Agenda and Abstracts

Day 1: April 27, 2021

Session	Title	Speakers	Allotted Time (min.)	Time (ET)
	Welcome, Logistics, & Meeting Opening	Nour E. Raouafi	30	10:00–10:30
	Heliophysics Division: Early Career Scientists and Diversity Support	Nicola J. Fox – NASA HPD, Director		
	Space Exploration at APL	Jason Kalirai – Mission Area Executive for Civil Space		
Wave-Particle Dynamics (Turbulence & Heating)	**Chairs: Kristoff Paulson & Vamsee Krishna**			
	New Insights into Small-scale Alfvénic Turbulence from Near-Sun Solar Wind Observations	**Lloyd Woodham** Imperial College London l.woodham@imperial.ac.uk	**20**	10:30–10:50
	Fast Electrostatic Waves with Frequency Shifts in the Solar Wind Sunward of 1/3 AU	**Lily Kromyda** CU Boulder - LASP lily.kromyda@lasp.colorado.edu	**20**	10:50–11:10
	Relative heating of ions and electrons in the young solar wind due to turbulent dissipation mediated through Landau damping	**Niranjana Shankarappa** University of Arizona niranjanats@email.arizona.edu	**20**	11:10–11:30
	BREAK		**10**	11:30–11:40
	Chairs: Robert Allen & Clara Froment			
	Wave Composition, Propagation, and Polarization of Magnetohydrodynamic Turbulence within 0.3 au as Observed by Parker Solar Probe	**Xingyu Zhu** Peking University ghoti@pku.edu.cn	**20**	11:40–12:00
	Evolution of Solar Wind Turbulence from 0.1 to 1 au during the First Parker Solar Probe – Solar Orbiter Radial Alignment	**Daniele Telloni** INAF – Astrophysical Observatory of Torino daniele.telloni@inaf.it	**20**	12:00–12:20
	Modeling ion beams, kinetic instabilities, and waves observed by PSP near perihelia	**Leon Ofman** NASA GSFC/CUA ofman@cua.edu	**20**	12:20–12:40
BREAK – Breakout Rooms			**25**	12:40–13:05

Chairs: Jamie Rankin & Claire Gasque				
Electrons – Instruments/Future Missions	Probing the ambipolar electric field and potential in the solar wind through in situ measured electron velocity distribution functions	**Laura Bercic** MSSL/UCL l.bercic@ucl.ac.uk	**20**	13:05–13:25
	Early IS⊙IS Measurements of Small Energetic Electron Events	**J. Grant Mitchell** GWU/GSFC john.g.mitchell@nasa.gov	**20**	13:25–13:45
	Sensitivity of Solar Wind Mass Flux to Coronal Electron Temperature	**David Stansby** MSSL/UCL d.stansby@ucl.ac.uk	**20**	13:45–14:05
	Student Thermal Energetic Activity Module (STEAM): X-Ray Spectrometer for Solar Flares and Active Regions	**Anne O'Connor, Gabriela Galarraga, Alvin Angeles, Owen Ahlers** Colorado Space Grant Consortium – CU Boulder anoc1832@colorado.edu	**20**	14:05–14:25
Open Discussion			**20**	14:25–14:45
End of Day 1				

