

Objective 2: How do solar transients drive heliospheric variability?

The dynamic Sun exhibits many forms of transient phenomena, such as flares, CMEs, eruptive prominences, and shock waves. Many directly affect the structure and dynamics of the outflowing solar wind and thereby also eventually affect Earth's magnetosphere and upper atmosphere, with significant consequences for society through hazards to, for example, space-based technology systems and surface power systems. Understanding these impacts, with the ultimate aim of predicting them, has received much attention during the past decade and a half under the banner of 'space weather.' However, many fundamental questions remain about the physics underpinning these phenomena and their origins, and these questions must be answered before we can realistically expect to be able to predict the occurrence of solar transients and their effects on geospace and the heliosphere. These questions are also pertinent, within the framework of the 'solar-stellar connection,' to our understanding of other stellar systems that exhibit transient behavior such as flaring (e.g., Getman et al. 2008).

Solar Orbiter will provide a critical step forward in understanding the origin of solar transient phenomena and their impact on the heliosphere. Located close to the solar sources of transients, Solar Orbiter will be able both to determine the inputs to the heliosphere and to measure directly the heliospheric consequences of eruptive events at distances close enough to sample the fields and plasmas in their pristine state, prior to significant processing during their propagation to 1 AU. Solar Orbiter will thus be a key augmentation to the chain of solar-terrestrial observatories in Earth orbit and at the libration points, providing a critical perspective from its orbit close to the Sun and out of the ecliptic.

In the following sections, we discuss in more detail three interrelated questions which flow down from this top-level question:

How do CMEs evolve through the corona and inner heliosphere? How do CMEs contribute to solar magnetic flux and helicity balance? How and where do shocks form in the corona and inner heliosphere?

- [2.1 How do CMEs evolve through the corona and inner heliosphere?](#)
 - [2.1.1 What are the global structure, initiation, and evolution of CMEs?](#)
 - [2.1.1.1 CME initiation](#)
 - [2.1.1.2 CME structure](#)
 - [2.1.1.3 CME evolution](#)
- [2.2 How do CMEs contribute to solar magnetic flux and helicity balance?](#)
 - [2.2.1 How do CMEs contribute to the global evolution of magnetic flux in the heliosphere?](#)
 - [2.2.2 What is the role of ICMEs in the Sun's magnetic cycle?](#)
- [2.3 How and where do shocks form in the corona and in the heliosphere?](#)
 - [2.3.1 Coronal shocks](#)
 - [2.3.2 What are the properties and distribution of heliospheric shocks?](#)
 - [2.3.2.1 Understand coronal conditions under which the shocks form and determine the interplanetary conditions where they evolve](#)
 - [2.3.2.2 Identify interplanetary shocks and characterise their spatial and temporal evolution](#)
 - [2.3.2.3 Study heating and dissipation mechanisms at shocks with radial distance](#)
 - [2.3.2.4 Identify mechanisms that heat the thermal solar wind particle populations near shocks and determine their energy partition](#)
 - [2.3.3 Resolve the interplanetary shock field and plasma structure down to the spatial and temporal scales comparable and smaller than the typical ion scales.](#)
 - [2.3.4 Shock-surfing acceleration mechanism](#)
 - [2.3.5 Understand the radio emissions from the ICME driven shocks](#)
 - [2.3.6 Identify shock accelerated particles](#)

SAP meeting on Objective 2 (13-14 April 2016) presentations:

David Berghmans: [Generic RS observing sequences for Objective 2](#)

Russ Howard: [CMEs: origin & structure](#)

Robin Colaninno: [Are all CMEs flux ropes?](#)

Miho Janvier: [ICME evolution and properties](#)

Vratislav Krupar: [Radio observations of transients](#)

Daniele Spadaro: [METIS input for discussion on Objective 2](#)