RSPP seminars

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"Probabilistic ULF models: how do they improve our understanding of the physics?"

Twenty-first century life is highly dependent on satellite services, which are at risk from the hazardous radiation belt environment. Ultra-low frequency waves (ULF, 1-10 mHz) are large-scale plasma waves, predominantly driven by the solar wind. These waves are responsible for the radial transport and energisation of electrons in Earth's radiation belt, and are therefore essential components of radiation belt modelling. Current models of ULF waves and the resulting radial diffusion are deterministic, producing a single output for each set of input parameters.

Meanwhile, probabilistic modelling is used heavily in weather and climate models to improve forecasting. These methods capture some of the uncertainty inherent in a complex system, accounting for the effects of sub-scale processes and accurately representing the full range of possible physical states more faithfully than by solely using the mean or median. We aim to apply these methods to better determine the impact of ULF waves on Earth's radiation belts.

Firstly, we use a machine learning technique (a decision tree) to predict ULF wave power in the magnetosphere, with carefully chosen settings to reduce common data analysis difficulties in space physics such as interdependence and bias. Secondly, we analyse distributions of power spectral density for both ground-based magnetometers and the corresponding in situ observations. Unexpected differences between distributions seen on the ground and in space give us insights into the generation and propagation of ULF waves in the magnetosphere. This suggests upper limits to the ability of the magnetosphere to support ULF waves and hence limits to radial diffusion, while the types of distribution may have consequences for probabilistic modelling.

Wednesday, January 22nd at 2 pm in Physics LTC