Day 2: April 28, 2021

	Title	Speakers	Allotted Time (min.)	Time (ET)
Chairs: Clara Froment & Claire Gasque				
Origins – Transport – Dust	Dynamic evolution of a solar flare current sheet	**Lakshmi Pradeep Chitta** MPS, Göttingen, Germany chitta@mps.mpg.de	**20**	10:00–10:20
	MHD Waves	**Somaiyeh Sabri** University of Tabriz s.sabri@tabrizu.ac.ir	**20**	10:20–10:40
	Examining the transport processes in solar energetic particle events observed by PSP near Perihelion	**Lulu Zhao** University of Michigan zhlulu@umich.edu	**20**	10:40–11:00
	Dust directionality and interplanetary dust populations detected by Parker Solar Probe	**Anna Pusack** LASP – CU Boulder anna.pusack@colorado.edu	**20**	11:00–11:20
BREAK			**10**	11:20–11:30
Chairs: Tatiana Niembro & Robert Allen				
Large-Scale Structures – Transients	Electron velocity distribution functions and the non-equilibrium Boltzmann entropy in the solar wind at 1 AU during the halo CME event on 13 May 2005	**Govind Nampoothiri** Space Physics Laboratory, Vikram Sarabhai Space Centre, ISRO, Kerala, India govindgn9@gmail.com	**20**	11:30–11:50
	Coronal mass ejections observed by WISPR/PSP and SECCHI/STEREO on April 1 and 2, 2019	**Carlos Braga** George Mason University cbraga@gmu.edu	**20**	11:50–12:10
	Ripples in the Heliospheric Current Sheet: Dependence on Latitude and Transient Outflows	**Ronan Laker** Imperial College London rl4215@ic.ac.uk	**20**	12:10–12:30
	The Unusual Widespread Solar Energetic Particle Event on 2013 August 19	**Laura Rodriguez-Garcia** Universidad de Alcalá, Madrid, Spain l.rodriguezgarcia@edu.uah.es	**20**	12:30–12:50

BREAK – Breakout Rooms			25	12:50–13:15
Chairs: Vamsee Krishna & Jamie Rankin				
Space Weather -- Switchbacks	Extreme events theory applied to the solar wind	**Carlos Larrodera** Universidad de Alcalá carlos.larrodera@edu.uah.es	**20**	13:15–13:35
	Energetic particle behavior in near-Sun magnetic field switchbacks	**Riddhi Bandyopadhyay** Princeton University riddhib@princeton.edu	**20**	13:35–13:55
	Possible Generation Mechanism for Compressive Alfvénic Spikes as Observed by Parker Solar Probe	**Jiansen HE** Peking University jshept@pku.edu.cn	**20**	13:55–14:15
	Assessing the Role of Interchange Reconnection in Forming Switchbacks	**Haoming Liang** UAH haoming.liang@uah.edu	**20**	14:15–14:35
Concluding Remarks		Nour E. Raouafi & All	**10**	14:35–14:45
End of Day 2				

Abstracts

1. **Lloyd Woodham** (post-soc)
   Imperial College London – l.woodham@imperial.ac.uk
   Title: New Insights into Small-scale Alfvénic Turbulence from Near-Sun Solar Wind Observations
   Description: We use the magnetic field measurements from the FIELDS fluxgate and search-coil magnetometers onboard Parker Solar Probe (PSP) during its first solar encounter to probe the nature of Alfvénic turbulence at small scales in the near-Sun solar wind. These high-resolution, low-noise measurements provide a rare opportunity to be able to investigate the spectral properties of magnetic field fluctuations to scales smaller than the proton gyro-radius. After accounting for sampling effects arising from the unique nature of PSP's orbit, we analyse a 12-hour interval during perihelion where the spacecraft encountered a highly Alfvénic slow wind stream. By comparing our results with a model spectrum of linear Alfvén waves, we find that the spacecraft observations are consistent with a transition from an Alfvénic to kinetic Alfvén turbulent cascade approaching the proton gyro-radius, as previously reported in simulations and elsewhere in the heliosphere. In addition, we find evidence for a possible second transition in the turbulence at even smaller scales, as suggested by a subsequent decrease in the amplitude of the coherent magnetic helicity signature toward zero from a peak close to the proton gyro-radius. A decrease in the helicity at these scales is seen by other spacecraft in the solar wind, but these data are often contaminated by an increasing contribution of noise to the physical signal toward smaller scales. After a detailed characterisation of the different sources of spacecraft and instrument noise throughout our interval, we conclude that the observed decrease in helicity observed by PSP is physical and extends over a larger range of scales compared previous studies. We discuss the possible physical interpretations of this transition to a state of zero magnetic helicity and the potential implications for sub-ion scale turbulence in the solar wind.

