Yuxuan Yuan

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Education

University of Cambridge, Ph.D., Astrophysics 2021 - 2025

Australian National University, Honours (equivalent to Master's), Astrophysics (GPA **7.0/7.0**) 2020 - 2021

Australian National University, Bachelor, Physics and Astrophysics (GPA **6.9/7.0**) 2018 - 2020

Beijing Institute of Technology, Applied Physics 2016 - 2018

Skills

Programming & Computing: Python (NumPy, SciPy, pandas, PyTorch, TensorFlow, and JAX), C/C++, Fortran, Git, SQL, numerical methods, high-performance computing including MPI-based parallelisation and GPU acceleration (CUDA), large-scale simulation, performance optimisation.

Modelling & Machine Learning: Monte Carlo simulation, Bayesian inference, time-series modelling, stochastic processes, numerical optimisation, statistical modelling, probabilistic modelling, signal extraction, high-dimensional data analysis, data preprocessing, scikit-learn.

Selected Research Experience

Statistical Modelling and **Signal Extraction** of Lyman-α Emission in Large-Scale Simulations 2022 - 2025

- Post-processed a **terabyte-scale** suite of cosmic-ray radiative-transfer magnetohydrodynamical simulations of galaxy formation with a **Monte Carlo method** to model Lyman α photon escape in high-redshift galaxies.
- Leveraged **high-performance computing** for large-scale numerical experiments, performing statistical analyses and managing terabyte-scale outputs.
- Conducted **time-series analysis** across hundreds of simulation snapshots, **detecting patterns**, such as merger-driven variability and feedback-regulated emission cycles, to derive predictive physical insights.
- **Extracted weak astrophysical signals** from simulated data using statistical filtering and peak-finding algorithms, yielding reliable physical diagnostics.
- Developed a **random forest regression model** relating Lyman continuum escape fractions to multiple line-shape parameters, identifying patterns in the relationships.
- Leveraged high-resolution JWST datasets to test and validate theoretical models, applying **data-driven analysis** to evaluate model fidelity.
- Collaborated with an **international, interdisciplinary team** across the UK, US, Switzerland, and Denmark, coordinating between simulation experts, observers, and theorists; resulted in 3 publications, including a high-impact paper in **Nature Astronomy** (Impact Factor: 14.3).

3D Computational Modelling and Bayesian Analysis of Multiphase Outflow Systems 2021 - 2022

- Applied a semi-analytical **3-dimensional physical model** to analyse multiphase galactic winds, extracting key system dynamics.
- Developed efficient numerical routines for solving **coupled hydrodynamic and radiative-transfer equations**, optimising performance for model computations.
- Employed a **Bayesian inference approach** (Markov Chain Monte Carlo algorithm) to constrain physical parameters with high precision by fitting models to telescope data.
- Used **Akaike information criterion (AIC) based ranking** to identify the optimal model.
- Utilised high-performance computing techniques to efficiently handle **high-dimensional parameter spaces**.

Awards

Cambridge Trust Isaac Newton Studentship, University of Cambridge (highly competitive) 2021 - 2025

University Medal, Australian National University (**33** winners across the entire University) 2021

3rd Prize, National High School Mathematics Competition, China 2015

Research Publications

First author papers

1. **Yuan, Y**. et al. Lyα emission as a sensitive probe of feedback-regulated LyC escape from dwarf galaxies. MNRAS 532, 3643–3668.

2. **Yuan, Y**. et al. Extended red wings and the visibility of reionization-epoch Lyman-α emitters. arXiv:2412.07970.

3. **Yuan, Y**., Krumholz, M. R. & Martin, C. L. The observable properties of cool winds from galaxies, AGN, and star clusters - II. 3D models for the multiphase wind of M82. MNRAS 518, 4084–4105.

4. **Yuan, Y**., Krumholz, M. R. & Burkhart, B. Understanding biases in measurements of molecular cloud kinematics using line emission. MNRAS 498, 2440–2455.

Non-first-author papers

1. Dome, T. et al. Increased Burstiness at High Redshift in Multi-Physics Models Combining Supernova Feedback, Radiative Transfer and Cosmic Rays. MNRAS 537, 629-639

2. Witten, C. et al. Deciphering Lyman-α emission deep into the epoch of reionization. Nature Astronomy 8, 384–396.

3. Burkhart, B. et al. The Catalogue for Astrophysical Turbulence Simulations (CATS). ApJ 905, 14.

Teaching

Tutor of the course "Stellar Dynamics and Structure of Galaxies" 2022