EP 2: Sun and Heliosphere II

Time: Monday 16:30–18:45 Location: H7

Invited Talk EP 2.1 Mon 16:30 H7

How can small satellites help advancing our physical understanding in heliospheric physics — •Noé Lugaz[1], Christina O. Lee[2], Nada Al-Haddad[1], Réka Winslow[1], Dave Curtis[2], Rob Lillis[2], and Toni Galvin[1] — [1]Space Science Center, University of New Hampshire, Durham, NH, USA — [2]Space Science Laboratory, University of California, Berkeley, CA, USA

The past decade has witnessed a significant growth in the private space industry, with new companies building small spacecraft and offering private launch opportunities. Here, I will discuss recent developments and ongoing projects taking advantage of the lower costs of space hardware and the increase in launch opportunities. In particular, this may present opportunities and challenges on how we think of and design space missions, as new orbits and swarms of spacecraft become more important than new instrumentations. In addition, the desire to lower costs and obtain uniform datasests must be balanced by the need to continue promoting diversity in the centers, laboratories and universities building space hardware.

Interplanetary and space weather sciences may be especially ripe for such developments since they are dominated by large and costly missions (Solar Orbiter, Parker Solar Probe, SWFO-L1, L5 mission) and must often rely on single-spacecraft measurements to understand complex three-dimensional solar eruptions, shocks, solar wind structures and energetic particle events. I will end by discussing some recent concepts that may take advantage of smallsat technology to advance our understanding of interplanetary transients.

EP 2.2 Mon 17:00 H7

The Solar Physics Research Integrated Network Group - SPRING — •Markus Roth — Leibniz-Institut für Sonnenphysik, Freiburg

Large, high-resolution solar telescopes admit only a small field of view. However, context data showing the big picture of the dynamics and magnetism at different heights of the solar atmosphere are equally important to understand the Sun in general. Real-time information about the variation of surface velocity, magnetic field, and intensity at different solar layers is an essential input to fundamental solar physics and space weather prediction. There is a consensus that a worldwide distributed network of a suite of small, dedicated telescopes which observe the entire solar disk is needed to obtain these data on a continuous basis. In this talk, I will report about the current status of designing such a network * SPRING * which is currently developed under SOLARNET (High-resolution Solar Physics Network). The key scientific products of this facility will be arc-second resolution images of the Sun in various wavelengths, synoptic vector magnetic fields, synoptic surface velocity fields with high time cadence, and observations of transient events such as flares.

EP 2.3 Mon 17:15 H7

Global solar coronal magnetic field modelling — •Thomas Wiegelmann[1], Thomas Neukirch[2], Iulia Chifu[3,1], and Dieter Nickeler[4] — [1]Max-Planck-Institut für Sonnensystemforschung, Göttingen — [2]School of Mathematics and Statistics, University of St. Andrews, UK — [3]Institute for Astrophysics, University of Göttingen — [4]Astronomical Institute, Czech Academy of Sciences, Czech Republic

Computing the solar coronal magnetic field and plasma environment is an important research topic on it's own right and also important for space missions like Solar Orbiter and Parker Solar Probe to guide the analysis of remote sensing and in-situ instruments. In the inner solar corona plasma forces can be neglected and the field is modelled under the assumption of a vanishing Lorentz-force. Further outwards (above about two solar radii) plasma forces and the solar wind flow has to be considered. Finally in the heliosphere one has to consider that the Sun is rotating and the well known Parker-spiral forms. We have developed codes based on optimization principles to solve nonlinear force-free, magneto-hydro-static and stationary MHD-equilibria.

EP 2.4 Mon 17:30 H7

3He measurements by the Suprathermal Ion Telescope on STEREO-A during solar cycle 24 and their association with electrons observed by SEPT and STE — •Marlon Köberle[1], Radoslav Bucik[2], Bernd Heber[1], Andreas Klassen[1], and Linghua Wang[3] — [1]Christian-Albrechts-Universität zu Kiel, Germany — [2]Southwest Research Institute, San Antonio, USA — [3]Institute of Space Physics and Applied Technology, Peking University, Peking, China

^{3}He-rich solar energetic particle (SEP) events are characterized by a peculiar elemental composition with rare species like ^{3}He or ultra-heavy ions tremendously enhanced over the solar system abundances. Previous studies have shown that the enormous enhancement of ^{3}He up to a factor of 10^4 above coronal abundances seems to be uncorrelated with the enhancement factor of heavier ions, indicating different acceleration mechanisms. The Suprathermal Ion Telescope (SIT) is a time-of-flight mass spectrometer designed to measure ions in the energy range of a few tens of keV up to several MeV per nucleon. The mass resolution of SIT doesnt allow to easily distinguish between ^{3}He and ^{4}He especially in cases of a low ^{3}He to ^{4}He ratio.
Here we present our semi-automatic detection approach that allowed us to identify 112 3He rich periods between 2007 and 2020, covering the whole solar cycle 24. A comparison between the Fe/O and ^{3}He/^{4}He ratios showed no correlation supporting the present picture. Additionally an association of ≈60% of the periods could be found with in-situ electron measurements by STEREO-SEPT and STEREO-STE.