2. **Lily Kromyda**
   CU Boulder – LASP – lily.kromyda@lasp.colorado.edu
   Title: Fast Electrostatic Waves with Frequency Shifts in the Solar Wind Sunward of 1/3 AU
   Brief Description: We show that fast (fractions of a second), electrostatic, intermittent, broadband and frequency chirping (millisecond timescales) plasma waves are ubiquitous in the solar wind sunward of 1/3 AU (FDWs for frequency-dispersed waves). The radial trend of the S/C independent FDW detections/km varies with each orbit of Parker Solar Probe. We prove that their k-vector is polarized parallel to the background magnetic field. The observations indicate that their frequency lies within 0.2 and 7 times the local ion plasma frequency. These facts point towards FDWs being a type of ion acoustic wave. The agents responsible for their generation are alpha particles and sharp gradients in the magnetic field, as these are the only parameters that can accurately predict FDW occurrence. We speculate that their shifting frequencies are the result of either

velocity dispersion in the alpha particles, or a rapidly changing magnitude of the k-vector. Their broadband character can be understood in the context of strong turbulence.

3. **Niranjana Shankarappa**
University of Arizona – niranjanats@email.arizona.edu
Title: Relative heating of ions and electrons in the young solar wind due to turbulent dissipation mediated through Landau damping
Brief Description: The relative heating of ions and electrons due to turbulent dissipation plays a crucial role in the thermodynamics of the solar wind. Landau damping is one plausible mechanism for damping of turbulent cascade in space and astrophysical plasmas. Observations from initial Parker Solar Probe (PSP) encounters have found the plasma beta is not much smaller in the near-Sun environment implying that Landau damping may be relevant. We consider an anisotropic turbulence cascade and dissipation mod el, developed in Howes et al 2008 and expanded in Kunz et al 2018, to determine relative proton and electron heating rates as a function of observable plasma parameters when dissipation is mediated by Landau damping. The model considers a steady-state cascade of wavevector anisotropic turbulent fluctuations from the inertial to dissipation range, connecting MHD and kinetic scales. We apply this model to observations from the first two PSP perihelion, characterizing how the relative heating rates vary as a function of radial distance, plasma conditions, and solar wind source, and compare these results to previous analysis of heating rates using the PSP observations, illuminating how energy is partitioned in the young solar wind.

4. **Xingyu Zhu**
Peking University – ghoti@pku.edu.cn
Title: Wave Composition, Propagation, and Polarization of Magnetohydrodynamic Turbulence within 0.3 au as Observed by Parker Solar Probe
Description: Turbulence, a ubiquitous phenomenon in interplanetary space, is crucial for the energy conversion of space plasma at multiple scales. This work focuses on the propagation, polarization, and wave composition properties of the solar wind turbulence within 0.3 au, and its variation with heliocentric distance at magnetohydrodynamic scales (from 10 s to 1000 s in the spacecraft frame). We present the probability density function of propagation wavevectors (PDF ($k_\|$, $k_\perp$)) for solar wind turbulence within 0.3 au for the first time: (1) wavevectors cluster quasi-(anti-)parallel to the local background magnetic field for $kd_i<0.02$, where d_i is the ion inertial length; (2) wavevectors shift to quasi-perpendicular directions for $kd_i>0.02$. Based on our wave composition diagnosis, we find that: the outward/anti-sunward Alfvén mode dominates over the whole range of scales and distances, the spectral energy density fraction of the inward/sunward fast mode decreases with distance, and the fractional energy densities of the inward and outward slow mode increase with distance. The outward fast mode and inward Alfvén mode represent minority populations throughout the explored range of distances and scales. On average, the degree of anisotropy of the magnetic fluctuations defined with respect to the minimum variation direction decreases

with increasing scale, with no trend in distance at any scale. Our results provide comprehensive insight into the scenario of transport and transfer of the solar wind fluctuation s/turbulence in the inner heliosphere.

