

Exploring Solar System Plasmas Using In Situ Spacecraft Observations

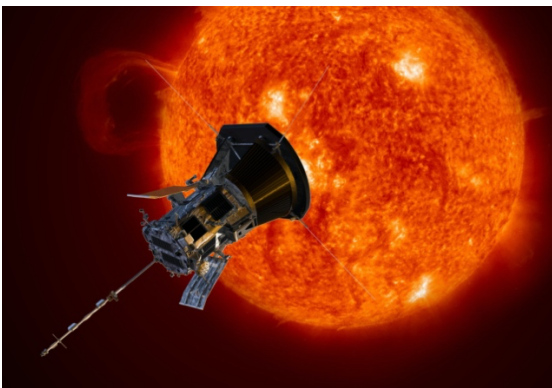
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In the last few decades, our knowledge of the physical processes occurring throughout the universe has been dramatically enhanced through the availability of spacecraft observations. In particular, in situ measurements – where spacecraft fly directly through the system of interest allow unprecedented understanding of the underlying physical mechanisms involved. The vast majority of the universe is in a plasma state, so in situ measurements of solar system plasmas allow us to probe the processes relevant to a variety of astrophysical situations. These include plasma waves, turbulence, instabilities, shocks, magnetic reconnection, particle acceleration, and kinetic plasma physics. Now is an ideal time to get involved in this field, with several spacecraft entering their prime mission phase (many of which we are team members of at QMUL) and many more planned for the future.

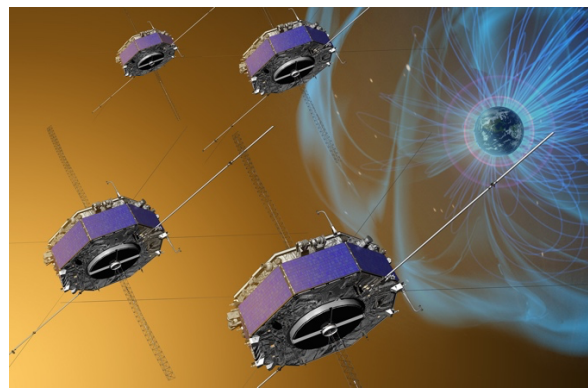
Examples of projects include:

- Using data from Parker Solar Probe and Solar Orbiter – two spacecraft just beginning to explore the solar corona and inner heliosphere in situ for the first time, to study turbulence/instabilities and the role they play in the origin of the solar wind.
- Exploring the outer edges of the heliosphere (the region of our galaxy dominated by the Sun's magnetic field) and directly probing plasma processes in the interstellar medium for the first time using the latest data from the two Voyager spacecraft.
- Probing the detailed fundamental plasma physics of near-Earth space using precision measurements from spacecraft such as Magnetospheric Multiscale, e.g. magnetic reconnection at the magnetopause, particle acceleration at the bow shock upstream of Earth.
- Studying the link between the multiple plasma processes occurring at multiple scales using spacecraft throughout the solar system.

All projects will involve comparison with theory and numerical simulations to understand the fundamental plasma physics and astrophysical context of the results.



Parker Solar Probe in the Sun's atmosphere



MMS spacecraft in the Earth's magnetosphere