2nd Annual Meeting of the Europlanet Society's Ireland and UK Hub

Organisers: Prof Nicholas Achilleos (UCL), Dr Licia Ray (U. Lancaster) (I-UK Hub Committee Chairs), Dr Joanna Fabbri (UCL)

Date: Tuesday 22 June 2021
Location: Zoom joining details have been circulated to all participants, but if you are in need of further assistance, please contact us at: ukieuroplanetmeeting@gmail.com

Programme of Talks

Time	Speaker	Title
10:00-10:05	Nick Achilleos (UCL)	Welcome and introduction
10:05-10:35	Marina Galand (Imperial College)	Discovery of cometary aurora in the FUV (Invited)
10:35-10:50	Affelia Wibisono (UCL-MSSL)	X-ray Emissions from the Giant Planets
10:50-11:05	Graziella Branduardi-Raymont (UCL-MSSL)	EXACT: Exploring the Earth's aurora with a Cubesat
11:05-11:20	BREAK	
11:20-11:35	Leigh Fletcher (Leicester)	Exploring Jupiter's Belt/Zone Structure as a function of Depth and Time
11:35-11:50	Dimitrios Millas (UCL)	Compressibility of the Jovian magnetosphere
11:50-12:05	Nawapat Kaweeyanun (Imperial College)	The driving of Ganymede's magnetosphere by plasma-magnetic interactions on the upstream magnetopause
12:05-12:20	Sophia Zomerdijk-Russell (Imperial College)	Variability of the interplanetary magnetic field as a driver of electromagnetic induction in Mercury's interior
12:20-13:00	LUNCH	Poster presentations
13:00-13:15	Richard Haythornthwaite (UCL-MSSL)	Heavy positive ion groups in Titan's ionosphere: Cassini Plasma Spectrometer IBS observations
13:15-13:30	Peter Stephenson (Imperial College)	Cooling of electrons at a weakly outgassing comet
13:30-13:45	Qasim Afghan (UCL-MSSL)	Observations of a gap in the dust tail of C/2014 Q1 (PanSTARRS)
13:45-14:00	Dimitri Veras (Warwick)	The future evolution of planetary magnetospheres: connecting solar system and extrasolar system science
14:00-14:15	Robert Kavanagh (Trinity College Dublin)	Planet-induced radio emission from the coronae of M dwarfs
14:15-14:30	BREAK	
14:30-14:45	Gordon (Kai) Yip (UCL)	Peeking inside the Black Box: Interpreting Deep Learning Models for Exoplanet Atmospheric Retrievals
14:45-15:00	Gerard Hutchinson (STFC)	Introduction to SWIMMR (Space Weather Instrumentation, Measurement, Modelling and Risk)
15:00-15:30	Rosie Cane (Thompson STEM Engagement)	Tools for Science Public Outreach (Invited)
15:30-16:00	Will Dunn (UCL-MSSL)	ORBYTS – Planetary Science Research-with-Schools Projects (Invited)
16:00-16:30	Angelos Tsiaras (UCL)	ExoClock – A citizen science project to monitor transiting exoplanets (Invited)
16:30-16:35	Nick Achilleos (UCL)	Closing Remarks

Posters:

Poster 1	Katherine Shirley (Oxford)	Destination: Space! A Virtual Flash Talk Series
Poster 2	Dimitrios Millas (UCL)	Compressibility of the Jovian magnetosphere
Poster 3	Sophia Zomerdijk-Russell (Imperial College)	Variability of the interplanetary magnetic field as a driver of electromagnetic induction in Mercury's interior

Further information:

- 2nd Annual Meeting IUK Hub webpage
- The Europlanet Society, with information about aims and membership
- The Ireland-UK Hub page

