Ultra-low frequency waves in the terrestrial magnetosphere

Project Description

Magnetohydrodynamic (MHD) waves are a ubiquitous phenomenon in astrophysical plasmas. Within the Terrestrial space environment, such waves manifest themselves as Ultra low frequency (ULF) waves with periods ranging from tens to thousands of seconds. Such waves are a major conduit of energy and momentum in the dynamic interaction between the solar wind and the interplanetary magnetic field and the terrestrial space environment. As such they are of intrinsic scientific interest, but also of societal and commercial importance as they form an important part of the space weather processes which impact on, for example, space hardware and communications systems.

Recent ULF wave research at Leicester has used in-situ spacecraft data to directly map the plasma mass density in the terrestrial magnetosphere. This density, along with the magnetic field strength, determines the wave propagation speed (Alfven velocity), and hence the standing wave frequencies (Image 1).

This project will explore its implications for the frequency, propagation and characteristics of ULF waves. We have also developed analysis techniques to use ground-based measurements of the wave frequency (Image 2) to remote sense these plasma mass distributions (so-called magnetoseismology).

This project will use these techniques to provide a comprehensive dataset characterising the plasma distributions and ULF wave fields in the terrestrial magnetosphere, and will also exploit spacecraft measurements of the energetic particle populations in the Earth’s radiation belt regions, which are known to provide both sources and sinks of wave energy.

The project will provide an extensive analysis of ULF wave data to relate the observed wave modes with the geomagnetic conditions. Subsequent investigations will compare the wave characteristics with spacecraft measurements of the energetic particle populations which can excite them, using, for instance data from the twin spacecraft of the NASA van Allen probes mission and from the JAXA ARASE spacecraft. The project will provide a wide variety of research skills to enable a successful future career in space science and a wide variety of other areas.
Predicted ULF wave frequencies
Predicted ULF wave frequencies in the equatorial plane (left) and on the Earth’s surface (right) for 2 plasma density models (from Sandhu et al., 2018)

Ground-based ULF wave analysis
Cross-phase analysis of an interval of IMAGE magnetometer data. (i) timeseries data (ii) calculated cross-phase (iii) automated identification of harmonic structures in the cross-phase (from Wharton et al., 2018).

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](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.