5. **Daniele Telloni**
   National Institute for Astrophysics - Astrophysical Observatory of Torino – daniele.telloni@inaf.it
   Title: Evolution of Solar Wind Turbulence from 0.1 to 1 au during the First Parker Solar Probe – Solar Orbiter Radial Alignment
   Brief Description: The first radial alignment between Parker Solar Probe and Solar Orbiter spacecraft is used to investigate the evolution of solar wind turbulence in the inner heliosphere. Assuming ballistic propagation, two 1.5 hr intervals are tentatively identified as providing measurements of the same plasma parcels traveling from 0.1 to 1 au. Using magnetic field measurements from both spacecraft, the properties of turbulence in the two intervals are assessed. Magnetic spectral density, kurtosis and high-order moment scaling laws are calculated. The Hilbert-Huang transform is additionally used to mitigate short sample and poor stationarity effects. Results show that the plasma evolves from a highly Alfvénic, less-developed turbulence state near the Sun, to fully-developed and intermittent turbulence at 1 au. These observations provide strong evidence for the radial evolution of solar wind turbulence.

6. **Leon Ofman** (Senior scientist)
   NASA GSFC/CUA – ofman@cua.edu
   Title: Modeling ion beams, kinetic instabilities, and waves observed by PSP near perihelia
   Description: Recent observations from Parker Solar Probe (PSP) mission in the inner Heliosphere show evidence of ion beams, temperature anisotropies, and kinetic wave activity likely associated with kinetic heating and acceleration processes of the solar wind. In particular the proton beams were detected by PSP/SPAN-I and related magnetic wave spectra were observed by the FIELDS instrument near perihelia. We present the results of 2.5D and 3D hybrid-particle-in-cell (hybrid-PIC) models of kinetic protons and alpha particle beams and models of associated kinetic instabilities in th e inner solar wind. We calculate the evolution of the ion velocity distribution functions (VDFs) with beams, ion relative drifts, and temperature anisotropy for solar wind conditions near perihelia. We model the partition of energies between the fields (waves) and particles (ions) and compare to observationally deduced values. We conclude that the ion beam driven kinetic instabilities in the solar wind plasma near perihelia is an important component in the cascade of energy on kinetic scale, resulting in solar wind plasma heating.

7. **Laura Bercic**
   Mullard Space Science Laboratory, UCL, UK – l.bercic@ucl.ac.uk
   Title: Probing the ambipolar electric field and potential in the solar wind through in situ measured electron velocity distribution functions

Brief Description: A key factor that determines the global expansion of the solar wind is the interplanetary electric field, which forms self-consistently as an ambipolar electrostatic field due to the differences in the ion and electron masses. This electric field presents a potential well for the solar wind electrons, and therefore shapes the electron velocity distribution functions (VDFs). We identify features in the electron VDFs measured by Parker Solar Probe, which could be related to the ambipolar electric field and use them to estimate the total electric potential in the solar wind.

8. **J. Grant Mitchell** (student)
George Washington University / NASA GSFC – john.g.mitchell@nasa.gov
Title: Early ISOIS Measurements of Small Energetic Electron Events
Description: The beginning of Parker Solar Probe's mission has taken place during very quiet solar minimum conditions with few solar energetic particle events. This, as well as Parker Solar Probe's close proximity to the Sun at perihelion, has provided the opportunity to observe small energetic electron events that may not be observable later in the mission when solar activity increases. In this work, we present observations of small electron events observed by the ISOIS energetic particle suite including the first measurements of energetic electrons of solar origin recorded within 0.2 AU of the Sun.

9. **David Stansby** (post-doc)
MSSL/UCL – d.stansby@ucl.ac.uk
Title: Sensitivity of Solar Wind Mass Flux to Coronal Electron Temperature
Description: Solar wind models predict that the mass flux carried away from the Sun in the solar wind should be extremely sensitive to the temperature in the corona. Using a range of in-situ and remote sensing measurements from Parker Solar Probe, the Solar Dynamics Observatory, and Hinode/EIS, we have tested this hypothesis by measuring the coronal electron temperature and coronal mass flux in both coronal holes and active region outflows. We find that a three-fold increase in coronal temperature from 0.7 MK to 2.2 MK results in a large increase in coronal mass flux by over a factor of 100. This is in qualitative agreement with current solar wind acceleration models, and provides a new empirical constraint for future models to be tested against.

