Sean Barrett

Computational Physicist

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Education

DPhil Astrophysics | *University of Oxford* October 2018 — present
Supervised by Julien Devriendt and Adrianne Slyz; expected thesis submission in September 2022

- ***Radiation-coupled primordial chemistry in simulations of the first galaxies (Thesis, in prep.):*** Modified the radiation-hydrodynamics code RAMSES-RT to include a model of (photo)chemistry for the universe's primordial gas, in order to self-consistently predict the formation of the first stars in the universe, and then subsequent star formation in metal-enriched gas. This enables prediction of the resultant stellar populations, and therefore spectra, of the oldest dwarf galaxies, as observed by JWST.
- ***A learned model to interpret JWST observations of the early universe (Paper, in prep.):*** Developed a statistical model to infer the intrinsic properties of high-redshift galaxies from their observed spectral-line fluxes, by using machine learning to extract information from a catalogue of simulated galaxies. This allows better measurements than conventional methods (that are calibrated using observations of the local universe instead).

MSci Physics with Theoretical Physics | *Imperial College London* 2014 — 2018
1st Class Honours; thesis project supervised by Carlo Contaldi

- ***Relativistic effects on the orbit of stars around Sagittarius A* (Thesis):*** Wrote a program to numerically solve the geodesic equation in a Kerr metric, and used this to predict general relativistic effects on the orbit of the star S2 during its close pass to the Milky Way's central black hole in 2018, and the gravitational lensing of light reaching Earth.
- ***Computational Physics:*** Studied numerical methods for solving ODEs and PDEs, Monte Carlo methods, FFTs. Applied these to physics problems in various projects.

Research Experience

NERC Undergraduate Research Placement | *University of Oxford* Summer 2017
Department of Earth Sciences, supervised by Samar Khatiwhala

- Developed and tested an algorithm for sampling probable trajectories of chemical tracer particles in the ocean. Implemented this in a distributed program with MPI for fast calculation across many processes, running on the university's ARCUS cluster.
- Attended a one week course on GPU programming with CUDA, with the intention of reimplementing my algorithm on GPUs for even greater speed. Although not completed during the summer, this work contributed to the ongoing research of Professor Khatiwala and his DPhil student.

Undergraduate Research (UROP) | *Imperial College London* Summer 2016
Department of Physics, supervised by Peter Török

- Searched for incomplete vector basis for approximately describing electric field in laser beams, to enable fast/cheap measurement of polarisation state. Performed simulations of measurements with shot noise to find accuracy of reconstruction of field compared with a complete basis.

Teaching

Teaching Assistant | *University of Oxford* 2020 — 2021
Department of Physics, course title: Radiative Processes in Astrophysics

- Led tutorials to solve exam-style problems in this master's-level lecture course. Marked students' problem sheets and past exam papers.

Instructor | *Turinglab* Jan. 2016 — Dec. 2017
London

- Travelled to clients' houses to teach small groups of children (8-12 years old) introductory programming in JavaScript, Python and Scratch. Tailored lesson content and set homework to suit abilities and interests of students

Conference Presentations

SAZERAC SIP: Models and Simulations of High-Redshift Galaxies
October 2021 — Online

RAMSES User Meeting
October 2021 — Online,
September 2019 — Niels Bohr Institute, Copenhagen

Training

Course on CUDA Programming
July 2018, 1 week (University of Oxford)

VI-HPS Performance Analysis Workshop
April 2019, 3 days (University of Bristol)

DiRAC Intel Optane Hackathon
June 2019, 3 days (Durham Univsersity)

Summer School on Galaxy Formation and Evolution
August 2019, 1 week (AKSS, Spetses)

Winter School on Computational Fluid Dynamics In Astrophysics
November 2019, 1 week (IAC, Tenerife)

DiRAC Course on Machine Learning for Science
March 2021, 4 days (online)

Skills

- Computational physics, scientific data analysis and visualisation with Fortran, C, Python and MATLAB
- Writing CPU+GPU programs for supercomputers with MPI and CUDA
- Profiling and tracing distributed programs with open-source tools
- Machine Learning with scikit-learn and Keras
- Document preparation with LaTeX
- Version control with git
- Diagram illustration with vector graphics software

References

Prof. Julien Devriendt, University of Oxford
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Prof. Adrianne Slyz, University of Oxford
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