Caden Phillips

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MPhys Astrophysics student at the University of Liverpool with research interests in neutron stars, gravitational waves, and computational astrophysics. Experienced in theoretical modelling of compact objects through both collaborative and independent research projects. Proficient in Python and scientific computing tools for data analysis and simulation.

Education

University of Liverpool *Expected 2027*
MPhys Astrophysics
Academic Advisor: Dr. Christopher Copperwheat
Current average: XX%
Key Modules: Physics of Galaxies, Advanced Observational Astrophysics, Physics of Planets, Relativity and Cosmology

Greenhead College *2021–2023*
A Levels: Physics (B), Chemistry (B), Mathematics (C)

Research Experience

Physics Internship, Institute of Nuclear Physics (IFJ PAN), Kraków, Poland *July-August 2025*
Supervisor: Dr. David Álvarez Castillo
Project: Physical Inputs for Simulations of Gravitational Wave Emissions from Compact Stars within the Einstein Telescope Detection Range

- Applied a Fisher Information Matrix framework to estimate tidal deformability uncertainties and assess their propagation in binary neutron star systems.
- Developed and implemented a Tolman–Oppenheimer–Volkoff (TOV) solver to compute mass–radius and tidal deformability relations for hybrid equations of state.
- Compared theoretical models with GW170817 observations to assess equation-of-state viability.
- Presented project results jointly with a fellow intern at the IFJ PAN Summer Internship Symposium 2025.

Gained experience in theoretical modelling and data analysis in a collaborative international research environment, strengthening problem-solving and computational skills using Python.

Full internship report available upon request.

Teide Observatory, Tenerife, Spain *June 2025*
Supervisor: Dr. Daniel Harman
Project: Week-long field work at Teide Observatory

- Conducted observations using the 0.8 m IAC-80 telescope, as well as a Celestron C14 Edge HD system with a QHY-163M/C CMOS detector.
- Took multi-band exposures and used these to construct composite images and Hertzsprung–Russell diagrams.

Gained practical experience at a professional research observatory, operating the 0.8 m IAC-80 and a C14 telescope and performing data, image, and photometric analysis to construct Hertzsprung–Russell diagrams.

Independent Study – Rotating Neutron Star Modelling   *Autumn 2025–ongoing*
Self-directed follow-up research after IFJ PAN internship

- Investigated the effects of stellar spin on neutron star structure, extending previous TOV-based models which neglect rotation.
- Used **RNS** and **LORENE** frameworks to model rapidly rotating neutron stars under different equations of state.
- Developed a **C++ program** to analyse how varying mass, radius, and rotational frequency influence relativistic stability limits within **RNS** and **LORENE**.

Increased theoretical and computational skills through independent research, demonstrating initiative and the ability to apply advanced modelling frameworks to complex astrophysical systems. Developed a C++ program to automate RNS and LORENE runs over varying mass, radius, and rotational frequency.

Technical Skills

- **Programming & Tools:** Python (NumPy, Matplotlib, Astropy), C++, Bash, ROOT, LaTeX, Jupyter Notebook, RNS, LORENE
- **Scientific Methods:** Fisher matrix estimation, TOV equation modelling, gravitational-wave parameter inference
- **Languages:** English (native), conversational Portuguese

Research Outputs

- **Internship Report:** "*Physical Inputs for Simulations of Gravitational Wave Emissions from Compact Stars within the Einstein Telescope Detection Range*," Institute of Nuclear Physics (IFJ PAN), Kraków, 2025.
- **Project Presentation:** "*Gravitational Wave Emissions from Compact Stars within the Einstein Telescope Detection Range*," presented with a fellow intern at the IFJ PAN Summer Internship Presentations 2025 (Slides online).

Awards & Achievements

- Awarded competitive summer internship placement at IFJ PAN (Poland) through PHYS309 Internship Module.

Memberships

- Associate Member, Institute of Physics (IOP)   *since 2023*

Interests

Astrophysics (particularly compact objects and gravitational waves); hiking and astrophotography.

References available upon request.