

Surface-atmosphere interactions on warm exoplanets

- Inferring the presence of surface minerals on the surfaces of Venus-like exoplanets
- Exploiting thermochemical equilibrium between surface and atmosphere to link atmospheric composition (via atmospheric modelling and retrievals) to surface mineralogy
- Awarded MASt/Part III Bursary to continue project the following summer

Max-Planck-Institut für Astronomie, Internship **Heidelberg, Summer 2022**

Turned down internship offers from Cambridge IoA and Oxford Astrophysics.

- Searching for high-redshift gravitationally-lensed quasars, using unsupervised machine learning
- Used SQL, bash scripting, astropy, to collect data from SIA service
- Applied several unsupervised ML techniques (e.g. variational autoencoders, self-organising maps), investigating different network architectures and hyperparameters
- Carried out SED fitting using MCMC techniques
- Applied a variety of clustering techniques (e.g. Gaussian mixture models, DBSCAN)
- Attended workshops on git, bash, astropy, and structuring python projects
- Presented my work at a seminar
- Awarded observing time: "Finding the missing gravitationally-lensed z>6 quasars", Gemini/GMOS-South (1.64h, PI: E. Farina), to observe two candidates. Both were found to be high-redshift quasars

CATAM Mathematics and Physics Projects **Cambridge, Sep 2021**

Computational projects and reports investigating a mathematics- or physics-related theme

- Simulated accretion discs, analysing trajectories of individual particles and angular momentum
- Calculated cosmological lookback times; measured distances for a range of cosmological models; tested uniformity of comoving density for a sample of 114 quasars up to $z = 3.0$
- Produced exemplary plots in Matplotlib

International Chemistry Olympiad 2019 **Paris, Jun 2019**

- Represented the United Kingdom at the IChO 2019
- Ranked 41st in the world
- Required learning extensive amounts of university-level chemistry (both theoretical and practical) in just two weeks

Extended Project Qualification – *Where do Cosmic Rays Originate?* **Birmingham, 2018**

- A report investigating the sources of cosmic rays at various energies
- A literature review as well as primary research; awarded A*
- Developed software in Python and MATLAB to analyse data from muon detectors to suggest sources for over 770,000 events

HiSPARC Project & Conference **Bath, 2018**

- Initiated my school's participation in the HiSPARC cosmic ray project
- Constructed a muon detector to be installed on the roof; carried out repairs/troubleshooting
- Used data collected from detector for Extended Project Qualification (above)
- Presented my research at the HiSPARC Conference 2018; received the Gold Award

Cavendish Laboratory **Cambridge, Jul 2017**

- Shadowed a PhD student using DNA-driven colloids to create structural colour
- Synthesised my own iridescent gel
- Learned some principles of soft condensed matter, Bragg reflection, and SEM

VDI Schülerforum 2016 **Frankfurt, Jun 2016**

- Five-month group research project on drone technology
- Delivered a presentation of the project (partially in German), to an audience of ~100 at the Frankfurt University of Applied Sciences

Outreach

- Appeared on *The Naked Scientists* live on BBC Radio Cambridgeshire
- Delivered an "incredibly entertaining" talk on the Messier Catalogue at *Varsity Sci 2021*
- Delivered a talk to the Cambridge University Physics Society about the dynamics of negative mass; authored an article on the subject in *BlueSci* magazine
- Student Ambassador for St Catharine's College, Cambridge; panellist on many Q&A sessions for prospective applicants
- Maintaining extensive document in LaTeX advising pupils on Oxbridge interviews

Other Projects

- Used machine learning techniques to develop handwritten number recognition software from scratch, achieved over 97% accuracy on the MNIST dataset
- Read *Deep Learning with Python* by François Chollet; improved accuracy to >99% using Keras module
- Delivered an "incredibly entertaining" talk on the Messier Catalogue at *Varsity Sci 2021*

Relevant Modules — University of Cambridge

Introduction to Python and Jupyter Lab **Feb 2022**

Developing Python skills in an astrophysical context

- Wrote an orbital integrator, investigating the effects of changing timestep and energy
- Visualisation of gravitational field in a binary system
- Analysis of SDSS and exoplanet.eu data; visualisation of colour and conversion of units using Astropy

Introduction to Computing in C++ **Feb 2021**

- Simulation of planetary orbits using Euler, Leapfrog, and RK4 methods
- Numerically estimating the specific heat ratio for a one-dimensional gas
- Estimation of ln(2) using a Monte Carlo method

Physics Research Skills Module **Feb 2021**

- Presented a poster and delivered a presentation on the Schiehallion Experiment
- Wrote a scientific essay on the Sources of Cosmic Rays
- Peer reviewed colleagues' essays on Bernoulli's Principle, Relativity of Simultaneity, the Arago Spot

Computer Practicals in Excel/VBA **Jan 2021**

- Eigenfunction Expansion in a Sturm-Liouville ODE. Effect of number of expansion functions on accuracy
- Gauss-Jordan Elimination. Effect of rounding errors and partial pivoting
- Solution of Laplace's Equation using Jacobi and Gauss-Seidel methods, with and without relaxation. Effect of step size and relaxation parameter on accuracy. Rate of convergence

Languages

- A* GCSEs in German, French and Mandarin
- Basic ability in Italian

Other Interests

- Piano – ARSM performance diploma; composed many solo pieces. Performed in countless concerts and shows, occasionally in an ensemble
- Long-distance running – ran the Birmingham Half Marathon in under 2 hours
- Football – Captained local youth team for 6 years, ascended through 5 divisions