AUTUMN MIST 2023

Time	Name	Title
Planetary session - Chair: Georgios Nicolaou		
10:25	Council	Welcome to Autumn MIST
10:30	Charles Bowers	Mercury's Magnetotail Lobe: A Statistical Analysis using MESSENGER Observations
10:42	Sophia Zomerdijk-Russell	Does Reconnection Only Occur at Points of Maximum Shear on Mercury's Dayside Magnetopause?
10:54	Dikshita Meggi	Martian ionospheric dynamics by crustal magnetic fields as observed by MARSIS-Mars Express
11:06	Gabrielle Provan	Jupiter's magnetodisc and magnetospheric currents during Juno's prime mission
11:18	Paola Ines Tiranti	Jupiter's local-time dependent vertical ionospheric profiles from Juno and JWST
11:30	**Poster Session 1**	
12:15	**Lunch and poster change**	
13:00	Council	MIST Update
Solar session - Chair: Jasmine Kaur Sandhu		
13:15	Nawin Ngampoopun	Investigation of small-scale evolution of coronal hole boundaries using high-cadence EUV observations
13:27	Georgios Nicolaou	Forward models of space plasma instruments for the accurate determination of plasma bulk parameters
13:39	Pauline Simon	The impact of pressure anisotropy on the turbulent cascade.
13:51	James Plank	Simulations of the evolution of turbulence across Earth's bow shock: correlation length, magnetic spectra and kurtosis for varying shock parameters
14:03	Laura Vuorinen	How do solar wind conditions and the solar cycle influence magnetosheath jet formation at the Earth's bow shock?
14:15	Jingting Liu	Particle-in-cell simulations of Langmuir-wave emission from magnetic holes
14:27	**Poster Session 2**	
Earth session - Chair: Sophie Maguire		
15:12	Samuel Greess	Modeling experimental magnetopause-like reconnection with multidimensional kinetic simulations: TREX and Cylindrical VPIC
15:24	Rosie Hodnett	Modelling the effects of the Alfvén velocity profile on the structure of the ionospheric Alfvén resonator and a comparison with observations from Eskdalemuir, UK
15:36	Suman Chakraborty	Intense chorus waves drive rapid acceleration of relativistic electrons during storm main phase
15:48	Sarah Bentley	How do radial diffusion dynamics and timescale depend on initial and boundary conditions?
16:00	Dovile Rasinskaite	A Number Density/ Temperature Description of the Earth's Outer Radiation Belt

16:12	Martin Cafolla	Variations with Season and Geomagnetic Activity seen in Space-Time Correlated Enhancements of Ionospheric TEC taken from JPL GIMs
16:24	Cara Waters	Energy Repartition in Magnetic Reconnection using 2.5-D PIC Simulation and Machine Learning Techniques
16:36	Michaela Mooney	Plasma observations in the distant magnetotail associated with cusp-aligned arcs
16:48	Patrik Krcelic	Variability in the electrodynamics of the small scale auroral arc
17:00	**END**	

Poster Session 1: 11:30 - 12:15	
Author	**Title**
Adrian LaMoury	Operational modelling of space weather ground effects with the GorgonOps simulation suite
Audrey Schillings	Space weather on Earth: how could we better preserve our technologies from space weather events?
Gareth Dorrian	Tracking asymmetric quasi-periodic oscillations within a travelling ionospheric disturbance from Poland to the North Sea with LOFAR
Harley Kelly	Investigating the Frequencies of Kelvin-Helmholtz Waves Globally: Mode Dominance, Superposition, and their Magnetospheric Effects in MHD Simulations
Jasmine Sandhu	How do Plasmaspheric Plumes Impact ULF Waves?
Joshua Ruck	On the use of SuperDARN Ground Backscatter Measurements for Ionospheric Propagation Model Validation
Maria-Theresia Walach	Introducing TiVIE: a new model of the Time-Varying Ionospheric Electric field
Martin Archer	Magnetosonic ULF Waves With Anomalous Plasma – Magnetic Field Correlations
Nawapat Kaweeyanun	In Situ Observations of Interaction Between the Closed Magnetic Field of Earth’s Transpolar Auroral Arcs and the Magnetopause
Ravindra Desai	ROARS: Revealing Orbital and Atmospheric Responses to Solar activity – A multi-spacecraft mission to Low Earth Orbit
Sam Rennie	Modelling of ULF Waves in SuperDARN Backscatter
Sophie Maguire	Large-scale plasma structures and scintillation in the high-latitude ionosphere
Konrad Steinvall	The Influence of Rotational Discontinuities on Magnetic Reconnection in the Shock Transition Region
Beatriz Sanchez-Cano	From the Sun to Mars’ surface: How solar energetic particles affect Mars' atmosphere and ionosphere
George Greenyer	Implementing the Boris Method in a Jovian Middle-Magnetosphere Plasma Simulation
Katerina Stergiopoulou	Ionopause detections in the Martian ionosphere
Zoe Lewis	Constraining ion transport in the diamagnetic cavity of comet 67P
Charalambos Ioannou	Polytropic analysis of ion-acoustic waves in the solar wind observed by Solar Orbiter.
Jack McIntyre	Observations of the turbulence transition range as evidence for the helicity barrier
Julia Stawarz	Distributed Receivers for Electron Astrophysics Measurements (DREAM): A CubeSat
Xueyi Wang	Wavelet determination of magnetohydrodynamic-range power spectral exponents in solar wind turbulence seen by Parker Solar Probe

Poster Session 2: 14:27 - 15:12	
Author	**Title**
Andrey Samsonov	Magnetospheric response to a southward IMF turning in the dayside and nightside magnetosphere
Daniel Ratliff	Nonlinear Whistler-Mode Chorus Waves: From Theory Towards Forecast
Gemma Bower	Identification of geomagnetic disturbances
James Waters	Evaluating remote auroral kilometric radiation observations as a classification and predictive tool for substorms
John Coxon	A geomagnetic storm case study of Birkeland current timescales
Kendra Gilmore	How important is magnetospheric time history for predicting auroras?
Christian Lao	On the robustness of a new global index of Solar Wind-Magnetospheric Coupling
Natalie Reeves	Understanding the sensitivity of TIE-GCM's forcing parameters
Nicholas Brindley	Intermittent turbulence in fine-scale auroral structure
Rowan Dayton-Oxland	Pc1 measurements of EMIC waves are not significantly linked to the acceleration of auroral protons in the cusp.
Shannon Killey	Mapping the Evolution of Relativistic Electrons During Geomagnetic Storms
Tom Daggitt	Chorus wave power at the strong diffusion limit overcomes electron losses due to strong diffusion
Adrian LaMoury	Magnetic reconnection in Earth’s turbulent magnetosheath: Exhaust structure and heating
Jonathan Nichols	Jovian magnetospheric injections observed by the Hubble Space Telescope and Juno
Georgios Nicolaou	Determining Electron Plasma Properties from Solar Orbiter Observations
Andrea Larosa	On the Relation between Switchbacks and Turbulence in the Inner Heliosphere for different types of Solar Wind
Domenico Trotta	Observations and modelling of accelerated particles at interplanetary shocks in the inner heliosphere
Abid Razavi	Investigating electron energisation across interplanetary shocks in the Solar Wind.
Utsav Panchal	An investigation of the helicity barrier effect using Parker Solar Probe.
Hannah Trigg	Highly detailed observations of symmetrical quasi-periodic oscillations with LOFAR
Patrik Krcelic	Local Joule heating profile near small scale auroral features estimated from high resolution electric fields.
Jasmine Sandhu	Results from the Survey of Bullying and Harassment in the MIST Community

Book of Abstracts
Autumn MIST 2023
(in alphabetical order)

1. Martin Archer – Imperial College London

Southwood, DJ; Hartinger, MD; Rastaetter, L; Nykyri, K;

Magnetosonic ULF Waves With Anomalous Plasma – Magnetic Field Correlations

Ultra-low frequency (ULF) wave observations across the heliosphere often rely on the sign of correlations between plasma (density/pressure) and magnetic field perturbations to distinguish between fast and slow magnetosonic modes. However, this result is derived under the assumption of a single travelling wave in a uniform background plasma. Planetary magnetospheres, in contrast, have spatially-varying plasma conditions and can reflect waves off of boundaries to form standing modes. We investigate what influence these effects have on both freely propagating waves and those tied to a surface through analytic theory and a global magnetospheric MHD simulation.

We find both effects can fundamentally alter the sign of plasma – magnetic field correlations. The interference pattern in standing waves can lead both body and surface magnetosonic waves to have different cross-phases than their constituent propagating waves. Furthermore, if the scale of gradients in the background are shorter than the wavelength or the waves are near-incompressible, then advection by the wave of inhomogeneities in the background can overcome the wave's inherent sense of compression. These effects need to be allowed for and taken into account when applying the typical diagnostic to observations.

2. Sarah Bentley - Northumbria University

Stout, J; Thompson, R; Ratliff, D; Watt, C E J

How do radial diffusion dynamics and timescale depend on initial and boundary conditions?

Radiation belt modelling aims to predict the distribution of high energy particles as they interact with waves in Earth's magnetosphere. Next-generation modelling must incorporate uncertainty to better reflect the variability in physical processes and for practical operational purposes. Ensembles are a proven method for addressing uncertainty in modelling. However, to understand the implications of ensemble variations, it's essential to grasp the inherent differences in outputs due to model settings. We explore the impact of initial distribution and outer boundary conditions on radial diffusion.

We present two measures (monotonicity and an energy-like density) show that each reveals different aspects of the dynamics. We observe that the dynamics are subject to changes based on location and the type of outer boundary condition chosen. These choices lack a clear-cut answer from our system understanding but undeniably influence model outcomes. However, while initial model settings yield domain-dependent results, our findings suggest that existing models of loss from pitch-angle scattering significantly shape the dynamics and may help mitigate the effects of these ambiguous choices.