10. **Anne O'Connor**
Colorado Space Grant Consortium at the University of Colorado Boulder – anoc1832@colorado.edu
Title: Student Thermal Energetic Activity Module (STEAM): X-Ray Spectrometer for Solar Flares and Active Regions
Brief Description: The Student Thermal Energetic Activity Module (STEAM) is a student payload hosted on one of the PUNCH Small Explorer spacecraft with an expected launch in mid-2023 and nominal 2-year mission life. STEAM's spectral observations of solar flares and quiescent active regions in soft and hard X-rays during the rise phase of solar cycle 25 will aid in measuring physical parameters

to help constrain potential coronal heating mechanisms. We will present the STEAM science motivation, design, current progress, and future outlook.

11. **Lakshmi Pradeep Chitta** (post-doc)
    Max Planck Institute for Solar System Research – chitta@mps.mpg.de
    Title: Dynamic evolution of a solar flare current sheet
    Description: Current sheets play a key role in solar flares as they are the locations where magnetic energy is liberated through reconnection and is converted to other forms. Yet, their formation and evolution during the impulsive phase of a flare remain elusive. In this talk, we will report new observations of a current-sheet formation and subsequent evolution in the early stages of a solar flare. In particular, we will present multi-phase evolution of a dynamic current sheet from its formation to quasi-stable evolution and disruption. Implications for the onset and evolution of reconnection will be discussed.

12. **Somaiyeh Sabri** (post-doc)
    University of Tabriz – s.sabri@tabrizu.ac.ir
    Title: MHD Waves
    Description: Coronal null points are locations where the magnetic field, and hence the local Alfven speed, is zero. The behaviour of all three MHD wave modes, i.e., fast and slow magnetoacoustic waves and the Alfven wave, has been investigated in the neighbourhood of 2D, 2.5D and (to a certain extent) 3D magnetic null points, for a variety of assumptions, configurations and geometries. We performed numerical studies for interpreting MHD waves behaviour in interaction with the magnetic null point in solar coronal condition. A shock capturing Godunov type PLUTO code is used to solve MHD equations. It is found that Alfven waves propagate toward the magnetic null point with inducing magnetoacoustic waves perturbations and also plasma flows. Besides, the transfer of the energy from the nonlinear Alfven wave during the propagation toward the magnetic null point is investigated. Moreover, the behaviour of the initial fast magnetoacoustic wave is studied. It is found that due to the interaction of magnetoacoustic wave with the null point, oscillatory magnetic reconnection takes place. This interaction also contributes to the significant creation of inflows and outflows that are possible candidates for the creation of solar jets which has important contribution towards coronal seismology.

13. **Lulu Zhao** (early-career scientist)
    University of Michigan – zhlulu@umich.edu
    Title: Examining the transport processes in solar energetic particle events observed by PSP near Perihelion
    Description: We studied a pair of SEP events observed by PSP when it passed its second perihelion using a coronal and interplanetary particle transport model. Both events were small in intensity and size and they were not observed by spacecraft at 1 au. The first event was weak, with only the low- energy protons showing intensity enhancements. The second event was more energetic, with the intensity of >1 MeV protons increasing by more than a factor of 100 above pre-

event intensities. However, the enhancement of the <100 keV protons in the second event was relatively weak. We examined the effects of the coronal magnetic field configuration, parallel/perpendicular transport, super-corotation of PSP in shaping the time intensity profiles at low and high energies.

14. Anna Pusack
LASP, University of Colorado, Boulder – anna.pusack@colorado.edu

Title: Dust directionality and interplanetary dust populations detected by Parker Solar Probe

