Magnetospheric Ultra-low Frequency Waves

T. Elsden[1], A. N. Wright [1]

[1] *School of Mathematics and Statistics, University of St Andrews, St Andrews, UK*

Ultra-low frequency (ULF) waves are oscillations of Earth's magnetic field with frequencies of ~1mHz – 1Hz, and represent the lowest frequency and largest scale waves of the magnetosphere. Such waves were first discovered following the Carrington event of 1859, through periodic pulsations recorded in ground magnetic field data. Driven predominantly by the interaction of the inhomogeneous solar wind with the magnetopause, they transport momentum and energy throughout the magnetosphere. In doing so, they critically affect several aspects of magnetospheric dynamics: they couple different magnetospheric regions together through the coupling of different wave modes; they drive electric currents responsible for some auroral emission as well as driving currents on the ground which can affect power grids; they can be used as a remote sensing tool to infer plasma properties in space (magnetoseismology); they interact with energetic particles trapped in Earth's magnetic field which form the radiation belts.

In this talk, I will give a brief historical account of ULF waves before moving on to the main area to which I have contributed, namely the topic of field line resonance (FLR). Referred to as resonant absorption in a solar coronal context, this is a fundamental magnetohydrodynamic (MHD) wave process whereby global compressional waves couple locally to transverse waves. This occurs at the location (magnetic field line) where the natural Alfven frequency matches the global (fast) wave frequency. Due to the resonant nature of this process, a significant amount of energy can be deposited locally (at the resonant set of field lines). I will discuss recent computational results which have established how this process works in a fully 3D inhomogeneous medium. Furthermore, I will comment on the potential implications of these new results for wave-particle interactions in Earth's radiation belts.