3. Gemma Bower - University of Leicester

Imber, S; Milan, S; Beggan, C; Gjerloev, J

Identification of geomagnetic disturbances

Rapid changes in the magnetic field can cause electric currents to be induced at the surface of Earth, these geomagnetically induced current (GICs) can cause damage to pipelines and power grids. A detection algorithm has been developed to identify rapid changes in 10 second averaged magnetometer data. This higher resolution data is important in capturing the most rapid changes associated with extreme GIC events. It is necessary to distinguish between sudden changes which are genuine and which are caused by instrumental effects, so the algorithm provides a data flag for each change, categorising it as good, doubtful or bad. It further extends this by classifying rapid changes that are appear to be due to waves in the magnetometer data. The algorithm has been used on a global array of ground-based magnetometers from INTERMAGNET and SuperMAG data creating a new list of geomagnetic disturbances (GMDs). The Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE) is used to place the observed GMDs in the context of the global pattern of magnetosphere-ionosphere field-aligned currents (FACs). The distribution of the identified GMDs during substorm times is also investigated using the SOPHIE substorm list.

4. Charles Bowers - School of Cosmic Physics, Dublin Institute for Advanced Studies

Jackman, CM; Sun, W; Holmberg, MG; Jia, X; Griton, L

Mercury's Magnetotail Lobe: A Statistical Analysis using MESSENGER Observations

We present a statistical analysis of the properties of Mercury's southern magnetotail lobe, as observed by during the orbital phase of the MESSENGER mission. The properties of the lobe field responds to changes in magnetic flux content and magnetopause flaring, making it a crucial region for analysing the magnetospheric response to the intense solar wind conditions at Mercury's orbit. We utilize data from the plasma spectrometer and magnetometer instruments onboard MESSENGER to define a set of empirically determined criteria which automatically determine time intervals when the spacecraft traversed the magnetotail lobes. From 3332 MESSENGER orbits, we identify 1242 lobe magnetic field intervals. From these, we derive a new expression for the falloff of Mercury's lobe field strength with radial distance from Mercury based on the complete MESSENGER sampling. This expression allows us to assess the extent to which each lobe crossing event is enhanced or diminished compared to its nominal state. Our findings reveal a direct correlation between the relative strength of the magnetotail lobe and the upstream solar wind dynamic pressure, estimated at the dayside magnetopause along MESSENGER's orbit. Thus, our study provides evidence for lobe magnetic flux response to upstream dynamic pressure conditions.

5. Nicholas Brindley - University of Southampton

Whiter, D; Gingell, I

Intermittent turbulence in fine-scale auroral structure

The mechanisms behind fine scale auroral structures with width scales of ~1 km and smaller are not well understood. Our work focusses on a specific type of fine scale dynamics – 'chocolate sauce' aurora, which exhibits movement characterised by what appears to be turbulence. We are investigating these turbulent processes by performing Local Intermittency Measure (LIM) analysis on spatial domain 2D radially averaged power spectra of images from the Auroral Structure and Kinetics (ASK) instrument. ASK is a multi-spectral imager currently on Svalbard, offering high spatial and temporal resolution (~20m per pixel at 100km altitude; 20 or 32 frames per second), for three different auroral emission wavelengths simultaneously.

We analyse the intermittency of structures in the images using LIM stack plots, allowing us to track peaks over time. Preliminary results indicate that events appearing to exhibit turbulence are characterised by two main types: a movement of a peak in intermittency to smaller scales over time; or the decay of a peak at larger scales, with the concurrent growth of a peak at smaller scales. We provisionally interpret these as indicative of an intermittent transfer of energy consistent with a turbulent cascade.

6. Martin Cafolla - Centre for Fusion, Space and Astrophysics; University of Warwick

Chapman, S C; Watkins, N W; Verkhoglyadova, O P; Meng, X

Variations with Season and Geomagnetic Activity seen in Space-Time Correlated Enhancements of Ionospheric TEC taken from JPL GIMs

TEC is a metric used to quantify variability in GPS position and timing. It is therefore central to the operation of LEO satellites, navigation and communication. Previous studies have mostly focused on spatially concentrated regions. Here we present a continental scale study of Ionospheric TEC variability. We consider GIMs from JPL, 18 years of global TEC maps obtained every 15 minutes from a network of GPS satellites and 100-200 ground stations. For each map, we find the level exceeded by the top 1% of TEC values and then identify spatially contiguous enhancements. We track these patches across consecutive maps in time to obtain a set of labelled coherent space-time blobs. Once a set of these blobs have been extracted over multiple years, dependence with geomagnetic activity and season can be explored statistically. Given Kp/Dst/F10.7, we can determine where these blobs form, how big/bright they are and how long they last. Our analysis detects, labels and tracks blob origin, path, areas, intensities and durations. The JPLI data set offers a higher accuracy of TEC estimation within the continental US and Europe as compared to other areas. We consider the impact of this non-uniform sampling on our results.

7. Suman Chakraborty - Northumbria University

I. J. Rae, C. E. J. Watt, I. R. Mann, L. Olifer, A. W. Smith, J. F. Ripoll, C. J. Rodger

Intense chorus waves drive rapid acceleration of relativistic electrons during storm main phase

Using 7 years of electron flux and electromagnetic wave measurements from the twin Van Allen Probes, we statistically investigate the effects of intense chorus waves on the relativistic electron population in the heart of the outer radiation belt ($L^* = 4 - 6$). In this study, we correlate the integrated chorus wave power with the statistical growth of relativistic electrons in the outer radiation belt. Our results show that the intense chorus waves result in rapid acceleration of relativistic electrons, especially in the energy range of 1.1 – 2.6 MeV during the main phase of geomagnetic storms. Our results also exhibit a positive correlation between the fractional change in electron fluxes and the chorus wave power, which shows that the variation in electron flux is more pronounced when the waves become more intense. This provides direct evidence of the effect of intense chorus waves on relativistic electron acceleration, which is found to be most effective at L* = 4.5. Overall our results provide crucial insights into the role of this distinct intense wave population on the radiation belt electron dynamics. This impact needs to be considered in radiation belt models to accurately capture the complex dynamics of the system.

8. John Coxon - Northumbria University

Shore, R.; Eggington, J.; Freeman, M.; Eastwood, J.

A geomagnetic storm case study of Birkeland current timescales

The Spatial Information from Distributed Exogenous Regression (SpIDER) technique allows for the correlation and time lag between two datasets to be visualised as maps. We employ this technique to generate maps of time lags during a geomagnetic storm, focusing on comparing AMPERE data with SuperMAG geomagnetic indices, and we get surprising results on which we would welcome discussion.

9. Tom Daggitt - British Antarctic Survey

Horne, R.B.; Glauert, S.A.; Del Zanna, G.; Albert, J

Chorus wave power at the strong diffusion limit overcomes electron losses due to strong diffusion

Earth’s radiation belts consist of high-energy charged particles trapped by Earth’s magnetic field. Strong pitch angle diffusion of electrons caused by wave-particle interaction in Earth’s radiation belts has primarily been considered as a loss process, as trapped electrons are rapidly diffused into the loss cone and lost to the atmosphere. However, the wave power necessary to produce strong diffusion should also produce rapid energy diffusion, and has not been considered in this context. We provide evidence of strong diffusion using satellite data. We use two-dimensional Fokker-Planck simulations of electron diffusion in pitch angle and energy to show that scaling up chorus wave power to the strong diffusion limit produces rapid acceleration of electrons, sufficient to outweigh the losses due to strong diffusion. The rate of losses saturates at the strong diffusion limit, whilst the rate of acceleration does not. This leads to the surprising result of an increase, not a decrease in the trapped electron population during strong diffusion. Our results suggest there is a tipping point in chorus wave power between net loss and net acceleration that global radiation belt models need to capture to better forecast hazardous radiation levels that damage satellites.

10. Rowan Dayton-Oxland - University of Southampton

Whiter, D.; Kim, H.

Pc1 measurements of EMIC waves are not significantly linked to the acceleration of auroral protons in the cusp.

It is widely believed that ElectroMagnetic Ion Cyclotron (EMIC) plasma waves are the responsible mechanism for the precipitation and acceleration of auroral protons - however, ground-based measurements of proton precipitation and Pc1 pulsations from Svalbard under the cusp region give evidence that there is no link between them. We have used spectrograph measurements of proton

aurora over Svalbard from the High-Throughput Imaging Echelle Spectrograph along with with 2-Axis Search-Coil Magnetometer measurements of Pc1 pulsations which can be used to measure EMIC waves at the ground level. Using these data over the 21/22 observing season we found no evidence of a link between Pc1 and proton aurora precipitation or acceleration, using three different methods. Firstly, we see no temporal interdependence of proton aurora and Pc1 pulsations. Secondly, the energy spectrum (acceleration) of the proton aurora is unchanged between Pc1 activity and quiet times. Lastly, no flickering in the proton aurora is detected during Pc1 pulsations, unlike in electron aurora which displays flickering behaviour due to EMIC acceleration. Alternative explanations and mechanisms are discussed.

11. **Ravindra Desai - University of Warwick**

ROARS Consortium (bit.ly/ROARS_mission)

ROARS: Revealing Orbital and Atmospheric Responses to Solar activity – A multi-spacecraft mission to Low Earth Orbit

The accumulation of space debris, and congestion of near-Earth orbits, represent an outstanding challenge to the safe use of our space environment. Satellite drag from the Earth’s upper atmosphere is a primary perturbative force on near-Earth satellite orbits, and its accurate characterisation is essential to predicting and preventing further collisions and the run-away proliferation of space debris. Atmospheric drag in LEO is highly sensitive to the solar wind-magnetosphere interaction. Unlike the many isolated in-situ measurements carried out by space missions so far, distributed neutral, plasma and magnetic field observations by a swarm of CubeSats across LEO, in tandem with precise tracking of their orbital dynamics, offer the global view necessary to disentangle the influence of the coupled magnetosphere-ionosphere-thermosphere system on satellite orbits. This novel mission architecture will obtain the first coordinated measurements in LEO across a range of altitudes, latitudes and longitudes to understand the evolution of field-aligned and ionospheric currents, Joule heating and response of the neutral atmosphere. Coordinated orbit- and ground-based space surveillance and tracking campaigns (GNSS, laser, optical) will simultaneously relate the CubeSats’ orbital dynamics to the in-situ measurements, whilst inter-satellite laser ranging will provide unprecedented insights into meso- and micro-scale atmospheric drag dynamics.

12. **Gareth Dorrian - Space Environment and Radio Engineering (SERENE), University of Birmingham**

Themens, D., Wood, A., Boyde, B., Fallows, R. A., Trigg, H.