Brief Description: Theory and previous space missions indicate that there are several populations of zodiacal dust. The most prominent populations are grains on bound elliptic orbits (α-meteoroids), and β-meteoroids on hyperbolic escape trajectories governed largely by their size and composition. Yet, there may be other populations not yet confirmed by observation. The Parker Solar Probe (PSP) spacecraft is able to observe in-situ dust populations in the densest part of the zodiacal cloud. Over the first seven orbits, dust count rates are well-organized by orbital groups based on orbital parameters of PSP's shrinking orbit. In particular, the first three orbits and the sixth orbit have a single, pre-perihelion peak in count rate with a gradual drop off post-perihelion, while Orbits 4-5 and 7 have two distinct count rate peaks on either side of perihelion. The secondary peaks in Orbits 4, 5, and 7 are inconsistent with current zodiacal dust models that account for only two dust populations: α- and β-meteoroids. In examining the directionality of dust impacts on the PSP spacecraft, the presence of an anti-ram impactor anomaly post-perihelion during Orbit 4 is evident. This anomaly may indicate another dust population beyond the well-known α- and β-meteoroids, and its origin may be related to the Geminids meteoroid stream associated with the asteroid 3200-Phaethon.

15. Govind Nampoothiri
Space Physics Laboratory, Vikram Sarabhai Space Centre, ISRO, Kerala, India – govindgn9@gmail.com

Title: Electron velocity distribution functions and the non-equilibrium Boltzmann entropy in the solar wind at 1 AU during the halo CME event on 13 May 2005

Brief Description: In this work, we studied the kinetic properties of the electron velocity distribution functions during the passage of a halo CME at 1 AU. The halo CME erupted on13 May 2005 (Carrington rotation 2029) from the active region NOAA AR 10759 (N12E11) and the ICME reached at the L1 point 33 hours after the eruption. Solar wind electron measurements from three-Dimensional Plasma Instrument (3DP) on board WIND spacecraft and CME observations from Large Angle and Spectroscopic Coronagraph (LASCO) on board Solar and Heliospheric Observatory (SOHO have been used for performing the present study. The velocity distributions of electrons observed at the L1 point, show distinct features representing the passage of the ICME plasma and associated magnetic cloud. Following the CME sheath plasma, a bi-directional electron heat flux representing a closed magnetic flux rope is observed. The Boltzmann entropy analysis of the event shows the magnetic cloud holds the largest non-equilibrium Boltzmann entropy among the whole ICME sectors.

16. **Carlos Braga**

George Mason University – cbraga@gmu.edu

Title: Coronal mass ejections observed by WISPR/PSP and SECCHI/STEREO on April 1 and 2, 2019

Brief Description: We study two coronal mass ejections (CMEs) observed between April 1 to 2, 2019 by both the inner Wide-Field Imager for Parker Solar Probe (WISPR-I) onboard the Parker Solar Probe (PSP) spacecraft (located between about 46 and 38 solar radii during this period) and the inner heliospheric imager (HI-1) onboard the Solar Terrestrial Relations Observatory Ahead (STEREO-A) spacecraft, orbiting the Sun at about 0.96 au. This is the first study of CME observations from two viewpoints in similar directions but at considerably different solar distances. Our objective is to derive CME kinematics from WISPR-I observations and to compare them with results from HI-1. This allows us to understand how the PSP observations affect the CME kinematics, especially due to its proximity to the Sun. We estimated the CME positions, speeds, accelerations, propagation directions, and longitudinal deflections using imaging observations from two spacecrafts and a set of analytical expressions that consider the CME as a point structure and take the rapid change in spacecraft position into account. We derived the kinematics using each viewpoint independently and both viewpoints as a constraint. We found that both CMEs are slow (< 400 km s^{-1}), propagating eastward of the Sun-Earth line (westward of PSP and STEREO-A). The second CME seems to accelerate between ~ 0.1 to ~ 0.2 au and deflect westward with an angular speed consistent with the solar rotation speed. We found some discrepancies in the CME solar distance (up to 0.05 au, particularly for C ME #1), latitude (up to $\sim 10^\circ$), and longitude (up to 24°) when comparing results from different fit cases (different observations or set of free parameters). Discrepancies in longitude are likely due to the feature that is tracked visually, rather than instrumental biases or fit assumptions. For similar reasons, the CME #1 solar distance, as derived from WISPR-I observations, is larger than the HI-1 result, regardless of the fit parameters considered. Error estimates for CME kinematics do not show any clear trend associated with the observing instrument. The source region location and the lack of any clear in situ counterparts (both at near-Earth and at PSP) support our estimate of the propagation direction for both events.

