Sydney Institute for Astronomy

Undergraduate Research Opportunities

WHAT IS ASTRONOMY RESEARCH?

Astronomers ask really big questions:

- Where did the Universe come from?
- How do galaxies form?
- Is there life beyond the Solar System?

To answer these questions, we observe the sky with telescopes; run supercomputer simulations; perform complex calculations; build and test astronomical instruments, and bring all of this together in research publications. In the Sydney Institute for Astronomy we study the Sun, exoplanets and stars, galaxies, black holes and the early Universe.

In your research project, you'll get to work in a team of astrophysicists solving real problems at the forefront of science.

- Astronomy research in your degree
- Contact us about projects
- Other opportunities

> **"I had the opportunity to study kinematic properties of stars in our Milky Way Galaxy, which reveal the signature spiral arms, corroborating analytical models with increasingly accurate observational data. I am excited to be continuing my research in a PhD program in the UK."**

Maria Djuric

2021 Physics Honours Student
Bok Prize
(for best Honours project by a student at an Australian university)

Credit: Alex Cherney

HOW CAN YOU DO ASTRONOMY RESEARCH IN YOUR DEGREE?

You can do astronomy research within a Physics Major, as part of your science degree. Starting in 2023, we also offer an Astrophysics Program, which includes a Physics Major plus additional units exploring an area of study in greater depth. In both of these, students can do astronomy research in their senior year.

Dalyell Scholars (ATAR 98+) and those in the Special Studies Program (92+ in HSC Physics) have opportunities earlier in your degree, as follows:

FIRST YEAR PHYSICS

PHYS1904 Physics 1B (SSP)
Work on an astrophysics research project with a small group of students. Three hours per week, replacing the project in the experimental lab.

SCDL1991 Science Dalyell showcase
Investigate a scientific question led by a senior undergraduate mentor, supported by an academic expert. You'll give a final presentation to share your discoveries.

SECOND YEAR PHYSICS

PHYS2921 Physics 2A (SSP)
PHYS2922 Physics 2B (SSP)
PHYS2923 Astrophysics and Relativity (SSP)
During each of the above units you will work on an individual research project, mentored by one or more academic research staff for around 3 hours per week, replacing work in the lab. At the end of the project you will give a presentation and write a report on your research.

THIRD YEAR PHYSICS

PHYS3888 Physics Interdisciplinary Project
You'll work in a project group for around 4 hours per week to tackle an interdisciplinary problem, e.g. using machine learning or data science to explore an astronomy dataset. At the end giving a presentation and report describing your results.

SCDL3991 Science Dalyell Individual Research Project
Get a first-hand experience of cutting-edge research by working in an astrophysics research group contributing to answering a novel research question, e.g. making theoretical predictions, exploring new astronomy data, or modelling an astrophysics phenomenon. You get to present your results in a scientific seminar and report.

PHYSICS HONOURS*

Tackle a substantial year-long astrophysics research project as the first step towards a research career, or to gain advanced training in problem solving and data analysis skills to take into industry. Focusing on unsolved problems in astrophysics, many students end up publishing one or more scientific papers based on their Honours thesis work.

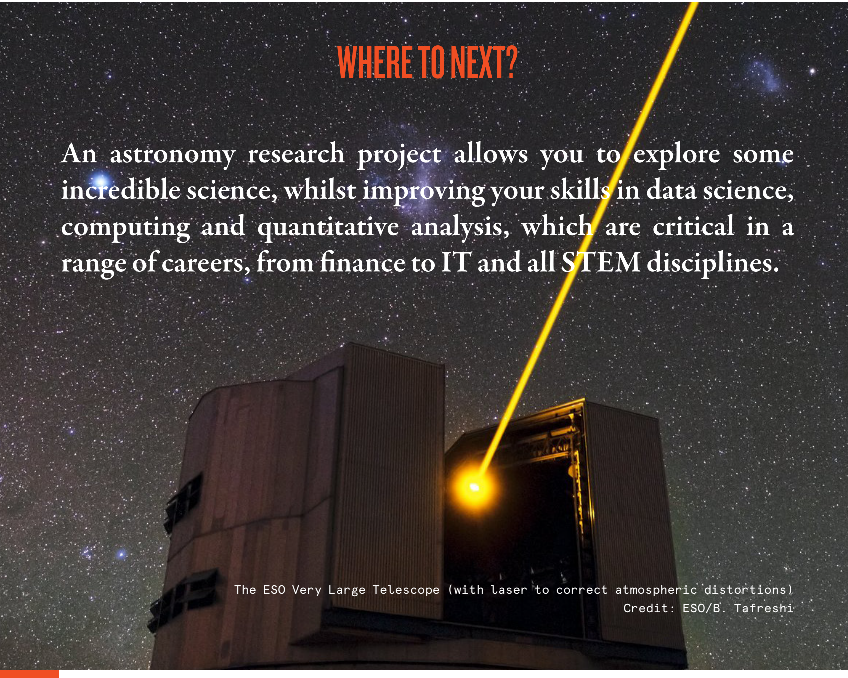
SUMMER VACATION SCHOLARSHIPS

Gain research experience over the summer break with a paid vacation scholarship aimed at high performing students. You will work for 5 weeks (full time) within SIfA over the Jan/Feb break.

