EP 11: Sun and Heliosphere IV

Time: Thursday 13:45–15:45 Location: ZHG101

EP 11.1 Thu 13:45 ZHG101

Magnetic structure of coronal dark halos — •Jonathan Nölke[1], Johann Hirzberger[1], Hardi Peter[1,2], Sami Solanki[1], and Pradeep Chitta[1] — [1]Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany — [2]Institut für Sonnenphysik (KIS), Freiburg, Germany

At low temperatures around 1 MK, distinct regions of the solar corona exhibit emission levels significantly below those of the quiet Sun. A prominent example are dark halos surrounding active regions, which are sometimes misidentified as coronal holes (CH). While the well-studied CHs owe their darker appearance to open magnetic field lines, the formation mechanism of dark halos remains unclear.

On 5 November 2021, Solar Orbiter and the Solar Dynamics Observatory observed the dark halo surrounding active region NOAA 12893. One of its patches overlaps with an adjacent CH, providing a unique opportunity to directly compare the two phenomena.

The magnetic field underneath the dark halo is weaker than in brighter areas. At its outer boundaries, it shows even lower field strengths than those typically found in the quiet Sun. In contrast to the reduced coronal emission at temperatures around 1 MK, at higher temperatures the emission is stronger. This shows a clear difference to CHs, which characteristically exhibit reduced emission at these temperatures. We further demonstrated that unlike the embedded CH, the dark halo patches are magnetically closed.

Our combined EUV and magnetic field observations suggest that dark halos result from reduced heating.

EP 11.2 Thu 14:00 ZHG101

High-resolution observations of small-scale activity in coronal hole plumes — •Ziwen Huang[1], Chitta Lakshmi Pradeep[1], Luca Teriaca[1], Regina Aznar Cuadrado[1], Hardi Peter[1,2], Sami K. Solanki[1], Thomas Wiegelmann[1], and Ferdinand Plaschke[3] — [1]Max Planck Institute for Solar System Research, Göttingen, Germany — [2]Institut für Sonnenphysik (KIS), Freiburg, Germany — [3]Institut für Geophysik und extraterrestrische Physik, Technische Universität Braunschweig, Braunschweig, Germany

Coronal hole plumes, largely radial ray-like structures located in coronal holes, are key targets for studying magnetohydrodynamic waves and solar wind origins. The plume bases are riddled with small-scale transients. We study three plumes within an equatorial coronal hole observed on 13 October 2022 by the High Resolution EUV telescope, part of EUI on board Solar Orbiter. By applying two different identification techniques, we detect tens to hundreds of small-scale brightenings at the plume bases. The statistical analysis of their properties (intensity, lifetime, area, shape, velocity) indicates that the majority of the observed brightenings are characterized by their small-scale nature, transient behavior, and display slightly elongated morphologies near the plume bases. Most of the brightenings appear to move with a velocity component in the plane of sky of less than 10km/s. Their de-projected 3D velocities are found to be substantially lower than the apparent outflow velocities (about 100km/s) detected at greater heights. We propose that the base brightenings may be related to either wave-driven Type I spicules or interchanging reconnections.

EP 11.3 Thu 14:15 ZHG101

Quasi-separatrix-layers channel solar wind outflows in coronal hole — •Kamlesh Bora, Pradeep Chitta, Yajie Chen, and Damien Przybylski — Max-Planck Institute for Solar System Research, 37077 Göttingen, Germany

Observations indicate that small-scale, transient jetlets at the base of plumes and upflows within coronal holes contribute substantially to the mass and energy flux of the solar wind. We use three-dimensional radiation magnetohydrodynamic (MHD) simulations of a coronal hole plume, conducted with the MURaM code, to examine the magnetic origins and driving mechanisms of these upflows/jets in the solar atmosphere. Our simulations show that interactions between the magnetic field of the plume with the surrounding like-polarity magnetic patches creates a strong quasi-separatrix layer (QSL), characterised by a filamentary fine structure. We analyse the resulting plasma flows and temperature structure, comparing them with synthesised 174 Å Extreme Ultraviolet Imager (EUI) emission at this QSL. We noted a transition from cooler downflows in the lower atmosphere to persistent hotter upflows in the corona at the QSL, with a substantial mass flux of $10^{-8} g\ cm^{-2}\ s^{-1}$, that could in principle be channelled as the solar wind outflow. Our simulations go beyond the traditional picture of upflows originating from an interchange reconnection between open and closed field lines, and show the important role of QSLs in the formation of the solar wind.

EP 11.4 Thu 14:30 ZHG101

Insights into the energy partition of solar flares and STIX spectral response calibration via simultaneous X-ray spectral fitting of CH-2 XSM and SO STIX data. — •Jake Mitchell[1], Alexander Warmuth[1], Frederic Schuller[1], Song Tan[1], Fanpeng Shi[1], Bhuwan Joshi[2], and Mithun N.P.S[2] — [1]Leibniz Institute For Astrophysics, Potsdam, Germany — [2]Udaipur Solar Observatory, Udaipur, India

Understanding the energy partition between thermal and non-thermal particles during the flaring process is an essential component in achieving a more holistic view of the physical processes that drive solar flares. Using both PyXspec and the python based Sunkit-Spex we analyse data from a sample of 18 flares selected due to a co-alignment of the Chandrayaan-2 XSM (Solar X-ray Monitor) and the Solar Orbiter STIX instrument. Contemporaneous data from these two instruments enables simultaneous fitting of the relatively soft and hard X-ray spectra respectively. We compare results from individual and simultaneous fits to the XSM and STIX data and investigate the effect of the inclusion of the softer X-rays from XSM into the modelling process whilst also gaining valuable insights into the intercalibration between XSM and STIX.