17. **Ronan Laker** (student)

Imperial College London – rl4215@ic.ac.uk

Title: Ripples in the Heliospheric Current Sheet: Dependence on Latitude and Transient Outflows

Description: The recent launches of Parker Solar Probe (PSP), Solar Orbiter (SO) and BepiColombo, along with several legacy spacecraft, have provided the opportunity to study the solar wind at multiple latitudes and distances from the Sun simultaneously. We take advantage of this unique spacecraft constellation, along with low solar activity between May and July 2020, to investigate how latitude affects the solar wind and Heliospheric Current Sheet (HCS) structure. We use ballistic mapping to compare polarity and solar wind velocity between several spacecraft, showing that fine scale ripples in the HCS can be resolved down to several degrees in longitude. We show that considering solar wind velocity is also useful when investigating the HCS structure, as it can reveal times when the spacecraft is within slow, dense streamer belt wind without changing magnetic polarity. We measured the local orientation of planar magnetic structures associated with HCS crossings, finding that these were broadly consistent with the shape of the HCS but at much steeper angles due to compression from stream interaction regions. We identified several transient magnetic clouds associated with HCS crossings, and have shown that these can disrupt the local HCS orientation up to four days after their passage, but did not significantly affect the position of the HCS. This work highlights that the heliosphere should always be treated as three dimensional, especially at solar minimum, where a few degrees in latitude can create a considerable difference in solar wind conditions.

18. **Laura Rodriguez-Garcia** (student)
Space Research Group, Universidad de Alcalá, Madrid, Spain – l.rodriguezgarcia@edu.uah.es

Title: The Unusual Widespread Solar Energetic Particle Event on 2013 August 19

Description:

Context. Late on 2013 August 19, STEREO-A, STEREO-B, MESSENGER, Mars Odyssey, and L1 spacecraft, spanning a longitudinal range of 222 degrees in the ecliptic plane, observed an energetic particle flux increase. The widespread solar energetic particle (SEP) event was associated with a coronal mass ejection (CME) that came from a region located near the far-side central meridian from Earth's perspective. The CME appeared to consist of two eruptions, and was accompanied by a M-class flare as a post-eruption arcade, and low-frequency (interplanetary) type II and shock-accelerated type III radio bursts.

Aims. The main objectives of this study are two, disentangling the reasons of the different intensity-time profiles observed by MESSENGER and STEREO-A, longitudinally separated by only 15 degrees, and unravelling the single solar source related with the SEP event.

Methods. The analysis of in situ data, i.e., particle fluxes, anisotropies and timing, and plasma and magnetic field data, is compared with the remote-sensing observations. A spheroid model is used for CME-driven shock reconstruction and ENLIL model is used for characterisation of heliospheric conditions, including the evolution of the magnetic connectivity to the shock.

Results. The solar source associated with the widespread SEP event is the shock driven by the two-stage CME, as the flare observed as a post-eruptive arcade is too late to explain the estimated particle onset. The different intensity-time profiles observed by STEREO-A, located at 0.97 au, and MESSENGER, at 0.33 au, can be interpreted as enhanced particle scattering beyond Mercury's orbit. The longitudinal extent of the shock does not explain by itself the wide spread of

particles in the heliosphere. The particle increase observed at L1 may be attributed to cross-field diffusion transport, and this is also the case for STEREO-B, at least until the spacecraft is eventually magnetically connected to the shock at~0.6 au. The CME-driven shock may have suffered distortion in its evolution in the heliosphere, such that the shock flank overtakes the shock nose at 1 au.