Tracking asymmetric quasi-periodic oscillations within a travelling ionospheric disturbance from Poland to the North Sea with LOFAR

We use ionospheric scintillation observations with the LOw Frequency ARray (LOFAR) to track the propagation and evolution of asymmetric quasi-periodic oscillations (QPO) within a travelling ionospheric disturbance (TID) over a distance of 1200 km. The TID was tracked all the way from the Baltic Sea to the North Sea in the early morning of 17 December 2018. Evidence from regional ionosondes and mesospheric radar suggest the ducting structure was a large scale sporadic-E layer which extended over most of Northern Europe and was present for at least 4 hours. QPO-like structures were also seen in GNSS signals on raypaths intersecting the ducting region with amplitudes of no more than +/- 0.1 TECu. Without exception the QPO seen across the LOFAR

network were all asymmetric, in which a large broadband signal fade precedes a series of decreasing intensity diffraction fringes. The propagation of the TID, acquired by observing event onset times at sequential LOFAR stations was approximately West-South West at 145 ms-1. The lifetime of each individual oscillation was of the order of a few minutes which, at the estimated velocity, corresponded to ionospheric plasma scale sizes of < 20 km.

13. Kendra Gilmore - Northumbria University

Bentley, S.

How important is magnetospheric time history for predicting auroras?

Forecasting the aurora and its location accurately is important to mitigate any potential harm to vital infrastructure like communications and electricity grid networks. Current auroral prediction models rely on our understanding of the interaction between the magnetosphere and the solar wind or geomagnetic indices. Both approaches do well in predicting but have limitations in respect to forecasting (geomagnetic indices-based models) or because of the underlying assumptions driving the model (due to a simplification of the complex interaction). By applying machine learning algorithms, gaps in our understanding can be identified, investigated, and closed. In this context, neural networks can capture non-linear behaviour not described by analytical or empirical functions. We use magnetic field measurements from SuperMAG (Gjerloev, 2012) and auroral boundary data derived from the IMAGE satellite (Chisham et al., 2022). Applying a LSTM (Long Short-Term Memory) model, designed to include time history for prediction, we predict if a given SuperMAG station is in- or outside of the main auroral oval. Leveraging the time history of a given station, we explore the impact on the predictive capabilities of the model. Additionally, we investigate the problem of imbalanced data and explore strategies of dealing with it.

14. George Greenyer - Lancaster University

Arridge, C; Wiggs, J

Implementing the Boris Method in a Jovian Middle-Magnetosphere Plasma Simulation

To improve simulation results for plasma transport in the Jovian magnetosphere, we are presenting an investigation into the advantages of the Boris velocity advancement method over the forward Euler method. Comparisons made for processing speed, energy conservation, and scope for expansion show that utilising the Boris method is conducive to more accurate simulations without significant penalty in processing time. These tests are performed in the context of a 2.5D model of the Jovian magnetosphere, which allows us to examine possible means of plasma transport and intriguing dynamics.

15. Samuel Greess - Queen Mary University of London

Egedal, J.; Stanier, A.; Gradney, P.; Kuchta, C.; Flores Garcia, R.; Yu, X.; Olson, J.; Le, A.; Forest, C.B.; Daughton, W.

Modeling experimental magnetopause-like reconnection with multidimensional kinetic simulations: TREX and Cylindrical VPIC

The Terrestrial Reconnection EXperiment (TREX) at the Wisconsin Plasma Physics Laboratory (WiPPL) creates and measures different reconnection geometries in collisionless plasmas, with the aim of understanding the reconnection mechanisms of low-density space environments. Work on TREX is supplemented by kinetic simulations using Cylindrical VPIC, a particle-in-cell code developed at Los Alamos National Laboratory. VPIC simulations of TREX work in tandem with laboratory experiments, such that each provide feedback that shapes the designs and objectives of the other. So far, TREX data and simulations have shown agreements in the layer width [1] and reconnection rate [2] of asymmetric anti-parallel reconnection; further work on modeling new TREX drive geometries and guide-field reconnection is ongoing. WiPPL is a collaborative research facility that is available to external users in the space and plasma sciences; experimental proposal submissions are welcome.

[1] Greess et al. https://doi.org/10.1029/2021JA029316

[2] Greess et al. https://doi.org/10.1063/5.0101006

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Fusion Energy Sciences under Award Number DE-SC0018266 and by a fellowship from the Center for Space and Earth Science (CSES) at LANL.

16. Rosie Hodnett - University of Leicester

Yeoman, T. K.; Beggan, C. D.; Wright, D. M.

Modelling the effects of the Alfvén velocity profile on the structure of the ionospheric Alfvén resonator and a comparison with observations from Eskdalemuir, UK

Ionospheric Alfvén Resonances (IARs) occur when Alfvén waves travelling parallel to magnetic field lines are partially reflected when the Alfvén velocity gradient reaches a maximum at boundaries in the ionosphere. We have observed IAR as bright fringes during local nighttime in spectrograms computed from the Eskdalemuir induction coil magnetometer data set. By using a neural network (U-Net), we have automatically extracted the frequencies of the IAR harmonics, from 2013 to 2021. To complement the data set, we have modelled the structure of the IAR harmonics with their frequencies by considering the non-uniform Alfvén velocity profile and solving a one-dimensional wave equation. The Alfvén velocity profile is modelled using the International Reference Ionosphere and the International Geomagnetic Reference Field. There is good agreement between observed and modelled harmonics. Previous uniform models of the IAR structure with equal spacing between the harmonics have investigated the lower boundary condition. We present a comparison between the Eskdalemuir data set and the results of the uniform and non-uniform models. We will discuss the implications the non-uniform Alfvén velocity profile has on the individual harmonic frequencies, and what can be inferred regarding the lower boundary condition of the IAR.

17. Charalambos Ioannou - UCL

Nicolaou, G; Owen, C.J.; Livadiotis, G

Polytropic analysis of ion-acoustic waves in the solar wind observed by Solar Orbiter.

An ion-acoustic wave (IAW) is a type of electrostatic, longitudinal oscillation of the ions in a plasma. IAWs can be generated by the current-driven instability or by resonant interactions with proton beams in the solar wind. These waves interact with particles in the plasma disrupting its velocity distribution function (VDF), and thus play an important role in the thermal evolution of the solar wind. Derivation of the ion sound speed from the Vlasov equation shows that electrons react isothermally, $\gamma_e=1$, and protons react adiabatically in one dimension, $\gamma_i=3$, to the electrostatic fluctuations of the IAW, where γ_e and γ_i are the respective electron and proton polytropic indices. We identify intervals of IAWs observed by Solar Orbiter and perform polytropic analysis on proton data gathered by the SWA-PAS instrument. We first use the ground moments proton data to determine the proton polytropic index. We then apply fitting techniques to the VDF data to derive the bulk properties and determine the polytropic index of the core and beam proton populations separately, to compare and contrast the behaviour of the two populations.

18. Nawapat Kaweeyanun - University of Southampton

Fear, R.C.

In Situ Observations of Interaction Between the Closed Magnetic Field of Earth's Transpolar Auroral Arcs and the Magnetopause

Transpolar arcs (TPAs) are extensions of auroral emission poleward beyond the main ovals, forming partial or complete bisections known as 'theta' auroras. A prominent hypothesis suggests that a TPA occurs through stagnation of magneto-plasma returning from Earth's magnetotail under northward interplanetary magnetic field (IMF), resulting in a 'wedge' of closed magnetic field lines in the open polar cap on which particles resemble those in the nightside equatorial plasma sheet. It has been proposed that a TPA's closed-field lines may reach sufficiently high latitude to magnetically reconnect with the IMF at the lobe magnetopause, leading to observed coincidence of the TPA and a cusp spot. Using conjugate data from Cluster, Imager for Magnetopause-to-Aurora Global Exploration (IMAGE), Special Sensor Ultraviolet Spectrographic Imager (SSUSI), and other instruments, we demonstrate two case studies of potential first in situ detections of TPA-IMF magnetic reconnection, and several observations of particles on closed-field particle populations near the lobe magnetopause. Pending affirmative analysis, the existence of such reconnection event will not only further support the 'wedge' TPA formation hypothesis, but also indicate that lobe reconnection can open topologically closed nightside magnetic field lines, introducing new polar cap dynamics under northward IMF.

19. Harley Kelly - Imperial College London

Archer, M.O; Eastwood, J.P; Eggington, J.W.B; Heyns, M; Desai, R.T; LaMoury, A; Mejnertsen, L; Chittenden, J

Investigating the Frequencies of Kelvin-Helmholtz Waves Globally: Mode Dominance, Superposition, and their Magnetospheric Effects in MHD Simulations

The Kelvin-Helmholtz instability (KHI) is a dominant driver of the viscous-like interaction at the interface of the solar wind-magnetosphere coupling, the magnetopause. It leads to the growth of magnetopause surface waves (MSWs) and their evolution into non-linear rolled-up vortices. We

present results of KHI-generated MSWs from the Gorgon global MHD model. We use a machine learning analysis technique known as dynamic mode decomposition (DMD) to identify wave-like structures. DMD decomposes a spatiotemporal signal into discrete spatial modes, amplitudes, and temporal signals. Using this technique reveals 5 dominant MSW frequencies (ranging from ~ 1-5 mHz) which constitute ~ 75% of the total fluctuation energy in the simulation. The analysis reveals the frequency dominance varies with local time and latitude, however, discrete frequency MSWs have a finite extent along the boundary and a superposition of modes is present showing the KHI both generates and advects MSWs and vortices. The analysis also reveals MSW effects on the magnetosphere: MSWs drive magnetosheath waves which cause bow shock motion; the KHI is present along the high-latitude magnetopause in the noon-midnight meridian; and MSWs are shown to be linked to plasma sheet waves. We conclude by discussing how this approach improves understanding of MSW energy transfer.

20. Shannon Killey - Northumbria University

Rae, I.J., Smith A.W., Watt C.E.J, Bentley S.N., and Chakraborty S.

Mapping the Evolution of Relativistic Electrons During Geomagnetic Storms

Relativistic electrons in the Van Allen Radiation Belts are driven by simultaneous magnetospheric processes, meaning their behaviour is highly dynamic and difficult to diagnose. Machine learning tools have recently been applied to 7-years of Van Allen Probe Relativistic Electron Proton Telescope (REPT) data to identify 6 different, distinctly shaped energy-dependent pitch angle distributions (PAD) that correspond to different physical processes operating in the Radiation Belts.