EP 11.5 Thu 14:45 ZHG101

CoSEE-Cat: the Comprehensive Solar Energetic Electron Event Catalogue — •Alexander Warmuth, Frederic Schuller, Song Tan, and Jake Mitchell — Leibniz-Institut für Astrophysik Potsdam (AIP)

We present a comprehensive catalogue of solar energetic electron (SEE) events derived from joint observations of remote-sensing and in-situ instruments on Solar Orbiter. The Energetic Particle Detector (EPD) is used to characterize the properties of energetic electrons in-situ and obtain injection times at the Sun. Timing, position, and magnitude of corresponding X-ray flares are identified with the Spectrometer/Telescope for Imaging X-rays (STIX), which is complemented by the Extreme Ultraviolet Imager (EUI) which provides additional context on the flare evolution and eruptive phenomena. The Metis coronagraph and the SoloHI heliospheric imager characterize the associated coronal mass ejection. Finally, type III radio bursts detected by the Radio and Plasma Waves (RPW) instrument are used to link the eruptive solar events to the SEE events detected in-situ. We discuss the contents of the catalogue, how the various parameters were determined, and discuss statistical results on SEE events obtained from the catalogue.

EP 11.6 Thu 15:00 ZHG101

STEREO REleASE: Real time solar energetic proton forecasting — •Henrik Dröge[1], Bernd Heber[1], Alexander Kollhoff[1], Patrick Kühl[1], Olga Malandraki[2], and Arik Posner[3] — [1]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, Germany — [2]National Observatory of Athens, Athens, Greece — [3]NASA/HQ, Washington, DC 20546, USA

Sudden Solar Energetic Particle (SEP) events can have a major impact on technology and humans in space. Therefore forecasts and early warning systems working to support those missions are desirable. One example is REleASE, which utilizes the close correlation of near relativistic electrons and the slower but more hazardous protons. The original HESPARIA REleASE system uses electron measurements from SOHO/EPHIN and ACE/EPAM to issue short term warnings before there is a significant flux increase of >20 MeV protons at L1.

We now adapted the method to work with the High Energy Telescope (HET) and the Solar Electron Proton Telescope (SEPT) on board of STEREO-A. The resulting forecasts are publicly available in real time. With now two REleASE systems operational we have the unique possibility to directly compare the forecasts from different points in the heliosphere and test the accuracy depending on the magnetic connection.

Furthermore, we gained valuable insights from adapting the method to the SEPT that uses the magnet/foil technique to separate electrons from ions, which can pose several difficulties.

EP 11.7 Thu 15:15 ZHG101

Evolution of fundamental and harmonic sources in LOFAR type III radio burst images — •Christian Vocks[1], Mario Bisi[2], Bartosz Dabrowski[3], Diana Morosan[4], Peter Gallagher[5], Andrzej Krankowski[3], Jasmina Magdalenic[6], Gottfried Mann[1], Christophe Marque[6], Barbara Matyjasiak[7], Hanna Rothkaehl[7], and Pietro Zucca[8] — [1]Leibniz Institute for Astrophysics Potsdam (AIP), Germany — [2]RAL Space, United Kingdom — [3]University of Warmia and Mazury, Olsztyn, Poland — [4]University of Turku, Finland — [5]DIAS, Dublin, Ireland — [6]Royal Observatory of Belgium, Brussels, Belgium — [7]Polish Academy of Sciences, Warsaw, Poland — [8]ASTRON, Dwingeloo, Netherlands

We present LOFAR observations of an M class flare with intense type III radio bursts. Some isolated burst have a fundamental-harmonic structure, but for most bursts this is not visible due to a rapid succession of bursts. Spectroscopic imaging with LOFAR shows type III bursts as a compact source for a given frequency. The intensity varies with burst evolution, and transient dual-source structures appear. We interpret these as signatures of fundamental and harmonic emission, the latter from a higher location in the corona. Fundamental-harmonic pairs, e.g. fundamental emission at 35 MHz and harmonic emission at 70 MHz, should originate from the same plasma volume. Differences in their positions and intensity variations are expected since radio wave transport effects in the corona, like scattering and refraction, should affect fundamental more than harmonic emission. Analyzing such differences therefore allows for quantifying these effects.

EP 11.8 Thu 15:30 ZHG101

Temperature anisotropy instabilities of solar wind electrons with regularized Kappa-halos resolved with ALPS — •Dustin Schröder[1], Horst Fichtner[1], Marian Lazar[1,2], Daniel Verscharen[3], and Kris Klein[4] — [1]Ruhr-Universität Bochum — [2]Katholieke Universiteit Leuven — [3]University College London — [4]University of Arizona

Space plasmas in various astrophysical setups are often hot & diluted, making them highly susceptible to waves/fluctuations, which are generally self-generated & maintained by kinetic instabilities. In this sense, we have in-situ observational evidence from the solar wind & planetary environments, which reveal not only wave fluctuations at kinetic scales of electrons & protons, but also non-equilibrium distributions of particle velocities. We report on the progress made in achieving a consistent modeling of the instabilities generated by temperature anisotropy, taking example of those induced by anisotropic electrons: whistler & firehose instabilities. The effects of the main electron populations, the quasi-thermal core & the suprathermal halo indicated by the observations, are captured. The low-energy core is bi-Maxwellian, & the halo is described for the first time by a regularized bi-κ-distribution (RKD), which was recently introduced to fix the inconsistencies of standard κ-distributions. In the absence of an analytical RKD dispersion kinetic formalism, the dispersion relation & (in)stability properties are directly solved numerically using the Aribitrary Linear Plasma Solver (ALPS). The results have an increased degree of confidence, considering the successful testing of ALPS on previous results.