19. **Carlos Larrodera** (early-career scientist)
Universidad de Alcalá – carlos.larrodera@edu.uah.es
Title: Extreme events theory applied to the solar wind
Description: Society's dependence on technology has increased during the past years. Therefore, understanding the hazardous events including space weather events that lead to technological problems is now critical. As solar wind is the driver of space weather, identifying extreme solar wind is important. In this work extreme value theory is used to characterize the solar wind parameters most relevant to space weather: interplanetary magnetic field strength and proton speed. This is done using an extreme value distribution for all data above a certain threshold for each parameter. Analysis demonstrates that these thresholds are around 900 km/s for the proton speed and around 95 nT for the interplanetary magnetic field. Based on 20 years of solar wind data, we made an estimation for the interplanetary magnetic field and solar wind proton speed with return periods corresponding to 4 and 6 solar cycles with a 99% confidence interval.

20. **Riddhi Bandyopadhyay**
Princeton University – riddhib@princeton.edu
Title: Energetic particle behavior in near-Sun magnetic field switchbacks
Brief Description: The observation of numerous magnetic switchbacks in Parker Solar Probe (PSP) during its first five orbits, particularly near the Sun, has attracted considerable attention. Switchbacks have been found to be systematically associated with correlated reversals in the direction of the propagation of Alfvenic fluctuations, as well as similar reversals of the electron strahl. Here we aim to see whether the energetic particles change direction at the magnetic field switchbacks. Using the energetic particles (energy range 80-200 keV/nuc) measured by the EPI-Lo instrument of the ISOIS suite, we find that energetic particles measured by EPI-Lo generally do not preferentially change their directionality from that of the background magnetic field to that of the switchbacks. This result provides the possibility of setting a constraint on the radius of the curvature of the magnetic field in switchbacks, a property not otherwise observed by PSP.

21. **Jiansen HE**
Peking University – jshept@pku.edu.cn
Title: Possible Generation Mechanism for Compressive Alfvénic Spikes as Observed by Parker Solar Probe
Description: The solar wind is found by Parker Solar Probe (PSP) to be abundant with Alfvénic velocity spikes and magnetic field kinks. Temperature enhancement is another remarkable feature associated with the Alfvénic spikes. How the

prototype of these coincident phenomena is generated intermittently in the source region becomes a hot topic of wide concerns. Here we propose a new model introducing guide-field discontinuity into the interchange magnetic reconnection between open funnels and closed loops with different magnetic helicities. The modified interchange reconnection model not only can accelerate jet flows from the newly opening closed loop but also excite and launch Alfvénic wave pulses along the newly-reconnected and post-reconnected open flux tubes. We find that the modeling results can reproduce the following observational features: (1) Alfvén disturbance is pulsive in time and asymmetric in space; (2) Alfvénic pulse is compressive with temperature enhancement and density variation inside the pulse. We point out that three physical processes co-happening with Alfvén wave propagation can be responsible for the temperature enhancement: (a) convection of heated jet flow plasmas (decrease in density), (b) propagation of compressive slow-mode waves (increase in density), and (c) conduction of heat flux (weak change in density). We also suggest that the radial nonlinear evolution of the Alfvénic pulses should be taken into account to explain the formation of magnetic switchback geometry.

22. **Haoming Liang** (early-career scientist)
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Title: Assessing the Role of Interchange Reconnection in Forming Switchbacks
Description: Abrupt deflections of the magnetic field in the solar wind, so called "switchbacks", are frequently observed by *Parker Solar Probe* (PSP) during its first two orbits and are believed to play an important role in unveiling the nature of the solar corona heating and solar wind acceleration in the inner heliosphere. Many attempts were made recently to understand the nature of switchbacks. However, the origin, propagation and evolution of the switchbacks are still under debate. In this study, we attempt to use the linear theory of Zank et al. (2020) to interpret the switchback observations. We select 96 simple one-humped switchback events during the first encounter of PSP and use a Markov Chain Monte Carlo technique to fit the observed magnetic field and plasma variables with the model predictions for each event. The chi-squared goodness of fit test is used to evaluate the fittings. We find that about 47.9% and 42.7% of the events are accepted as good fits below the 95% and 90% critical values respectively. This statistical study validates the reliability of the linear theory of Zank et al. (2020) for a significant number of switchback events. The statistical analysis provides most probable initial conditions for switchbacks generated by interchange reconnection, which provides insight into the environment at which interchange reconnection was occurring.