We focus on the spatial and temporal evolution of PADs through geomagnetic storms to understand the physical mechanisms responsible for pitch angle evolution. We find that there are clear sequences of PAD evolution as a function of radial distance (L*) through each phase of a geomagnetic storm. We link this PAD evolution to their respective physical drivers and show when and where these physical mechanisms dominate pitch angle evolution in the Van Allen Radiation Belts during geomagnetic storms.

21. Patrik Krcelic - University of Southampton

Fear, R.C; Whiter, D. K; Lanchester, B

Variability in the electrodynamics of the small scale auroral arc.

We use the narrow-field Auroral Structure and Kinetics (ASK) camera in order to estimate the small scale auroral electrodynamics. The camera observes three distinct wavelengths, two prompt emissions and one metastable. Two prompt emissions have a lifetime shorter than the temporal resolution of the camera, and therefore we treat it as instantaneous. The emissions are carefully chosen so we can extract the energy and flux of precipitating electrons from the ratio of the two emissions. The metastable emission has a lifetime of around 5 seconds, which allows us to estimate the ion drift using a careful modeling of the metastable emission. Our instruments allow us to infer the high resolution dynamics of the aurora. We have cross-correlated the electric field measurements with a modelled auroral source to understand the mechanism and connections in auroral electrodynamics as well as to understand the source of high auroral variability.

22. Patrik Krcelic - University of Southampton

Fear, R.C; Whiter, D. K; Lanchester, B

Local Joule heating profile near small scale auroral features estimated from high resolution electric fields.

We use a combination of ASK, HiTIES and EISCAT measurements to estimate the local Joule heating profile near highly dynamic small scale auroral features during the events on February 1st and 2nd 2017. The ratios of various measured emissions, as well as careful modelling of auroral features, allow us to estimate small scale electric fields on a sub second resolution. HiTIES is a spectrograph measuring auroral emissions in the infrared spectrum. The obtained spectrum is highly dependent on the high altitude atmosphere neutral temperature, which is estimated from fitting of synthetic spectra to the measured one. From EISCAT measurements we use profiles of electron densities as well as ion and electron temperatures. All measurements are taken from the same, narrow field of view. Our reasoning is that the small scale electric fields near the auroral features have much higher variability and intensity compared to the more stable neutral wind so that the collision frequency remains practically unchanged. Furthermore, our Joule heating estimates give significantly larger values (up to 100 times higher) than those estimated with more broad, lower resolution measurements. Such intense local heating in auroral region certainly plays an important role in the ionosphere and must be further researched.

23. Adrian LaMoury - Imperial College London

Heyns, M; Eggington, JWB; Kwagala, NK; Hagen, JTG; Archer, MO; Cave-Ayland, C; Desai, RT; Kelly, HM; Mejnertsen, L; Chittenden, J; Eastwood, JP

Operational modelling of space weather ground effects with the GorgonOps simulation suite

In order to safeguard critical ground-based infrastructure in the face of extreme space weather scenarios, the provision of tailored and accurate geospace outputs is vital for building societal resilience. In this context, physics-based modelling is an extremely powerful tool. GorgonOps is an operational space weather forecasting suite built on the Gorgon global magnetohydrodynamic (MHD) code and optimised for real time operation. By ingesting measured or modelled solar wind conditions at L1, GorgonOps provides several space weather forecasting products, including predictions of the ground geomagnetic field, visualisations of the geospace response, global geomagnetic indices, and key ionospheric and magnetospheric parameters. Bespoke end-user specific localised forecasts are also possible. Here we showcase the functionality and forecasting capabilities of GorgonOps. We also discuss the current status of the model deployment and service provision at the Met Office as part of the UK SWIMMR Activities in Ground Effects (SAGE) programme, and within the ESA Space Weather Service Network as part of the Bergen Imperial Global Geospace (BIGG) forecasting system, therefore providing services informed by end-user needs in the UK and European sectors. We conclude with a discussion about different concepts for operational service provision in the future based on lessons learned to date.

24. Adrian LaMoury - Imperial College London

Cheng, IK; Eastwood, JP; Fargette, N; Lewis, HC; Waters, CL

Magnetic reconnection in Earth's turbulent magnetosheath: Exhaust structure and heating

Magnetic reconnection is a fundamental plasma process whereby energy is released via the instantaneous breaking and topological rearranging of magnetic fields. The Magnetospheric Multiscale (MMS) mission, launched in 2015, has allowed us to probe reconnection processes in unprecedented detail. Here we present a statistical study of magnetic reconnection observed in the terrestrial magnetosheath by MMS. Typically consisting of large-scale solar wind current sheets advected through the bow shock, our data set contains a range of symmetric and asymmetric inflow conditions, often with significant guide fields. Using the database, we examine reconnection exhaust structure and heating. In particular, we present the first statistical study on the prevalence of separatrix-aligned density cavities, counterstreaming electron beams, and their evolution with estimated distance from the X-line. We analyse exhaust heating profiles and probe the influence of guide fields on the efficiency of energy conversion. Our findings further reveal the complex geometries associated with reconnection in the turbulent magnetosheath environment.

25. Christian Lao - UCL Mullard Space Science Laboratory

Isola, B; Delzanno, GL; Borovsky, JE; Sorathia, KA

On the robustness of a new global index of Solar Wind-Magnetospheric Coupling

Studies of Magnetospheric response to Solar Wind have typically applied correlation studies with a physics informed coupling function and indices. In this study, we apply a system science tool, Canonical Correlation Analysis, to create new coupled indices of the Solar Wind and the Magnetosphere, derived from state vectors describing the driver (Solar Wind) and system (Magnetosphere), with predictive performance greater than that of previous Solar Wind coupling functions. We test the data requirements for the new coupled indices to converge and find that, relative to the size of the Space Physics dataset, a very small amount of data is required for them to converge. Furthermore, we test the robustness of the method to the differing Solar Wind and Geomagnetic conditions that occur in the period between 1997 and 2020. We find that the new indices can make good predictions of extreme events even when only “trained” on the quiet-time Solar Wind and Magnetosphere. Finally, due to occurrences of data dropouts and instrument issues on spacecraft, a minimal model composed of only a few variables per state vector, that still provides high correlations, is explored.

26. Andrea Larosa - Queen Mary University of London

Chen, C.H.K; McIntyre, J.R.; Jagarlamudi V.K.

On the Relation between Switchbacks and Turbulence in the Inner Heliosphere for different types of Solar Wind

We investigate the evolution of the magnetic field vector increments and rotation distributions in the inner heliosphere with Parker Solar Probe data. In Larosa+2023 (submitted) we showed that the distributions, that include magnetic switchbacks, evolve in a scale and distance dependent fashion towards a log-normal shape in a manner consistent with the turbulent processing of expansion driven fluctuations. Here we extend those results by investigating the behavior of the distributions for different solar wind streams (fast vs slow wind, alfvenic vs sub-alfvenic). These results are important in general for the understanding of turbulence in the inner heliosphere and particularly for the evolution of the magnetic field switchbacks.

27. Zoe Lewis - Imperial College London

Beth, A; Galand, M; Henri, P; Rubin, M; Stephenson, P

Constraining ion transport in the diamagnetic cavity of comet 67P

Comet 67P was the target of the ESA Rosetta mission, escorted by the spacecraft for two years. By perihelion in August 2015, the neutral and plasma data obtained by the spacecraft instruments showed that the comet had become a dynamic object with large scale plasma structures and a rich ion environment. One such structure is the diamagnetic cavity: a region surrounding the nucleus where mass loading by un-magnetised cometary ions prevents the solar wind from carrying the magnetic field to the surface. Within this region, unexpectedly high ion bulk velocities have been observed, thought to be caused by acceleration from an ambipolar electric field. The nature of this field is difficult to determine analytically.

In this study we use a 1D numerical model of the cometary ionosphere to constrain the impact of various electric field profiles on the ion density profile. In the model we include three ion species, H2O+, H3O+ and NH4+, and assess how their relative composition, as well as the total plasma density, vary with ambipolar electric field strength. We compare the modelled plasma density with electron density measurements from the Rosetta Plasma Consortium (RPC) instruments to determine the electric field required to explain the observations.

28. Jingting Liu - University College London

Daniel Verscharen, Jesse Coburn, Jeffersson Agudelo, Kai Germaschewski, Hamish Reid, Georgios Nicolaou, Christopher Owen

Particle-in-cell simulations of Langmuir-wave emission from magnetic holes

Langmuir waves are frequently detected in the solar wind and affect the energetics of the plasma electrons. Previous observational studies have found Langmuir waves associated with magnetic holes in the solar wind. In our work, we aim to understand the connection between magnetic holes and these waves.

The Langmuir instability is a well-known consequence of electron beams in plasmas. We use particle-in-cell (PIC) simulations of a collisionless electron-ion plasma in a magnetic hole structure. We study the triggering of Langmuir waves by inhomogeneous beam instabilities in this configuration.

Our simulations reveal patterns that suggest that injecting a beam into the magnetic hole has the potential to create spatially inhomogeneous Langmuir wave packets by instability. We support our PIC simulations with linear stability calculations and discuss the conditions required for magnetic holes to emit Langmuir waves through our proposed mechanism. Ultimately, we will subject our simulation results a rigorous comparison with data of Langmuir-wave emitting magnetic holes collected by Solar Orbiter.

29. Sophie Maguire - Space Environment and Radio Engineering (SERENE), University of Birmingham

Wood, A.G.; Themens, D.R.

Large-scale plasma structures and scintillation in the high-latitude ionosphere

The terrestrial ionosphere is a highly variable medium that has the ability to affect the propagation of radio waves. Within the ionosphere, large-scale structures, such as polar cap patches, auroral forms, blobs and polar holes, have been observed. Small-scale irregularities associated with these large-scale structures result from instability processes which can lead to scintillation of trans-ionospheric radio signals, such as those used for Global Navigation Satellite Systems (GNSS).

