EP 5: Sun and heliosphere I

Time: Wednesday 10:45–12:45 Location: ZEU/0160

Invited Talk EP 5.1 Wed 10:45 ZEU/0160

New insights into the elusive magnetic processes operating in the solar corona with SolO/EUI — •Lakshmi Pradeep Chitta — Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen

The solar corona, million Kelvin hot outer atmosphere of the Sun, is governed by magnetic fields. Streams of charged particles continuously escape this hot atmosphere into the heliosphere as solar wind. Magnetic processes responsible for coronal heating and for powering the solar wind are a subject of active debate for over six decades. With its unprecedented high-resolution, high-cadence view of the Sun, the Extreme Ultraviolet Imager (EUI) onboard the Solar Orbiter mission is shedding new light on the elusive magnetic processes operating in the corona. At closest approach, EUI can provides data with a spatial resolution of about 200 km and a cadence of below 3 s. During the first science perihelion observing campaigns of Solar Orbiter, the EUI instrument imaged untangling of small-scale coronal magnetic braids through reconnection, and subsequent heating of plasma in some active region coronal loops. These observations suggest that magnetic reconnection in coronal loops might be operating on short timescales of a few 10 s and on spatial scales of a few 100 km. The EUI data also revealed ubiquitous high-speed reconnection-driven jets from coronal holes. These jets can channel sufficient heated material to sustain the solar wind mass flux. In this talk, we present these novel observations and discuss the role of magnetic reconnection in the heating of coronal plasma and in the driving of solar wind.

EP 5.2 Wed 11:15 ZEU/0160

Picoflares in the Quiet Solar Corona Observed by the Solar Orbiter — •Olena Podladchikova[1,2], Alexander Warmuth[1], Francis Verbeeck[3], Marco Velli[4], Susanna Parenti[5], Frederic Auchere[5], Astrid Veronig[6], Stefan Purkhart[6], Stefan Hofmeister[1], Udo Schuehle[7], Luca Teriaca[7], Aznar Cuadrado[7], Andrea Battaglia[8], Frederic Schuller[1], and Anik De Groof[9] — [1]AIP, Potsdam, Germany — [2]Kiev Polytechnic University, Ukraine — [3]ROB, Belgium — [4]UCLA, USA — [5]IAS, France — [6]University of Graz, Austria — [7]MPS, Germany — [8]ETH, Switzerland — [9]ESA, Madrid, Spain

On May 30, 2020, the Solar Orbiter High-Resolution Imager (HRIEUV) operating in 174 A being for the first time approximately at 0.5AU to the Sun, registered a large number of sudden heating events so-called campfires with rich morphology and smaller space-time characteristics than nanoflares. We found that campfires emit thermal energy in the picoflares range of $3.4 \times 10^{20} - 9.8 \times 10^{23}$ ergs per event. The relationship between the emission measure and the temperature of campfires can be fitted by the power law covering 1 - 2.7 MK temperature range similar to large X-Ray flares. Their frequency distribution can be fitted by power-law $f(E) \approx E^{2.82\pm0.11}$, but at higher than nanoflares frequencies and lower energy range. The additional previously unaccounted energy input of $\geq 3\sigma$ is 1.0075 percent of the total required power to sustain a quiet solar corona. The observed power law would have to continue to about 1.25×10^{18} ergs in order to fulfill the observed coronal heating requirement.

Invited Talk EP 5.3 Wed 11:30 ZEU/0160

Studying solar flares with the X-ray telescope STIX during the cruise and early science phase of Solar Orbiter — •Alexander Warmuth — Leibniz-Institut für Astrophysik Potsdam (AIP)

Of the six remote-sensing instruments aboard Solar Orbiter, the Spectrometer/Telescope for Imaging X-rays (STIX) is the one dedicated to the study of solar flares. It performs X-ray imaging spectroscopy in the hard X-ray regime, which provides key physical diagnostics on both the hot thermal plasma as well as on the accelerated energetic electrons. During its operation since launch in 2020, which now includes the first year of the nominal mission phase, STIX has detected over 10000 solar flares. The first scientific results based on these novel observations will be discussed. In particular, we will focus on studies that use STIX jointly with other observational assets, such as the other remote-sensing instruments on Solar Orbiter, various X-ray instruments on other spacecraft, and in-situ particle detectors.

