

# Alexander Byrne

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## Education

### University of Cambridge, St Catharine's College

Cambridge, 2019-pres

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

### King Edward VI Camp Hill Boys

Birmingham, 2012–2019

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

## Experience

### Max-Planck-Institut für Astronomie, Summer Internship

Heidelberg, Jul 2022

Turned down similar offers from Cambridge IoA and Oxford Astrophysics.

- Searching for gravitationally-lensed quasars at  $z > 5$  using unsupervised machine learning (ML)
- Compiled data from DES using SQL, SIA service, *bash* scripting and *astropy*
- Applied several unsupervised ML techniques (e.g. variational autoencoders, self-organising maps), investigating the effects of different network architectures and hyperparameters
- Applied a variety of clustering techniques (e.g.  $k$ -nearest neighbours, Gaussian mixture models)
- Attended seminars and group meetings

### Introduction to Python and Jupyter Lab

Cambridge, 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

### 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 lookback times; measured cosmological 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 using Matplotlib

### Introduction to Computing in C++

Cambridge, Feb 2021

- Simulation of planetary orbits using Euler, Leapfrog, and RK4 methods
- Numerically estimating the specific heat ratio for a one-dimensional gas
- Calculation of  $\ln(2)$  using a Monte Carlo method
- Finding roots of a transcendental equation
- Generation of the Collatz sequence of a number
- Calculation of triangle-based pyramidal numbers

### Physics Research Skills Module

Cambridge, 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 other essays on Bernoulli's Principle, Relativity of Simultaneity and the Arago Spot

## Computer Practicals in Excel/VBA

Cambridge, 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
- Root finding using Bisection, Newton–Raphson, Linear Interpolation, and Secant methods. Investigation of rates of convergence
- Solution of ODEs using Euler and RK4 methods, and investigating their stabilities
- Numerical Integrations of complicated functions using Simpson's and Trapezium Rules, including investigation of errors and behaviours near singularities

## ICHO 2019

Paris, Jun 2019

- Represented the United Kingdom at the International Chemistry Olympiad 2019
- Ranked 41<sup>st</sup> 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 & HiSPARC Conference

Bath, 2018–pres

- Initiated my school's participation in the HiSPARC cosmic ray project
- Constructed a muon detector; installed it 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
- Return annually to inspire and oversee future students' research projects

## 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

## Extracurriculars

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### 2021

- 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*

### 2020

- Delivered a talk to the Cambridge University Physics Society about the dynamics of negative mass ([youtu.be/ovptNIUAtto](https://youtu.be/ovptNIUAtto))
- Wrote an article on the same subject in *BlueSci* magazine

### 2019–pres

- Maintaining extensive document in LaTeX advising pupils on Oxbridge interviews
- Modified Excel spreadsheets for organising my school's entrance exam

- Student Ambassador for St Catharine's College, panellist on many Q&A sessions for prospective applicants

### **2017-19**

- Gave a series of well-attended talks about the Schrödinger Equation to school colleagues

## **Languages**

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

## **Other Interests**

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