In order to test the relationship between large-scale structures and scintillation, an experiment named Scintillation and Plasma Density Gradients (SGRAD) was run on the European Incoherent Scatter (EISCAT) radars. The initial results from the SGRAD run on the 5th of January 2023 (1800UT-2359UT) showed that multiple plasma mechanisms, in this case transportation and particle precipitation, can act simultaneously on the same plasma. This result is believed to be the first direct observation of this phenomena and so it offers interesting possibilities for the associated scintillation effects. GNSS receivers are used to provide measurements of the phase and amplitude scintillation, as well as the Total Electron Content (TEC). The scintillation effects associated with the physical phenomena are discussed.

30. Jack McIntyre - Queen Mary University of London

Chen, C H K; Larosa, A

Observations of the turbulence transition range as evidence for the helicity barrier

The means by which energy is dissipated in solar wind turbulence, a process which can heat and accelerate the solar wind, is not fully understood. Observed properties of the turbulence power spectrum at dissipation scales remain unexplained, including the variability in the shape and location of the break between inertial and kinetic scales. These questions, and other debated elements of solar wind turbulent dissipation, are suggested by Meyrand et al. 2021 to be addressed by their proposed “helicity barrier”. For imbalanced turbulence with low plasma beta, conditions regularly met in the inner heliosphere, they argue that oppositely directed generalised helicity cascades create a “barrier” effect at ion scales, limiting the cascade of the dominant Elsasser field. This should result in a steep transition region between the inertial and kinetic scales of the power spectrum, a feature observed from in situ measurements. Using data from the Parker Solar Probe mission we measure properties of this transition, exploring their dependence on cross helicity and plasma beta. As these parameters can be used to identify regions where the barrier would be expected to be active, such analysis can provide evidence in support of the helicity barrier - we evaluate the strength of this evidence.

31. Dikshita Meggi - University of Leicester

Sanchez-Cano, B; Lester, M; Stergiopoulou, K; Joyce, S; Regan, C; Andrews, D; Xu, S; Witasse, O

Martian ionospheric dynamics by crustal magnetic fields as observed by MARSIS-Mars Express

Mars, without a global dipole magnetic field, has its atmosphere directly exposed to the impinging solar wind. However, this solar wind interaction is made complex by the large presence of remnant crustal magnetic fields in the southern hemisphere of Mars, which rotate with the planet and produce a “hybrid magnetosphere”. Their irregular distribution and variety of strengths and inclinations also gives rise to a varied and dynamical magnetic topology, which influences the Martian plasma environment. We use nearly 12 years of observations from the Mars Advanced Radar

for Subsurface and Ionosphere Sounding (MARSIS) on board Mars Express to characterise the variability of the topside electron density profiles over the strong anomalies in the southern hemisphere. Statistical analysis involves calculation of relative electron density differences and the total electron content of the profiles normalised with respect to solar zenith angle. The effect of numerous parameters, such as the solar zenith angle (hence, local time), solar activity, Mars' season, crustal magnetic field inclination, and solar wind dynamic pressure are investigated in relation to the ionospheric dynamics. The observations are compared to the Chapman layer theory, profiles from unmagnetized regions and the magnetic topology at Mars.

32. Michaela Mooney - University of Leicester

Milan, S.E.; Bower, G.E.

Plasma observations in the distant magnetotail associated with cusp-aligned arcs

Intervals of northward interplanetary magnetic field (IMF) alter the structure and dynamics of the magnetosphere. Under northward IMF, reconnection occurs at higher latitudes tailward of the cusps. High latitude reconnection occurring simultaneously in both hemispheres can close significant amounts of open flux in the magnetospheric lobes resulting in an almost entirely closed magnetosphere and has been linked to characteristic auroral signatures including cusp-aligned arcs.

We examine an 8-day interval of predominantly northward IMF in October 2011 where multiple instances of cusp-aligned arcs are observed in the polar region. Coincident with the cusp-aligned arc observations, the electrostatic analyser on-board ARTEMIS measures high ion and electron fluxes at approximately 60 RE downtail in regions of the magnetotail which would typically be the magnetotail lobe containing open flux evacuated of plasma. Meanwhile, Cluster observe a similarly dense (~1 cm-3) plasma far out of the equatorial plane (Z ~ 13 RE, Milan et al., 2023). We interpret these observations as trapped plasma on closed field lines indicating that the magnetotail may be closed down to 60 RE. We suggest that this trapped plasma could be the source plasma population that precipitate into the polar region, resulting in the cusp-aligned arc signatures.

33. Nawin Ngampoopun- MSSL/UCL

Long, D.M.; Green, L.M.; Yardley, S.L.; James, A.W.; Mason, E.I.; Uritsky, V.M.

Investigation of small-scale evolution of coronal hole boundaries using high-cadence EUV observations

The origin and formation of the slow solar wind remains an open question in solar physics. One possible scenario is that the slow solar wind may arise from coronal hole boundaries (CHBs) via interchange reconnection. This process also dominates the small-scale evolution of coronal hole boundaries. In this study, we investigate the small-scale evolution of magnetic field and plasma properties at the boundary of a large equatorial coronal hole to identify signatures of interchange reconnection. Using data from the Solar Dynamics Observatory, the coronal hole boundary is identified and tracked across a 7-day observation period with very high spatial and temporal resolution. Differential Emission Measure (DEM) analysis is used to derive plasma properties, such as the emission measure, plasma temperature, plasma density and thermal energy. We also implement the correlation dimension mapping (CDM) analysis to measure the irregularities of CHB. All of these enable us to effectively analyse the shift in CHB and the evolution of relevant magnetic and plasma properties on very short temporal scales, providing insight into the ongoing process of interchange reconnection at the edge of the coronal hole and the surrounding region.

34. Jonathan Nichols - University of Leicester

F. Allegrini, F. Bagenal, B. Bonfond, G. B. Clark, J. T. Clarke, J. E. P. Connerney, S. W. H. Cowley, R. W. Ebert, G. R. Gladstone, D. Grodent, D. K. Haggerty, B. Mauk, G. S. Orton, G. Provan, R. J. Wilson

Jovian magnetospheric injections observed by the Hubble Space Telescope and Juno

We compare HST observations of Jupiter's FUV auroras with contemporaneous conjugate Juno in situ observations in the equatorial middle magnetosphere of Jupiter. We show that bright patches on and equatorward of the main emission are associated with hot plasma injections driven by ongoing active magnetospheric convection. During the interval that Juno crossed the magnetic field lines threading the complex of auroral patches, a series of energetic particle injection signatures were observed, and immediately prior, the plasma data exhibited flux tube interchange events indicating ongoing convection. This presents the first direct evidence that auroral morphology previously termed ``strong injections" is indeed a manifestation of magnetospheric injections, and that this morphology indicates that Jupiter's magnetosphere is undergoing an interval of active iogenic plasma outflow.

35. Georgios Nicolaou - Department of Space and Climate Physics, Mullard Space Science Laboratory, University College London

Owen, C.J.

Determining Electron Plasma Properties from Solar Orbiter Observations

Solar Wind Analyser’s Electron Analyser System (SWA-EAS, Owen et al., 2020) is designed to measure Solar Wind electrons and resolve their three-dimensional (3D) Velocity Distribution Functions (VDFs). The accurate construction of the electron 3D VDFs relies not only on the data quality, but also on the data analysis methods. In this presentation, we describe the up-to-date methods we have developed to analyse SWA-EAS observations, to construct accurate 3D VDFs and calculate their velocity moments. The latter determine the bulk properties of the electron plasma, such as the electron density and temperature. We explain how we account for the acceleration of the electrons due to the spacecraft potential, how we remove the contamination from secondary- and photo-electrons, and subsequently combine the observations by the two EAS sensors to construct the distributions in the spacecraft reference frame. We then discuss the comparison between the electron densities we determine from our analysis with the density estimates derived from the analysis of the quasi-thermal noise measurements by the Radio and Plasma Waves (RPW, Maksimovic et al., 2020) instrument on-board Solar Orbiter. Finally, we discuss illustrative studies in which our data-products have been essential to address dynamic mechanisms in plasmas.

36. Georgios Nicolaou - Mullard Space Science Laboratory, University College London

Ioannou, C.

Forward models of space plasma instruments for the accurate determination of plasma bulk parameters

Forward models ore often used to simulate observations of plasma instruments in specific plasma environments. Typical data analyses use forward modeling to optimize the plasma bulk parameters that fit the actual observations. However, several studies use simplified instrument models in order to reduce the computational time required for the analysis. Here, we develop a high-resolution forward model of a typical electrostatic analyser with aperture deflectors and a position sensitive detector. We simulate measurements of this concept instrument in typical Solar Wind plasma protons without any simplification in our calculations. We then analyse the simulated measurements with the standard simplifications implemented in the analysis and determine the plasma bulk speed, density, and temperature. We then compare the determined parameters with those we use to simulate the observations in the first place. This comparison shows that the standard simplifications of the analysis can lead to significant misestimations of some of the plasma properties. The plasma temperature suffers the largest misestimations, while the plasma speed is barely affected. Moreover, we show that the misestimations get larger when the analysis is performed in colder and/or faster plasmas.

37. Utsav Panchal - Northumbria University

Robert T.Wicks, Julia E.Stawarz

An investigation of the helicity barrier effect using Parker Solar Probe.

The fundamental mechanisms that heat and accelerate the solar wind are, as yet, unknown. The energy injected at large scales in the system drives turbulence and transports energy to kinetic scales, but the mechanism dissipating the energy into heat is not known. Do instabilities grow from free energy in the anisotropy of collision-less velocity distributions of protons to generate waves in the plasma, or does energy transport by turbulence create waves via magnetic helicity conservation (helicity barrier), which in turn damp on the proton velocity distribution to create anisotropy? The helicity barrier is a recently proposed theory; it can be tested by finding corelation between magnetic, cross helicity and injection imbalance ($\sigma\varepsilon$). Helicity barrier is proposed to be active when the injection imbalance is less than the ratio of electron inertial length to ion gyroradius. Here, we test the helicity barrier theory by calculating the energy cascade rates using 3rd order structure functions and show magnetic and cross helicity for the same intervals produced using Fourier transforms. We perform a structure functions analysis on such intervals to see if the curves of Elsasser variables ($z+$, $z-$) behave as power laws near the sun and at different radial distances from the sun.

38. James Plank - University of Southampton

Gingell, I.L.