ABSTRACTS

Time	Title, Author/s and Abstract
10:05- 10:35	***Discovery of cometary aurora in the FUV (INVITED)*** **Marina Galand** (m.galand@imperial.ac.uk, Imperial College London, UK) The European Space Agency mission, Rosetta, is the first to escort a comet along its orbit. The escort phase by comet 67P lasted over two years from 3.6 au from the Sun to perihelion near 1.2 au and up to 3.8 au to the end of mission on the cometary surface. A very rich and unique dataset was acquired during this journey. Rosetta observed the neutral coma (primarily made of H_2O, CO_2, CO and O_2), cometary plasma, and ultraviolet emissions from the coma throughout the escort phase with variations with season, cometary distance, and heliocentric distance. The atomic hydrogen and oxygen emissions observed in the Far UltraViolet (FUV) were first thought to be the result of dissociative excitation of molecules by locally-produced, unaffected photoelectrons. We will present a quantitative analysis of the FUV brightnesses through an original approach linking Rosetta multi-instrument dataset with a physics-based model. The measured FUV brightnesses will be compared to modelled ones driven by energetic electron fluxes observed in situ as well as in situ and remote-sensing (submm and infrared) observations from the neutral gas. We will highlight how different the spectroscopic signature of these emissions is between the northern and southern hemispheres. We will identify the main mechanism responsible for the FUV emissions and the source of the energetic particles responsible for the excitation. We will reveal the auroral nature of these emissions and how some of the lines could be used in the context of space weather.
10:35- 10:50	***X-ray Emissions from the Giant Planets*** **Affelia Wibisono** (UCL Mullard Space Science Laboratory, UK) Our Solar System is full of X-ray emitters – such as the Sun, comets, planets, and moons. One of the brightest sources is Jupiter due to its intense X-ray aurorae. High charge state ions precipitate into the planet's atmosphere at the polar regions and charge exchange with atmospheric neutrals to emit soft X-rays (photon energy < 2 keV). These emissions are also often observed to pulse quasi-periodically with periods of tens of minutes. Hard X-ray (photon energy > 2 keV) emissions surround the soft X-rays and arise from electron bremsstrahlung. X-rays have also been detected from Jupiter's Galilean Moons. These satellites fluoresce in X-rays because of interactions between their solid surfaces and plasma in the jovian magnetosphere. Solar X-rays are scattered by the atmospheres of Jupiter and Saturn. Furthermore, Saturn's rings emit X-rays due to fluorescent scattering of solar X-rays from oxygen atoms in the icy rings. X-ray auroral emissions from Saturn have so far not been detected despite several attempts over many decades and during a rare planetary alignment when Saturn was enveloped by Jupiter's magnetotail. The latest planet to be added to the list of known X-ray emitters in the Solar System is Uranus. Data obtained in 2002 and 2017 by the Chandra X-ray Observatory, showed a low signal detection of X-rays from this enigmatic planet. The measured X-ray fluxes from these observations surpassed what was expected if the emissions were only from scattered solar X-rays. This suggests that Uranus may have a higher X-ray albedo than Jupiter and Saturn, or that there is at least one other mechanism that enables Uranus to produce X-rays.