EP 5.4 Wed 12:00 ZEU/0160

Joint LOFAR and STIX observations of flare-accelerated electrons in the solar corona — •Malte Bröse — Leibniz-Institut für Astrophysik Potsdam (AIP), Germany

A joint analysis approach is used to study flare signatures both in the low and higher corona. STIX, AIA and LOFAR data provide an extensive picture about different aspects of flare characteristics. Recent data by the STIX instrument complement the picture of accelerated electrons, which propagate along magnetic field lines towards the Sun. These observations are linked to the LOFAR data, which contain information about the elctrons propagating away from the Sun through the corona above the active region. Although, the active region and its thermal evolution (Differential Emission Measure (DEM) reconstruction of AIA data), flare accelerated electrons and their radio traces (LOFAR, STIX) are in principal all associated with the energy release during the flare process, they are often studied seperatly. Hence, the investigation of possible relations is part of this project. Solar magnetic fields as a binding element between low and high corona, accelerated electrons and heated flare loops are included in the analysis via a Potential Field Source Surface (PFSS) model.

EP 5.5 Wed 12:15 ZEU/0160

Exploring the inner heliosphere with combined LOFAR and Solar Orbiter / Parker Solar Probe observations — •Christian Vocks for the LOFAR Solar and Heliospheric KSP-Collaboration — Leibniz-Institut für Astrophysik Potsdam (AIP), Potsdam, Germany

The phenomena of the active Sun, like flares and coronal mass ejections (CMEs), have significant influence on Earth and our technical civilization. This is usually referred to as "Space Weather". Flares and CMEs accelerate electrons and ions to high energies. These particles are studied both remotely by ground- and space-based telescopes, and in situ by spacecraft. Energetic electrons emit radio waves as they move through the coronal plasma. This plasma emission is observed by radio telescopes, e.g. LOFAR. Since the frequency decreases with plasma density higher in the solar atmosphere, and radio waves below 10 MHz cannot pass Earth's ionosphere, spacecraft are needed to continue observations further into interplanetary space. They are also required for measuring energetic particles and observations of X-ray emission in the corona. Therefore, combining LOFAR and spacecraft data provides new insights into the physical processes in the region where the solar corona turns into the solar wind. Parker Solar Probe (PSP) and Solar Orbiter are two missions currently exploring the inner heliosphere. I'll present LOFAR observing campaigns during PSP and Solar Orbiter perihelia, that cover the Sun and it's surroundings by making use of LOFAR's capability of running multiple observing modes in parallel, and show how they connect the corona with the heliosphere.

EP 5.6 Wed 12:30 ZEU/0160

Quasi-discontinuous solar wind solutions — •Lukas Westrich — Ruhr-Universität Bochum, Institute for theoretical physics IV

In this talk the solar wind and its acceleration and heating will be examined. Recently Shergelashvili et al. (2020) developed a new class of discontinuous solar wind solutions. They considered a case of quasi-adiabatic radial expansion with a jump in the flow velocity, density, and temperature but a continuous Mach number at the critical point and derived analytical solutions. Therefore, they proposed a localized external heating source without actual modeling. First I will present the motivation and the physical background for this solutions. After a discussion of this new discontinuous concept for the solar wind, I will develop and discuss continuous numerical solutions, more similar to the classical Parker solar wind model, but with quasi-adiabatic radial expansion with an explicitly formulated localized heating source. This will be done both stationary and dynamically. This kind of solutions can reproduce the analytically derived solutions without discontinuous jumps in the physical properties.