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Interpretable Models for Understanding Planetary Space Environments: Bayesian Views of Mars' Magnetic Environment

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Recent planetary science missions are returning increasingly large datasets. The data volumes generated by modern missions have necessitated the use of data science methods, including machine learning to engage in data analysis. It is advantageous to use these data-intensive methods to study planetary systems as they provide new system-wide perspectives. However there are several challenges that create difficulties when engaging in the scientific process with currently available data and methods. First, planetary science data, much like other data from natural systems, is inherently spatio-temporal, of multiple resolutions, and contains uncertainty. This creates a barrier for data processing when using traditional machine learning methods. Second, many planetary science questions require the use of interpretable models to pursue inference. In other words, answering these questions requires models that follow some underlying physical rules or constraints, or otherwise simple functional form that allows for human understanding of the model's form and outputs. This presentation will provide an overview of these challenges before discussing a recent application of Bayesian methods to quantify the spatio-temporal nature of Mars' magnetic field environment. This environment is shaped by the competing influences of spatially variable crustal fields and the temporally variable solar wind. This project aims to provide a quantified understanding of Mars' solar wind interaction.