Simulations of the evolution of turbulence across Earth's bow shock: correlation length, magnetic spectra and kurtosis for varying shock parameters

Recent high-resolution observations of Earth's bow shock, using spacecraft such as Magnetospheric Multiscale, have shown significant variations in the quantities used to characterise turbulence when comparing regions upstream, within, and downstream of the shock. Variations have also been seen between the quasi-parallel and quasi-perpendicular regimes, and between high and low Mach numbers. To gain a stronger understanding of the effect of the bow shock on turbulence, we perform a range of hybrid and full-PIC simulations of shocks. We choose shock normal angles of 40 (quasi-parallel) and 60 (quasi-perpendicular) degrees, and Mach numbers of 6 and 12. We split each simulation into short intervals with varying distance upstream and downstream of the shock, which we then use to describe the average behaviour of the magnetic spectrum, kurtosis and correlation length as a function of distance from the shock. Our initial findings show that the scaling of the kurtosis of turbulent fluctuations generated by the shock decays to background levels over a length scale of 20-50 ion inertial lengths, where the longer decay occurs in the quasi-perpendicular, high Mach regime. We also show that the magnetic spectral index downstream of the shock fluctuates in the range of -2.5 to -3.

39. Gabrielle Provan - University of Leicester

J. D. Nichols, S. W. H. Cowley, R. J. Wilson, F. Bagenal and J. E. P. Connerneyd

Jupiter’s magnetodisc and magnetospheric currents during Juno’s prime mission

We study the Jupiter’s magnetic field and plasma parameters during Juno’s prime mission, using data from Juno’s FGM magnetometer and ion measurements from the Jovian Auroral Distributions Experiment Ion (JADE-I) sensor on Juno. We compare the observed poloidal magnetic field and the plasma density with results from the Nichols et al. (2015) axisymmetric magnetic vector potential model. This magnetodisc model balances the j x B force of the azimuthal magnetodisc currents with the outwards forces of the plasma pressure gradient, plasma pressure anisotropy and the centrifugal force associated with the rotating plasma. By varying the model parameters for each orbit we model how Jupiter’s mass outflow rate, plasma angular velocity, ‘hot’ and ‘cold’ plasma temperatures and densities vary throughout Juno’s prime mission. We further examine how changes in magnetospheric conditions are related to variations in the magnetosphere–ionosphere coupling parameters, in particular by studying the azimuthal and radial currents and the ionospheric field-aligned current density.

40. Dovile Rasinskaite - Northumbria University

Watt C.E.J.

A Number Density/ Temperature Description of the Earth’s Outer Radiation Belt

Substorms can inject electrons of energies ranging from 10s to 100s keV into the magnetosphere which can be accelerated to relativistic energies and be harmful to space-based infrastructure. Currently we have an energy/ flux description of the inner magnetosphere and a density/temperature description only at geosynchronous orbit. Here we present a density/temperature description of the Earth’s outer radiation belt in this energy range obtained from omni-directional flux and energy measurements from the HOPE and MagEIS instruments from the Van Allen Probe mission. A density/ temperature description is advantageous over an energy/flux description as it allows us to differentiate between the transport and heating of electrons. This dataset provides a comprehensive statistical study of the whole Van Allen probe era. Values of density and temperature are extracted by fitting energy and phase space density to obtain the distribution function. Zeroth and second moments are taken respectively of the distribution function to calculate the number density and temperature. Analysis has indicated that a bi-maxwellian fit is sufficient and that there are two independent plasma populations. General statistical properties are presented and spatial variation in L* and MLT of density and temperature of the two plasma populations are discussed.

41. Daniel Ratliff - Northumbria University

Allanson,O; Bentley,S.N.;

Nonlinear Whistler-Mode Chorus Waves: From Theory Towards Forecast

In this talk, we recount recent theoretical work on the evolution of nonlinear Whistler-Mode Chorus (WMC) waves, using perturbative approaches to derive equations governing the evolutions of wavepackets. This balances wave dispersion with amplitude modulations and includes a novel "self frequency steepening" term. From this, we demonstrate that the models reproduce the formation of tones WMC are renown for, but additionally provides theoretical evidence for the formation of the bandgap at half the gyrofrequency.

Finally, we present preliminary new results as to how such a model can be used to generate wave amplitude distributions, using techniques from ocean wave forecasting, providing insight into how and when extreme wave activity might occur.

42. Abid Razavi - University College London

Owen, C.J; Nicolaou, G; Lewis, G; Watson, G; Anekallu, C; Kelly, C; Trotta, D; Maksimovic, M;

Investigating electron energisation across interplanetary shocks in the Solar Wind.

Magnetosonic shocks may occur near the interface between two distinct plasma regimes. The shocks act to dissipate plasma flow energy into magnetic and plasma thermal energy. To understand this conversion of energy and how it is partitioned between the particles in the solar wind, in particular to electrons, short time scale processes must be examined.

In this presentation, we explain how we use in-situ Solar Orbiter data to classify and characterize different types of shocks. We further use measurements from the Electron Analyser System, part of the Solar Wind Analyser suite onboard the Solar Orbiter to construct high time-resolution electron 3D velocity distribution functions across magnetosonic shocks and examine the previously reported flat-topped electron distributions that occur in the downstream region.

We describe the results of a statistical study to determine which shock parameters may increase the likelihood for this type of distribution to occur and the degree of their effect on the distribution shape. Whistler waves are right-hand polarised electromagnetic waves and are thought to be one of the mechanisms involved in driving electrons to form these flat-top distributions. We discuss our future plan to investigate the correlation of flat-top distributions and Whistler wave activity.

43. Natalie Reeves - Space Environment and Radio Engineering (SERENE), University of Birmingham

Elvidge, S; Themens, D

Understanding the sensitivity of TIE-GCM's forcing parameters

Understanding the sensitivity of the thermosphere and ionosphere to solar and geomagnetic conditions is critical for space weather predictions. This study aims to use Global Sensitivity Analysis (GSA) techniques to evaluate how Kp and F10.7 daily averages can influence Thermosphere Ionosphere Electrodynamics General Circulation Model (TIE-GCM) output (e.g., electron density, total electron content and solar wind parameters). Each model input was varied individually, and the induced variations are visually and quantitatively compared to model predictions. This analysis looks at the robustness of simulated results with the purpose of generating better ensembles for the Advanced Ensemble Electron Density (Ne) Assimilative System (AENeAS) forecasting model. Since AENeAS uses TIE-GCM as a background model and to propagate the model densities forward in time.

44. Sam Rennie - University of Leicester

Milan, S. ; Imber, S.

Modelling of ULF Waves in SuperDARN Backscatter

Ultra-low frequency (ULF,~2mHz–5Hz) magnetohydrodynamic waves are common in Earth's magnetosphere and play an important role in energy transfer throughout the solar-terrestrial system and the driving of radiation belt dynamics. A wave's azimuthal wave number, m, is important for understanding its drivers and interactions with magnetospheric particle populations. However, it is difficult to observe waves with larger m-numbers using ground-based magnetometers due to their spatial resolution, phase mixing, and ionospheric attenuation of the wave's magnetic field.

SuperDARN radars, which are sensitive to the motion of field-aligned plasma irregularities in the E- and F-region ionosphere, can detect and observe ULF waves: periodic fluctuations in observed line-of-sight Doppler velocities are oscillating ExB drifts induced by the wave's electric field. SuperDARN offers a much-improved spatial resolution over ground-magnetometers and backscatter is not afflicted by ionospheric attenuation, allowing a more accurate determination of wave characteristics such as m-number.

This poster presents the development of a plane wave-based model of ULF wave propagation in the ionosphere and SuperDARN backscatter and a consequent technique to characterise the parameters of observed waves. The aim of this work is to statistically investigate the characteristics of a large number of waves.

45. Joshua Ruck - Space Environment and Radio Engineering (SERENE), University of Birmingham

Themens, D.R; Elvidge, S.

On the use of SuperDARN Ground Backscatter Measurements for Ionospheric Propagation Model Validation

By operating in the high-frequency (HF) band (3-30 MHz), radars can regularly see beyond the horizon, with this non-line-of-sight (LOS) propagation achieved through the use of the ionosphere as a reflector. Over-the-horizon radar systems (OTHR) exploit this phenomenon and are unique in their ability to detect targets at extreme ranges, offering distinct strategic advantages. For reliable target positioning, OTHR requires accurate propagation models and so it is essential to validate the combination of ionospheric models and raytracing prior to use in operational OTHR systems. The Super Dual Auroral Radar Network (SuperDARN) is a global network of HF coherent scFruckatter radars operating in the range of 8-20 MHz and provides a vast data set of oblique HF soundings. We present a new technique for utilizing this data set for validating ionospheric models over a wide range of geographical areas and time periods. Two-dimensional numerical ray tracing is employed with the IRI2016 ionospheric model to simulate the time evolution of ground backscatter echoes. We comprehensively demonstrate the utility of this data for validation through assessment of errors by use of the skip distance errors and elevation-range relationships.

46. Andrey Samsonov - MSSL, UCL

Branduardi-Raymont, G.

Magnetospheric response to a southward IMF turning in the dayside and nightside magnetosphere

We use global MHD simulations to study magnetospheric response to a southward interplanetary magnetic field turning. We show that interaction between the southward turning and the magnetopause starts dayside reconnection which results in a sunward plasma flow in the magnetosphere. The region of the sunward flow gradually extends from the dayside to the nightside magnetosphere. This process occurs simultaneously with magnetic flux accumulation in the tail lobes. About one hour after the beginning of the dayside reconnection, the nightside reconnection starts, immediately a high-speed tailward stream in the tail appears lasting for a relatively short time, and then an earthward flow gradually enhances and quasi-stationary magnetospheric convection forms. We also discuss the temporal variations in the ionosphere which complement and confirm the changes in the magnetosphere. We display the differences in the results between the two MHD models, SWMF and LFM.

