Understanding Space Weather And Our Ability To Predict Its Impacts

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Space weather refers to the changing plasma conditions in near-Earth space that can have a range of impacts on our modern society. The solar wind is highly structured, and when this meets the Earth's magnetic field, disturbances can lead to a chain of events that have an impact on the ground, including power grid blackouts, satellite damage, increased radiation, and the aurora. Large solar events, such as flares and coronal mass ejections are known for their space weather impact, although less is known about the full range of plasma processes involved (turbulence, reconnection, shock properties, instabilities, plasma mixing, particle scattering, etc.) and prediction capabilities are currently severely inadequate for being able to adequately protect our society from some of its more harmful effects. There is much to work on to improve this from both observation and simulation approaches, starting from understanding the role of fundamental plasma processes in space weather, to developing large-scale prediction models.

Examples of projects include:

- Investigating the more complex and less well-understood role of the smaller-scale plasma processes, such as turbulence and instabilities in the solar wind, on space weather impacts
- Data science approaches, such as machine learning, to develop empirical approaches to making sense of the complexity of plasma process occurring together throughout the space weather chain of events from Sun to Earth
- Developing tools to improve space weather model predictions and understand fundamental limits on the predictability of this, based on fundamental plasma principles

All projects will involve aspects of spacecraft data analysis from various international space missions throughout the solar system, numerical simulations of space weather, plasma physics theory, and data science techniques, although the balance can be tailored to the project.