Circulation of the Giant Planets from Infrared Remote Sensing

Project Description

Despite four decades of planetary exploration, the physical and chemical processes responsible for the banded appearance of the giant planets remain mysterious. Observations from NASA’s Juno mission at Jupiter, and ground-based microwave observations of the Ice Giants, have revealed that the belts and zones extend to great depths, well below the visible cloud tops. In addition, our long-term programme of ground-based infrared observations has shown that the belts and zones undergo dramatic variations on periodic timescales, evidence for non-seasonal atmospheric cycles on the the giant planets. This PhD project would utilise a suite of radiative transfer and spectral inversion tools to investigate the atmospheric circulation of the giants as a function of depth, latitude, and time, comparing ground- and space-based observations to the predictions of radiative-climate models.

The PhD candidate would join a group of planetary atmospheres researchers at the University of Leicester, and be part of a wider international team exploring the giant planets. The project would initially focus on the Gas Giants, Jupiter and Saturn, to test the hypothesis that the circulation patterns alter as a function of depth into the planet (the “stacked cells” hypothesis) - this will be accomplished via a combination of existing spacecraft measurements (Juno at Jupiter, Cassini at Saturn) and new ground-based observations (primary from the VLT in Chile and the IRTF in Hawaii). The remote sensing would focus in particular on the distribution of ammonia (a key condensible) and phosphine (a disequilibrium species tracing atmospheric mixing), as measured in the mid-infrared and sub-millimetre spectral ranges. What we learn at Jupiter and Saturn could then be applied to the Ice Giants, Uranus and Neptune, as this team leads early observations of these targets from the forthcoming James Webb Space Telescope (JWST). Those data should become available during the latter half of this PhD thesis, and the tools developed using Juno/Cassini data could reveal new insights into the belt/zone pattern of the Ice Giants.

With Leicester’s current involvement in Juno and JWST, and future involvement in the Jupiter Icy Moons Explorer (JUICE), this 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. Opportunities may exist for ground-based observations, as well as dissemination or research at national and international scientific conferences.
Belt and Zones of Jupiter and Saturn
Contrasting the banded structure of Jupiter and Saturn using images from the Cassini spacecraft.

Jupiter’s bands in visible and infrared light
The temperature, composition, and aerosol properties of Jupiter’s bands as revealed in reflected sunlight (left), the mid-infrared (centre), and the near-infrared (right) from the VLT in Chile.

References

Application Instructions
When applying, please ensure we have received all of the following required documents by Wednesday 29th January 2020:

- Submit an online application form https://le.ac.uk/study/research-degrees/funded-opportunities/stfc-studentships
- 2 academic references
- STFC Research Interests Form
- CV
- Undergraduate transcripts
  - If you have completed your undergraduate degree, we will also require your undergraduate degree certificate
  - If you have completed a postgraduate degree, we will also require your transcripts and degree certificate
If we do not have the required documents by the closing date, your application may not be considered for the studentship.