UNIVERSITY OF LEICESTER

A Chemical Inventory of the Giant Planets with JWST

• Giant planet atmospheres provide a time capsule for exploring planetary origins, and a laboratory for planetary weather. • Exploit cutting-edge JWST infrared spectroscopy to measure temperatures, clouds, and composition. • Join an ERC-funded team to study the Outer Solar System with JWST infrared spectroscopy.	**Level**	PhD
	First Supervisor	Prof. Leigh Fletcher
	Second Supervisor	Prof. Jonathan Nichols
	Application Closing Date	17th January 2027
	PhD Start date	27th September 2027

Project Details:

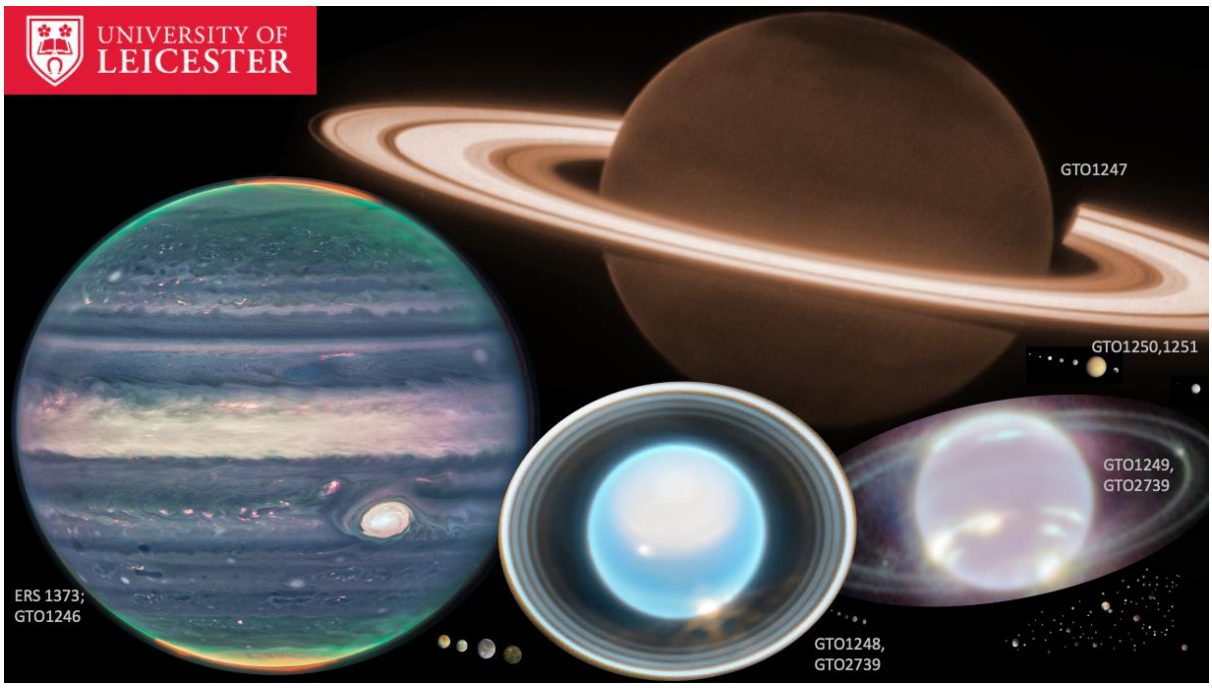
Infrared observations from the James Webb Space Telescope (JWST) have rapidly become a cornerstone in the current era of Solar System exploration, and Leicester planetary scientists have been leading the exploration of the four giant planets. The Gas and Ice Giants provide planetary-scale laboratories for studying Solar System origins and evolution; weather, chemistry, and clouds; and the coupling of atmospheres to magnetospheres via auroras.

This PhD will use the exquisite sensitivity and spectral coverage of JWST to map Jupiter, Saturn, Uranus and Neptune to constrain and compare their atmospheric composition: from key elements like carbon, nitrogen, sulphur, phosphorus and oxygen, to isotopic ratios, to the complex blend of hydrocarbons high in their stratospheres. These provide a window onto the reservoirs of dust, ice, and gas that were present as the giant planets first formed, using giant planet composition as a time capsule for the earliest era of our Solar System.

The student will join the Planetary Atmospheres team within the School of Physics and Astronomy, supported by a European Research Council (ERC) grant known as "JWSTVoyager." This PhD will train the student in using cutting-edge spectroscopic data to characterise the atmospheres of giant planets. It is likely that the student will initially focus on the composition of Uranus and Neptune, as the least well-studied worlds. After that, the PhD is open-ended: sophisticated radiative transfer and spectral inversion software anchors the PhD training, and will be used to extract environmental properties from data (e.g., temperatures, gaseous distributions, and aerosols), but the student will then be able to pursue their own novel discoveries using the results.

The student will join a team with expertise in using ground-based observatories, space-based telescopes, and visiting spacecraft (Voyager, Cassini, Juno, and JUICE). In particular, Leicester led the first JWST observations of the giant planets and has acquired new data every year. The student will gain skills in data acquisition and reduction, radiative transfer and spectral retrieval, and interpretation via dynamical and chemical models. This is a computationally intensive project, and candidates will be expected to be proficient in coding (especially Python).

Images:



JWST NIRCAM views of the four giant planets in 2022-23, shown approximately to scale with their major satellites. Programme numbers are provided for the datasets, which include the NIRSpec and MIRI spectroscopy required for the planetary atmospheres research proposed here. *Credit: NASA, ESA, STScI, compilation by L.N. Fletcher.*

Further Reading:

- Find out more about the Planetary Atmospheres team at https://leighfletcher.github.io/
- Read about some of the latest discoveries at https://leighfletcher.substack.com/
- JWST: New Infrared Eye on the Solar System: https://www.europlanet-society.org/europlanet-magazine/issue-3/jwst-solar-system/
- G. L. Villanueva & S. N. Milam (2023), A new era in solar system astronomy with JWST, doi: https://doi.org/10.1038/s41467-023-43313-z
- Fletcher et al. (2023), Saturn's Atmosphere in Northern Summer Revealed by JWST/MIRI: https://doi.org/10.1029/2023JE007924
- Melin et al. (2025), Discovery of H_3^+ and infrared aurorae at Neptune with JWST: doi: https://doi.org/10.1038/s41550-025-02507-9
- Harkett et al. (2024), The Thermal Structure and Composition of Jupiter's Great Red Spot From JWST/MIRI: doi: https://doi.org/10.1029/2024JE008415
- A. Sanchez-Lavega, An Introduction to Planetary Atmospheres, CRC press – for general introduction to planetary atmospheres.

Further Details:

- **Proposed Funding Source: ERC**
- **Proposed Start Date:** 27th September 2027 for 4 years.
- **Closing Date:** 23:59 Sunday 17th January 2027.
- **Eligibility:** UK. International applicants must show that they can cover the fee difference between UK/International costs (~£16k/year).
- **Entry requirements:** Applicants are required to hold/or expect to obtain a UK Bachelor Degree 2:1 or better in a relevant subject. The University of Leicester English language requirements apply where applicable.
- **Application enquiries to pgradmissions@le.ac.uk**

Further information on how to apply and funding can be found here