47. Beatriz Sanchez-Cano - University of Leicester

Christina O. Lee, Leng Ying Khoo, Majd Mayyasi, Laura Rodríguez-García, Erika Palmerio, Bent Ehresmann, Robert F. Wimmer-Schweingruber, Marco Pinto, Mark Lester, Simon Joyce, Bruce Campbell, Christopher Gerekos, David J. McComas, Eric Christian, Nathan Schwadron, Mark Wiedenbeck, Ralph McNutt, Christina Cohen

From the Sun to Mars' surface: How solar energetic particles affect Mars' atmosphere and ionosphere

One of the largest widespread solar energetic particle (SEP) events of the current solar cycle was the one that occurred on 15 February 2022, observed by almost all missions deployed in the inner solar system. It was a proton-rich SEP event that also hit Mars, producing one of the largest ground level enhancements ever observed at the surface of Mars by the Radiation Assessment Detector (RAD) onboard the Curiosity rover of the Mars Science Laboratory (MSL) mission. The shower of solar particles into Mars' atmosphere severely degraded the propagation of signals of the MARSIS/MEX radar. However, despite the large shower of protons into Mars' atmosphere, the other radar in operation at Mars, SHARAD/MRO, which operates at a higher frequency, was only affected by partial attenuation, which indicate that the role of protons may not be that important below 100 km when compared to electrons. This is the first time that we have been able to track the fate of SEP particles in Mars' atmosphere from space until the surface of Mars.

48. Jasmine Sandhu - Northumbria University

Rae, I. J.; Murphy, K. R.; Hartley, D. P.; Osmane, A.

How do Plasmaspheric Plumes Impact ULF Waves?

ULF wave driven radial diffusion plays a key role in the energisation, loss, and transport of radiation belt electrons. During geomagnetically active periods, with enhanced ULF wave power sources, cold plasmaspheric plumes can populate the region. In this presentation, we explore how the presence of these plumes impact the properties of ULF wave propagation, and consider the consequences on radiation belt dynamics.

We use Van Allen Probes observations of ULF waves during storm-time plume crossings. The results show that plumes can be associated with unique changes in polarisation as well as the spatial localisation of wave power, suggesting that plumes are important in shaping the propagation and generation of ULF waves in the inner magnetosphere. However, this distinct storm-time behaviour is not accounted for in current radial diffusion models. We explore implications for radial diffusion modelling, and show that plumes can significantly alter the magnitude of radial diffusion during geomagnetic storms. Overall, the results highlight the need for improved understanding and modelling of the complex coupling between ULF waves and the cold plasma population.

49. Jasmine Sandhu - Northumbria University

MIST Council

Results from the Survey of Bullying and Harassment in the MIST Community

Earlier this year, MIST Council ran a survey to understand the prevalence and forms of bullying and harassment in the MIST Community. A key motivation of the work is to identify parallels and any unique aspects of the MIST Community compared to the wider Royal Astronomical Survey on Bullying and Harassment that was ran in Spring 2020. In this presentation we will highlight key findings of the survey and discuss future initiatives to address identified issues.

Similarly to the Royal Astronomical Society's investigations, we report that incidents of bullying and harassment are commonplace for our members, that the nature of the incidents can be variable. We similarly identify that there are important institutional failings regarding reporting. We obtain an insight into priorities of MIST members, as well as how the MIST community views itself and the wider institutional environments that our range of members encounter. We also discuss how demographic identities may result in higher risk and impact of incidents.

We conclude by looking forward at how we can fully utilise expertise within the MIST Community. We open discussion on new initiatives to support our peers and share best practice cross-institutionally.

50. Audrey Schillings - University of Leicester, UK; Umeå University, Sweden

S. E. Milan, H. J. Opgenoorth, G. E. Bower, M. Hamrin

Space weather on Earth: how could we better preserve our technologies from space weather events?

Our modern society relies more and more on technologies; from GNSS (Global Navigation Satellites System) data inserted in almost every electronics to the consumption of electricity that explodes in the last decades. However, these technologies and the power lines, for example, are vulnerable to strong and quick magnetic field variations. These short-lived magnetic field variations create disturbances in the ionosphere leading to satellites signals perturbations as well as potentially induced currents on the ground. Approaching the maximum of the solar cycle in 2025, we expected an increasing number of geomagnetic storms and subsequently more of these magnetic field perturbations. Existing space weather models and forecasts already demonstrated their need and efficiently, however, some caveats remain. Therefore, we first studied these strong and short-lived magnetic variations in Fennoscandia during storms as well as their localized effects. Currently, we are studying these magnetic variations coupled with ionospheric fast flows in the sub-auroral regions also called sub-auroral polarization streams (SAPS) over the US. We use datasets from ground-based magnetometers and auroral cameras, satellites data, and SuperDARN radars. Space weather became more important in the last decade and its importance enlarges with our society's evolution.

51. Pauline Simon - Department of Physics and Astronomy, Queen Mary University of London

F. Sahraoui

The impact of pressure anisotropy on the turbulent cascade.

The Solar Wind is a magnetized, collisionless plasma where turbulence ensures the transfer of energy to scales small enough for dissipation to be efficient and contribute to particle heating. In order to evaluate the transfer rate, assumed to be equal to the dissipative rate, we use a generalization of Kolmogorov's 4/5 law for an incompressible fluid to the case of a bi-adiabatic magnetized fluid with Hall effect. This model in particular retains pressure anisotropy, whose influence on the energy cascade is investigated by performing a statistical analysis of the data of three-dimensional simulations previously considered in Ferrand et al., 2021. Such analysis reveals a significant contribution of pressure anisotropy on the cascade of energy.

52. Julia Stawarz - Northumbria University

Wicks, R. T.; Verscharen, D.; Nicolaou, G.; Klein, K.; Matteini, L.; Franci, L.; Berthomier, M.; Soucek, J.; Pisa, D.; Khotyaintsev, Y.; Graham, D.; Sahraoui, F.; Dudok de Wit, T.

Distributed Receivers for Electron Astrophysics Measurements (DREAM): A CubeSat Mission Concept for Probing Electron-Scale Energisation Processes

Electron-kinetic processes are the final, crucial step in the dissipation of the highly complex turbulent plasma dynamics that are prolific in all space and astrophysical plasmas across the Universe. However, due to the nearly-collisionless nature of many space plasmas, a variety of district plasma processes can contribute to electron energisation. The Distributed Receivers for Electron Astrophysics Measurements (DREAM) mission is an electron-astrophysics mission concept aimed at measuring the thermal properties, heating, and energy exchange processes for electrons in interplanetary space. DREAM would employ a swarm of up to 11 CubeSats orbiting within a few kilometres of each other to form a distributed electron instrument in space. This distributed instrument would both be capable of characterising the 3D electromagnetic fluctuations present at electron-scales in the plasma and, using a novel electron sensor, provide fast and sensitive measurements of the field particle correlation between the electrons and electromagnetic fields in phase space on-board the spacecraft. The novel measurements from DREAM will be highly complementary to the new multiscale plasma missions, such as HelioSwarm and Plasma Observatory, that are on the horizon and will provide targeted electron-scale measurements necessary to disentangle the complex processes responsible for nearly-collisionless electron energisation.

53. Konrad Steinvall - University of Southampton

Gingell, I.

The Influence of Rotational Discontinuities on Magnetic Reconnection in the Shock Transition Region

Spacecraft observations have revealed that reconnecting current sheets are ubiquitous in the shock transition region. They are believed to contribute significantly to the energy dissipation across the Earth's bow shock. Recent hybrid simulations have shown that the occurrence of ion-scale reconnection in the shock transition region depends strongly on the angle between the shock surface normal and the upstream magnetic field (θ_{Bn}), and the Alfvénic Mach number (M_A), favouring small θ_{Bn} and large M_A. These simulations used homogeneous and steady upstream conditions. However, the solar wind is in general highly dynamic, containing large-scale magnetic discontinuities (current sheets). Spacecraft observations have shown that the interaction between such current sheets and the bow shock can drive magnetic reconnection, but the degree to which such interactions affect ion-scale reconnection in the transition region remains poorly understood. In this study we build on a local hybrid model to investigate how upstream rotational discontinuities (RDs) affect the occurrence of magnetic reconnection at shocks. Our results show that RDs can significantly increase the reconnection occurrence, depending on the geometry of the shock and RD. The largest reconnection bursts are associated with the presence of foreshock transients and RDs with large magnetic shear.

54. Katerina Stergiopoulou - University of Leicester

Lester, M; Sánchez-Cano, B; Fowler, C; Andrews, D; Joyce, S; Meggi, D;

Ionopause detections in the Martian ionosphere

The variability, irregularities and boundary regions in the upper dayside ionosphere of Mars are yet to be fully characterised. In this study, we start by focusing on the ionopause boundary, which separates the planetary plasma from the solar wind, and we use observations from NASA's MAVEN mission to probe the Martian upper dayside ionosphere and describe the physics of the boundary as well as the variability drivers. We use a Change Point Detection method to identify the ionopause as the location where electron density and temperature gradients are detected. We focus on the 8th MAVEN deep dip campaign (DD8) from October 2017 that consists of 50 consecutive orbits. The trajectories of the DD8 orbits are similar to each other and thus, the impact of the changing upstream conditions on the Martian ionosphere can be studied. We utilise and compare data from several instruments on board MAVEN, namely the LPW, SWEA, STATIC, SWIA and MAG, in order to investigate in detail the factors controlling the ionopause and the observed irregularities. Combining measurements from several different instruments we are able to better understand and describe the structure and behaviour of the Martian dayside ionosphere and ionopause.

55. Paola Ines Tiranti - University of Leicester

H. Melin, T. S. Stallard, J. O'Donoghue, L. Moore, R. Wang, E. M. Thomas, K. Knowles

Jupiter's local-time dependent vertical ionospheric profiles from Juno and JWST

In September 2023, JWST observed ionospheric emissions above Jupiter's limb at dusk and dawn. By pairing JWST NIRSpec data with Juno/JIRAM's vertical profiles as function of local-time, we explore the upper atmosphere of Jupiter. Much is still unknown about this region, particularly with the ongoing giant planet "energy crisis". Here, we analyse vertical H3+ temperature and ion density variations to probe the ionosphere. At the same time, in coordination with JWST, Juno's radio occultation took place at mid-latitudes providing electron densities in the sub-auroral region of the planet. While H3+ emissions at mid-to-low latitudes are produced by photoionization by incoming solar EUV, constraints on the lifetime of the ion remain uncertain. Merging observations from Juno and JWST provides a unique view of Jupiter: with JIRAM it is possible to obtain vertical profiles up to 1000km, with JWST we expect vertical profiles of up to 5000km. This allows to investigate at which altitude is H3+ produced at dawn, and similarly how its morphology varies at dusk and after it. Hence, local-time observations from JIRAM across the planet allows us to look at the evolution of H3+ profiles across the dayside and explore this dynamical area.