* To enter Honours you usually need a credit (65) average across Senior Physics, as well as a WAM of at least 65 or above. Contact the Honours coordinator to discuss alternative paths.

WHERE TO NEXT?

An astronomy research project allows you to explore some incredible science, whilst improving your skills in data science, computing and quantitative analysis, which are critical in a range of careers, from finance to IT and all STEM disciplines.



The ESO Very Large Telescope (with laser to correct atmospheric distortions)
Credit: ESO/B. Tafreshi

CONTACT US ABOUT PROJECTS

Tim Bedding studies oscillations in stars ("starquakes") to reveal details about their interiors. He uses data from NASA's Kepler and TESS spacecraft to measure the ages of stars and understand their internal structure, including those with exoplanets.

Joss Bland-Hawthorn builds models of the Milky Way with the goal of understanding how it formed and evolved over billions of years. He is an expert in Galactic archaeology, a field that concentrates on the oldest stars.

Céline Boehm is an astroparticle physicist working at the interface of particle physics, astrophysics and cosmology. She is trying to discover what dark matter is made of.

Julia Bryant examines how gas gets into galaxies. She is Director of the Astralis-USydney labs where new optical and mechanical devices are developed into novel astronomical instruments for large telescopes. She leads the Hector Galaxy Survey team in which images of galaxies in '3-D' help to understand how galaxies form and evolve.

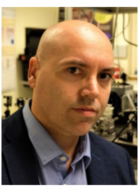
Manisha Caleb is engaged in surveys and studies of the dynamic radio sky with telescopes like MeerKAT and ASKAP, to discover new transients. She is an expert in fast radio bursts and their multi-wavelength follow-up.

Scott Croom explores galaxy evolution and cosmology. He leads the SAMI Galaxy Survey, using an instrument developed by SIfA with the Australian Astronomical Observatory. He is an expert in black holes and quasars, and their role in galaxy formation.

Anne Green is engaged in radio astronomy surveys of star-forming complexes and astrophysical masers as well as searching for cosmic sparklers. She is an expert in radio supernova remnants - the shocks that live on after massive stars die.

Dan Huber studies the fundamental properties of exoplanets and the stars that host them, by combining observations from ground-based telescopes and NASA Missions. He also conducts research on the structure and evolution of stars and stellar populations in our galaxy.

Helen Johnston conducts research into stellar remnants like neutron stars and black holes, particularly those in binary star systems. She also studies the supermassive black holes at the centres of galaxies.



Sergio Leon-Saval develops optical and photonic instruments for cubesats, for astronomical telescopes and for commercial applications. He is Director of Sydney Astrophotonic Instrumentation Laboratory (SAIL), the experimental arm of SIfA.

Geraint Lewis explores the dark side of the Universe. With galactic cannibalism and gravitational lensing he maps dark matter throughout the cosmos, and with synthetic universes, he hunts for signs of new physics beyond standard cosmology.

Don Melrose is a theoretical physicist who builds complex models of energetic processes in the Universe. He studies phenomena such as solar outbursts, pulsar activity and relativistic plasmas in astrophysical jets.

Tara Murphy studies some of the most energetic sources in the sky including gamma-ray bursts and supernovae using new radio telescopes like ASKAP and the MWA. She leads the radio follow-up of gravitational wave events that occur when neutron stars merge.

John O'Byrne has been engaged in high resolution imaging, interferometry and photonic developments, but also has interests in astronomy education.

Elaine Sadler studies the coevolution of massive galaxies and their central black holes. She also searches for neutral hydrogen gas around distant galaxies to learn about the fueling process of star formation.

Peter Tuthill develops novel technologies to image the theatres of stellar birth and death, revealing the cradles of solar system formation. He also leads a space telescope project to find exoplanets around stars in our immediate galactic neighborhood.

Mike Wheatland builds complex models of solar flares and solar activity, and examines the plasma interaction between the Earth and the Sun. He also constructs computational models of mechanical devices.

OTHER OPPORTUNITIES TO STUDY ASTRONOMY

The field plate of the Hector instrument mounted on the Anglo-Australian Telescope
Credit: Jesse van de Sande & the Hector Team

Astrophysics Program – Core Units

PHYS2013/2913/2923 Astrophysics and Relativity

PHYS2014/2914 Data Science in Astronomy

You can also study astronomy in the following Units of Study

OLET1636 Astronomy: from Earth to Exoplanets

OLET1638 Astronomy: from Stars to Black Holes

OLET1640 Astronomy: from Big Bang to Darkness

PHYS3037/3937 Astrophysics and Plasma Physics

PHYS4122 Astrophysics and Space Science

PHYS4123 General Relativity and Cosmology

> "Studying astronomy allows us to explore and understand the Universe. This ranges from studying the Universe's exponential expansion to the formation and evolution of solar systems, galaxies and entire galaxy clusters. There is no other subject that offers such depth."

Charlie Sharpe

2021 Physics Honours Student