Conaire Deagan

Astrophysics PhD Candidate | University of New South Wales

ML anomaly detection for time-domain astronomy • high-precision astrometry • stellar surface reconstruction • exoplanet detection and characterisation

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Education

Doctor of Philosophy in Physics — University of New South Wales Feb 2023 – Nov 2026 (expected)

Advisor: Dr Ben Montet

Thesis: *Data-driven models of stellar activity and its impact on exoplanet habitability*

Bachelor of Advanced Studies (Honours) — University of Sydney Jul 2021 – Jul 2022

Advisors: Prof. Peter Tuthill, Dr Ben Pope

Thesis: *Advanced astrometry: Modelling the TOLIMAN space telescope*

Bachelor of Science (Physics & Mathematics) — University of Sydney Feb 2018 – Jun 2021

Research Interests

My research focuses on stellar surface reconstruction and its impact on exoplanet detection using high-precision astrometry. I develop information-theoretic and Bayesian frameworks for reconstructing the surfaces of unresolved Sun-like stars, exploiting the complementary sensitivity of astrometric and photometric signals to different spherical harmonic modes. This work informs realistic noise models for detecting Earth analogues around nearby stars. In parallel, I develop weakly supervised and unsupervised machine-learning methods with Bayesian uncertainty quantification to identify rare and anomalous behaviour in large time-domain photometric surveys such as *TESS*. I also maintain a broader interest in SETI and astrophotonic instrument design.

Publications

Inferring hemispheric asymmetries of stellar active regions through the information content of astrometric signals

Deagan, C., et al.

Submitted to MNRAS (2026)

Demonstrates that high-precision astrometry can recover information about unresolved stellar surface features, breaking degeneracies in light-curve inversion.

arXiv:2601.11707

Astrometric exoplanet detection survives solar-like stellar contamination

Deagan, C., et al.

Submitted to MNRAS (2026)

Quantifies the limits of astrometric planet detection in the presence of stellar activity, demonstrating the robustness of future astrometric missions.

Research Experience

PhD Research — UNSW (NEWTS Research Group / TOLIMAN Project) Feb 2023 – Present

- Developed information-theoretic frameworks for stellar surface reconstruction, demonstrating that astrometry breaks degeneracies inherent to photometry-only inversions.
- Performed Bayesian analysis of custom simulations of stellar surfaces and activity-driven signals.
- Analysed decade-long, multi-wavelength photometric datasets treating the Sun as a star.
- Built weakly supervised and unsupervised ML pipelines with Bayesian uncertainty quantification for anomaly detection in *TESS* light curves.
- Accumulated >30 nights as observing astronomer on the 3.9 m Anglo-Australian Telescope, operating the VELOCE spectrograph.

Defence Science and Technology Group — Internship First Quarter 2025

- Developed ML models for nuclear safety monitoring, including event detection, classification, and localisation.
- Outperformed a competing Los Alamos National Laboratory model in two of three evaluation metrics.
- Applied Gaussian processes, transformer-based autoencoders, recurrent neural networks, contrastive learning, and saliency analysis.

Research Assistant — Sydney Astrophotonic Instrumentation Laboratory, University of Sydney Jul 2022 – Jun 2024
Supervisor: Prof. Peter Tuthill

- Modelled optical aberrations in the TOLIMAN space telescope's diffractive pupil.
- Extended Honours research through end-to-end forward modelling of astrometric signal recovery.

Selected Talks & Presentations

Stellar surface recovery using astrometric signals: An information-theoretic approach
MaxEnt 2025

Stellar cartography: Mapping the surfaces of stars with high-precision astrometry
ASA 2025

The surfaces of unresolved Sun-like stars
Stars in Brisbane / Australian Exoplanet Workshop 10 (2024)

The role of astrometry in SETI and exoplanet science
Interstellar Frontiers (2024)

Star-spots, stellar dynamos and habitable exoplanet astrometry
Australian Exoplanet Workshop 9 (2023)

Teaching & Mentoring

Head Tutor — QBUS3600: Business Analytics in Practice Jun 2024 – Present
University of Sydney

- Managed the tutorial programme for a capstone course involving semester-long industry and not-for-profit projects.
- Designed and deployed a Kaggle-style model evaluation leaderboard, enabling secure and reliable benchmarking of student models against held-out test data.
- Developed teaching materials covering optimisation, classification, clustering, ensemble methods, and model evaluation.

- Coordinated tutors, assessment workflows, and external partners.

Tutor — QBUS3600, QBUS6600, BUSS6002 Jul 2022 – Jun 2024
University of Sydney
Consistently >90% positive student feedback across all categories.

Marker — PHYS4016: Bayesian Data Inference and Machine Learning
University of Sydney

Community & Service

UNSW AstroStats Club — Instructor and Organiser Jan 2026 – Present
UNSW Sydney

- Design and deliver workshops on Bayesian inference and ML for PhD students and research staff.
- Materials publicly available: github.com/ConaireD/UNSW_Astro_Stats_Club

Early Career Researcher Representative 2024
UNSW Sydney
Represented ECR interests within the astronomy department and attended faculty meetings

Astronomy Journal Club — Organiser Q3 2023 – 2024
UNSW Sydney
Organised and ran the weekly astronomy journal club for the department.

Affiliations

- Member, NEarby Worlds and Their Stars (NEWTS) Research Group
- Science Team Member, TOLIMAN Space Telescope Project

Technical Skills

Programming:	Python (advanced), LaTeX, Fortran, IDL
Statistics / ML:	Bayesian inference, Gaussian processes, Fisher information, transformers, contrastive learning, representation learning, recurrent neural networks, anomaly detection
Computing:	High-performance computing, Linux, Git/GitHub

References

Available upon request.

Last updated: February 2026