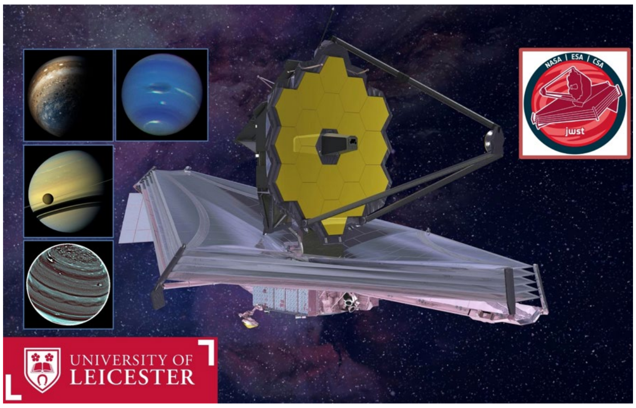
Giant Planet Origins from the James Webb Space Telescope

- **Determine the bulk elemental and isotopic composition of Solar System Giant Planets to constrain planetary origins.**
- **Exploit Leicester's role in the James Webb Space Telescope MIRI instrument to get unique access to new data.**
- **Learn how to acquire, analyse, and interpret observations from JWST and ground-based facilities.**

Level	PhD
First Supervisor	Leigh Fletcher
Second Supervisor	Henrik Melin
Application Closing Date	19 January 2022
PhD Start date:	26 September 2022

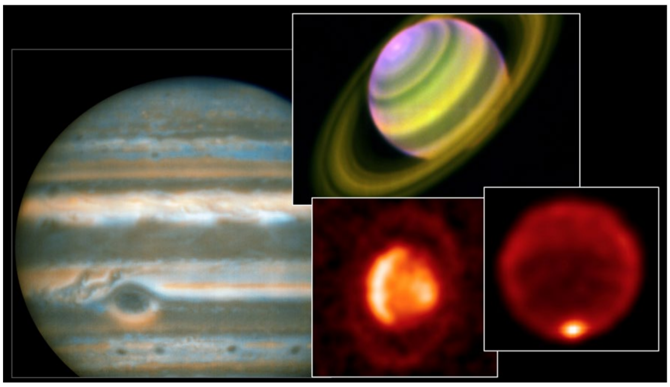
Project Details:

The James Webb Space Telescope (JWST) will be the premier observatory for infrared astronomy and planetary science for the coming decade. Researchers at the University of Leicester were directly involved in the development of the MIRI instrument (5-30 micron spectroscopy in the mid-infrared), and Leicester planetary scientists have unique access to guaranteed-time observations of all four giant planets, to be acquired during the first year of operations (2022-23). We expect to obtain a rich new dataset, consisting of high-resolution spectroscopic maps of all four giants, supported by images from ground-based observatories.



The James Webb Space Telescope Giant Planet Programme

These will be used to study the meteorology and chemistry of these worlds, but are also able to offer new insights into the bulk composition of their atmospheres. By comparing how the elemental abundances and isotopic ratios vary as a function of distance from the Sun, we can place constraints on the primordial reservoirs of icy and rocky material accessible to the forming protoplanets. The PhD candidate will explore the distribution of carbon, nitrogen, sulphur, and deuterium using state-of-the-art spectroscopic inversion techniques, coupled with the development of sophisticated data reduction pipelines for this world-class facility.



Cutting-edge mid-infrared imaging of the four Giant Planets from VLT

The PhD candidate would be welcomed to a team of planetary atmospheres researchers at Leicester, to be trained in inversions of infrared spectroscopy to extract useful information on temperatures, chemical distributions, clouds, and atmospheric dynamics. The student will use a well-developed suite of radiative transfer and spectral inversion tools (known as NEMESIS) to compare previous spacecraft observations to the highly-anticipated new data from JWST. Through these studies, the student will gain skills in processing and manipulating spacecraft data, extensive software development, and will have the opportunity to engage with the wider community of planetary observers across the globe.

Further information on how to apply and funding can be found [HERE]

JWST observations will be supplemented by a campaign of ground-based supporting observations from world-leading facilities (e.g., observatories in Chile and Hawaii). Given the risks involved with the JWST mission, this studentship can also be undertaken with existing spacecraft and ground-based data.

With Leicester's current involvement in Juno and JWST, and future involvement in the Jupiter Icy Moons Explorer (JUICE) and Ice Giant missions, this Planetary Science PhD project offers the potential for exciting new discoveries on the giant planets. Successful PhD candidates would have some prior background in coding, as they will be using Fortran, IDL, and Python-based packages on Leicester's High-Performance Computing facility. Some prior knowledge of planetary atmospheric science and radiative transfer is desirable.

References:

1. Fletcher et al. (2021), The JWST Giant Planet Atmospheres Programme, https://doi.org/10.5194/epsc2021-39, 2021.
2. Press releases on Leicester involvement in JWST Jupiter (https://go.nasa.gov/3bADQPt) and Saturn (https://go.nasa.gov/3i2plpT) observations.
3. D. Andrews, An Introduction to Atmospheric Physics, Cambridge University Press
4. Atreya et al. (2020), Deep Atmosphere Composition, Structure, Origin, and Exploration,

   https://arxiv.org/abs/2006.13869
5. P.G.J. Irwin, Giant Planets of our Solar System, Springer-Praxis