EP 2.5 Mon 17:45 H7

First widespread solar energetic particle event observed by Solar Orbiter on 2020 November 29 — •Alexander Kollhoff[1], Athanasios Kouloumvakos[2], David Lario[3], Nina Dresing[4], Bernd Heber[1], and Robert Wimmer-Schweingruber[1] — [1]IEAP, Christian Albrechts-Universität zu Kiel, Kiel, Germany — [2]IRAP, Université Toulouse III - Paul Sabatier, CNRS, CNES, Toulouse, France — [3]NASA Goddard Space Flight Center, Heliophysics Science Division, Greenbelt, USA — [4]Department of Physics and Astronomy, University of Turku, Finland

With the launch of Solar Orbiter on 2020 February 10 a new era of multi-spacecraft observations opened up. An excellent example for the potentials of this era are the observations of the first widespread solar energetic particle event of solar cycle 25 on 2020 November 29. During this event relativistic electrons as well as protons with energies >50 MeV were observed by Solar Orbiter (SolO), Parker Solar Probe (PSP), the Solar Terrestrial Relations Observatory (STEREO)-A and multiple near-Earth spacecraft. The particle event was associated with an M4.4 class X-ray flare and accompanied by a coronal mass ejection (CME) and an extreme ultraviolet (EUV) wave as well as a type II and multiple type III radio bursts. Here we will present the in situ particle and remote sensing observations of this event and compare the timing of energetic particles observed at the four different locations with remote sensing observations of the solar source. We will particularly highlight the measurements of energetic electrons and protons by the Energetic Particle Detector (EPD) on board Solar Orbiter.

EP 2.6 Mon 18:00 H7

Non-thermal electron velocity distribution functions generated by kinetic magnetic reconnection in the solar atmosphere — •Xin Yao[1,2], Patricio Muñoz[2], and Jörg Büchner[2,1] — [1]Max Planck Institute for Solar System Research, 37077 Göttingen, Germany — [2]Centre for Astronomy and Astrophysics, Technical University of Berlin, 10623 Berlin, Germany

Magnetic reconnection in solar flares can generate non-thermal electron beams. Those accelerated electrons can, in turn, emit radio waves via kinetic instabilities. We aim at investigating the properties of those electrons beams that are relevant for those instabilities (sources of free energy) and their resulting radio emission. For this sake we utilize fully kinetic Particle-In-Cell simulations. Our results show that: (1) Parallel sources of free energy due to magnetized electrons are mainly generated in the diffusion region below/above the X point and separatrices, which can cause bump-on-tail instabilities and generate harmonics of electrostatic Langmuir waves. (2) Perpendicular sources of free energy due to unmagnetized electrons are formed in the diffusion and outflow region near the midplane of the reconnection, which can cause electron cyclotron maser instabilities and generate electrostatic Bernstein waves. In particular, a crescent-shaped EVDF in the velocity space perpendicular to local magnetic field is found. (3) The strength of external field has a negative influence on the formation of perpendicular sources of free energy. Our results allows us to remote diagnose some local plasma properties at the source regions of coronal magnetic reconnection via its radio emission.

EP 2.7 Mon 18:15 H7

Heating of Helium ions in a low-beta multi-ions plasma —
•Zhaodong Shi[1], Patricio Munoz[1], Joerg Buechner[1], and Siming Liu[2] — [1]Center for Astronomy and Astrophysics, Berlin Institute of Technology — [2]Purple Mountain Observatory, Chinese Academy of Sciences

We study the heating of Helium ions ($^4He^{2+}$) in a multi-ions plasma consists of electrons, protons, and Helium ions via the 2D hybrid simulation using CHIEF code. Our results show that the eigenmodes of cold plasma waves in such a plasma can be recovered in our simulation. We find that Helium ions are heated both in the parallel and perpendicular directions (relative to the background magnetic field), while the perpendicular heating is preferred. Protons are also heated in the parallel direction, however, the perpendicular heating is very weak for them. And we find the significant parallel heating for both Helium ions and protons is due to the formation of ion beams and plateaus along the background magnetic field in their velocity distribution functions, while the perpendicular heating for Helium ions can be attributed to the increase of their perpendicular temperature. Our results are useful for understanding the preferential heating of ^{3}He and other heavy ions in the ^{3}He-rich solar energetic particle events, because Helium ions play a crucial role as the background ions regulating the behaviors of plasma in these events.

EP 2.8 Mon 18:30 H7

Thermal-nonthermal energy partition in solar flares: current state and first results from STIX on Solar Orbiter —
•Alexander Warmuth — Leibniz -Institut für Astrophysik Potsdam (AIP)

Solar eruptive events are characterized by a complex interplay of energy release, transport, and conversion processes. A quantitative characterization of the different forms of energy therefore represents a crucial observational constraint for models of solar eruptions in general, as well as for magnetic reconnection, heating, and particle-acceleration processes in particular. This talk will focus on the energy partition between the thermal plasma and the nonthermal particles and review recent studies that have tried to constrain this partition using X-ray, EUV, and bolometric observations. Theses studies have shown large discrepancies, and an effort will be made to identify the reasons for this. Finally, the first results on energy partition from the STIX instrument on Solar Orbiter will be presented.