56. Hannah Trigg - Space Environment and Radio Engineering (SERENE), University of Birmingham

Dorrian, G., Boyde, B., Wood, A., Fallows, R. A.

Highly detailed observations of symmetrical quasi-periodic oscillations with LOFAR

Observations of cosmic radio sources Cassiopeia A and Cygnus A made with the LOw Frequency ARray (LOFAR) showed the rare and interesting phenomenon of ionospheric quasi-periodic oscillations at an unprecedented level of detail. The observations were taken under geomagnetically quiet conditions (Kp <=2), between 0422–0500 UT on 30th January 2018 and 1817–1950 UT on 15th December 2016.The dynamic spectra (signal power as a function of time and observing frequency) showed a succession of highly symmetrical v-shaped signal fades which were bounded by a series of diffraction fringes. The repeated enhancements and fades in the signal suggested focussing and defocussing by a series of troughs and peaks in electron density, as would be the case with a wave-like travelling ionospheric disturbance. The high periodicity, symmetrical appearance, and consistency of the observed features are the only such examples in the LOFAR data set. The delay-Doppler spectra (2D Fourier transform of the dynamic spectra) showed very clear parabolic arcs corresponding to each of the periodic features. Velocities derived from their curvature varied over time between 50-120 ms-1. A thin phase screen numerical model was used to reproduce the observed signal variations to a consistently high degree of accuracy.

57. Domenico Trotta - Imperial College London

Observations and modelling of accelerated particles at interplanetary shocks in the inner heliosphere

Interplanetary (IP) shocks are important sites of particle acceleration in the Heliosphere and can be observed in-situ utilizing spacecraft measurements. Such observations are crucial to address important aspects of energy conversion for a variety of astrophysical systems.

From this point of view, Solar Orbiter provides observations of interplanetary shocks at different locations in the inner heliosphere with unprecedented time and energy resolution in the suprathermal (usually above 50 keV) energy range. I will present such novel observations for selected, recently observed IP shocks, and corroborate the observations with small-scale, kientic simulations. I will focus on the theme of shock variability by presenting: 1. a strong shock showing novel dispersive signals in the suprathermal particle fluxes observed by the Solar Orbiter SupraThermal Electron and Proton sensor; 2. a joint PSP-Solar Orbiter observation of an IP shock which help us addressing the role of shock evolution in the production of energetic particles.

58. Laura Vuorinen - University of Turku, Finland

Hietala, H; LaMoury, A. T.; Koller, F.; Plaschke, F.

How do solar wind conditions and the solar cycle influence magnetosheath jet formation at the Earth's bow shock?

Magnetosheath jets are dynamic pressure enhancements that frequently emerge from the Earth's bow shock. Jets can traverse the magnetosheath and eventually impact the magnetopause. Their occurrence is strongly influenced by solar wind and interplanetary magnetic field (IMF) conditions. While jets are overwhelmingly more common downstream of the quasi-parallel shock, the quasi-perpendicular configuration is more common at Earth and, thus, quasi-perpendicular jets represent a significant fraction of observed jets. To better understand the solar wind influence on jet formation in these two different shock regimes, we study jets using Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft observations from the subsolar magnetosheath and OMNI solar wind measurements. We find that jet occurrence downstream of the quasi-parallel shock is not sensitive to other solar wind parameters. However, downstream of the quasi-perpendicular shock, jet occurrence is higher during low B, low n, high β, and high M_A solar wind conditions. As solar wind conditions vary throughout the solar cycle, we also estimate the yearly jet occurrence rates throughout solar cycle 24. We find that jet occurrence is not strongly dependent on solar activity phase. Therefore, jets may play a significant role in solar wind-magnetosphere interaction particularly during quiet times.

59. Maria-Theresia Walach - Lancaster University

Grocott, A.

Introducing TiVIE: a new model of the Time-Varying Ionospheric Electric field

We present a statistical model of the ionospheric electric field derived from line-of-sight plasma velocity measurements from the Super Dual Auroral Radar Network (SuperDARN). Electric field patterns are produced using an established technique that models the electric field as a spherical harmonic expansion of the ionospheric electric potential. Major improvements over existing models are achieved by the use of novel parameterisations that capture three major sources of time-variability of the coupled solar wind-magnetosphere-ionosphere system: 1) the upstream solar wind conditions, specifically the strength and orientation of the interplanetary magnetic field and the steadiness of the solar wind, 2) substorm onset location as well as the time relative to substorm onset, and 3) the variability introduced by geomagnetic storms. These account for the variability in the magnetosphere-ionosphere system, which occurs even under continuous steady driving by the solar wind. The second source of variability relates to the storage and release of energy in the magnetosphere that is associated with magnetospheric substorms. The electric field evolves throughout the substorms cycle and geomagnetic storm phases, and its morphology is strongly influenced by their occurrences. We discuss the details of the model, and assess its performance by comparison to other models and to observations.

60. Xueyi Wang - 1.Centre for Fusion, Space and Astrophysics, Physics Department, University of Warwick 2.Department of Mathematics and Statistics, University of Tromsø 3.International Space Science Institute

Chapman, S. C., Dendy, R. O., Hnat, B.

Wavelet determination of magnetohydrodynamic-range power spectral exponents in solar wind turbulence seen by Parker Solar Probe

The solar wind has high Reynolds numbers and is a natural setting for researching turbulence in situ. Parker Solar Probe's radial location spans 0.17 AU to 1 AU, enabling the study of turbulence as the solar wind expands. We identify extended intervals of uniform solar wind turbulence, which exclude coherent structures. These datasets span spectral scales from low frequency '1/f' to the MHD inertial range and into the kinetic range below the ion gyrofrequency. Our power spectral density estimation uses discrete Haar wavelet decomposition. We report accurate determinations of scaling exponents and scale breaks in the power spectra of MHD turbulence. These enable differentiation between Kolmogorov and IK turbulence within individual spectra, and across samples with respect to distance from the Sun and plasma beta values. Within 0.3 AU, the IR reveals two distinct scaling ranges: an inner range aligned with IK turbulence, and an outer range exhibiting shallower exponents. Beyond 0.5 AU, exponents are generally steeper than Kolmogorov turbulence. We explore dependence on the magnetic field and solar wind directions, and on switchbacks, using the PVI method. These PSD-estimated scaling exponents are pivotal in turbulence theories, providing valuable insights into solar wind turbulence evolution.

61. Cara Waters - Imperial College London

Fargette, N.; Eastwood, J. P.; Goldman, M. V.; Newman, D. L.; Lapenta, G.

Energy Repartition in Magnetic Reconnection using 2.5-D PIC Simulation and Machine Learning Techniques

Magnetic reconnection is fundamentally important in astrophysical, laboratory, solar, and space plasmas due to the release and repartition of magnetic energy stored within the reconnecting field. In particular, magnetic reconnection drives the Sun-Earth interaction and has significant impacts on magnetospheric dynamics. In this work, we focus on understanding the energy partition of the magnetic reconnection process by using a 2.5-D Particle-In-Cell simulation with a geometry comparable to that of the Earth's magnetotail. We integrate over space in the simulation, considering the total energy fluxes across the whole structure. We then use machine learning techniques to identify different regions of the reconnection site, such as the inflows, outflows and separatrices. We find that these regions are distinct in their energy partition signatures, meaning that different energy transfer mechanisms may be playing a role. The analysis of energy transfer signatures in these simulations is particularly relevant to the identification of these same signatures in spacecraft data, such as that of the Magnetospheric Multiscale Mission, and we discuss how this may improve our understanding of observed energy flux structure.

62. James Waters - Aix Marseille Univ, CNRS, CNES, LAM, Marseille, France

Lamy, Laurent; Coxon, John

Evaluating remote auroral kilometric radiation observations as a classification and predictive tool for substorms

Auroral kilometric radiation (AKR) is a cyclotron maser instability generated radio emission that occurs above discrete auroral features. Remote observations provide an insight into the spatial and temporal development of acceleration processes in the magnetosphere ionosphere coupling region during energetic phenomena. However, the emission is beamed anisotropically, which makes it difficult to observe global variability of AKR when a spacecraft is not in an ideal position, namely at dayside local times. With an automatic extraction of AKR observations from the Wind spacecraft, we have access to nearly 30 years of data from a variety of viewing positions. The latest 20 years of observation are made from the dayside, near L1. Recent statistical work examines the potential of AKR observations as an independent indicator of substorm activity, comparing 10 years of data with lists derived from the SuperMAG magnetometer network. The classification skill is highly dependent on the partitioning of events. Observer local time also affects the classification skill as expected, although dayside observations have the lowest false alarm probability. Observations show a bias towards lower frequencies for substorm-associated observations in multiple local time sectors, also implying that substorm dynamics remain observable when in other regions than the nightside.

63. Sophia Zomerdijk-Russell - Imperial College London

Masters, A; Sun, W. J.; Fear, R. C.; Slavin, J. A.

Does Reconnection Only Occur at Points of Maximum Shear on Mercury's Dayside Magnetopause?

Extensive MESSENGER observations of flux transfer events (FTEs) have revealed that frequent and intense magnetic reconnection is a strong driver of Mercury's magnetospheric dynamics. As products of reconnection, the study of FTEs can provide insight into whether reconnection sites favour points of maximum shear on the dayside magnetopause. Here, we analyse 201 FTEs associated with relatively stable upstream solar wind conditions that were observed by MESSENGER as it made an inbound pass of Mercury's magnetopause. Formation paths for these FTEs were then modelled along the magnetopause to determine the location and conditions of the reconnection site at which the FTE formed. Most FTE formation paths intersected high-magnetic shear regions, defined as shears exceeding 135˚. However, we identified seven FTEs where the maximum shear angle between the reconnecting magnetic field lines was less than 80˚. Under the global-scale picture of magnetic reconnection, this supports the idea that at Mercury's dayside magnetopause very low-shear reconnection can occur. Additionally, for these events, it may be difficult to justify tracing a dominant X-line that connects points of maximum shear along the magnetopause as it would pass through very low-shear regions, suggesting reconnection could be occurring anywhere across Mercury's dayside magnetopause.