10:50- 11:05	***EXACT: Exploring the Earth's aurora with a Cubesat*** **G. Branduardi-Raymont** (UCL Mullard Space Science Laboratory, UK), D. Kataria (UCL-MSSL), I. J. Rae (Northumbria University, UK), Q. Shi (Shandong University, China) The aurora is one of the most spectacular and fascinating phenomena on Earth. Thanks to ground observations as well as rocket and satellite experiments we understand the basic facts leading to auroral production, and their connection with solar activity and the variability of the solar wind. However, despite the cause-effect link between solar wind and auroral, in particular X-ray, emissions, no systematic attempt has been made to correlate the two with coordinated particle and radiation measurements. We propose to use a low cost, nano-satellite, a Cubesat, to observe the X-ray aurora, which is associated with the most energetic particles and which has not been explored in detail yet, and to correlate its strength and variability with simultaneous particle and magnetic field measurements. Alongside its scientific potential, this Cubesat mission will constitute an excellent opportunity for postgraduate student training and outreach. EXACT (Earth X-ray Aurora Cubesat Telescope) will carry a small X-ray camera, based on a pinhole or a micropore optic design and incorporating an X-ray sensitive spectroscopic imaging detector, and miniaturised particle analysers, measuring energy and direction of plasma and neutral particles. A magnetometer will complete the payload. If flying in the timeframe 2025-2026 EXACT will be an invaluable complement for SMILE (Solar wind Magnetosphere Ionosphere Link Explorer), the ESA-CAS mission under development which will image the magnetosheath and cusps in soft X-rays produced by solar wind charge exchange, and the northern aurora in UV light. EXACT will provide a correlated X-ray view of the ultimate fate of the solar wind particles precipitating in the Earth's atmosphere and creating the auroral manifestations.
11:05- 11:20	**BREAK**
11:20- 11:35	***Exploring Jupiter's Belt/Zone Structure as a function of Depth and Time*** **L.N. Fletcher** (School of Physics and Astronomy, University of Leicester) Jupiter's characteristic bands of bright zones and darker belts, organised by powerful east and west jet streams, dominate the appearance of the gas giant in both reflected sunlight and thermal emission. The canonical explanation – air rising and cooling in zones to promote cloud condensation, and vice versa in belts – has been called into question by numerous lines of evidence over the past two decades. To reconcile observations of Jupiter's temperatures, winds, distribution of gases, lightning, and eddy-momentum convergence on the jets, a tiered system of stacked 'Ferrel-like' circulation cells has been proposed (reviewed by Fletcher et al., 2020, doi:10.1007/s11214-019-0631-9). Belts would be characterised by net subsidence in the upper troposphere, and net upwelling in the deeper troposphere, with a transition somewhere within the clouds. NASA's Juno mission, and specifically the microwave radiometer (MWR), allows us to test this complex structure for the first time, by probing ammonia and temperature contrasts from 0.6 bar to the ~120 bar level. We observe a transition from microwave-bright belts (ammonia depleted and/or physically warm) in the upper troposphere, to microwave-dark belts (ammonia enriched and/or physically cool) in the deeper troposphere, consistent with the existence of multiple stacked circulation cells in Jupiter's troposphere. Jupiter's bands are therefore observed to extend deep into Jupiter's atmosphere.

	In addition, ground-based long-term infrared images show that although the locations of the cells are relatively stable, the strength of the circulation appears to vary over quasi-periodic cycles (as observed by changing clouds at 5 microns and in visible light, Antunano et al., 2019, doi:10.3847/1538-3881/ab2cd6), resulting in cycles of equatorial zone disturbances every 6-7 years (Antunano et al., 2018, doi: 10.1029/2018GL080382), and an anti-correlated 4-5 year variation in the equatorial belts that remains poorly understood. This presentation will discuss the latest findings on Jupiter's belt/zone circulation patterns.
11:35-11:50	***Compressibility of the Jovian magnetosphere*** **Dimitrios Millas** (University College London, UK) The magnetospheres of giant planets in our Solar System (Jupiter and Saturn), are a unique type of space laboratories for magnetized plasma. Their rapid rotation, composition and size result in major differences compared to the terrestrial magnetosphere, the most prominent being the presence of a disc-type magnetic structure. A global model of the magnetosphere, including the magnetodisc, can be constructed using Caudal's iterative scheme, assuming axisymmetry and a magnetic dipole as an initial state. In addition, we implement a correction algorithm (Pontius' scheme), using the equatorial magnetic field structure to obtain an angular velocity profile consistent with the magnetodisc. This updates the angular velocity obtained from Hill's method, which is valid for a magnetic dipole. Although internal drivers are considered important in some cases, the solar activity remains the most prominent (external) driver which determines the dynamics of these magnetospheres. The response of the magnetosphere due to a change in the solar wind can be quantified by the compressibility index, calculated from the magnetopause radius as a function of the total pressure. We present results of a numerical study of the compressibility of the Jovian magnetosphere, using the algorithms described above. First, we produce a large ensemble of models which are used as virtual observations (or "crossings"). Each model has a different system size (defined by the magnetopause distance) and hot plasma content (defined by the hot plasma index. We evaluate methods of different order to obtain the compressibility index and discuss the effects of the system size. We compare the results with observations of the Jovian magnetosphere and with similar studies focused on the magnetosphere of Saturn.
11:50-12:05	***The driving of Ganymede's magnetosphere by plasma-magnetic interactions on the upstream magnetopause*** **N. Kaweeyanun**[1], A. Masters[1], X. Jia[2], H. Zhou[3] ([1]Department of Physics, Imperial College London, [2]The Climate and Space Sciences and Engineering Department, University of Michigan, [3]Space Physics Research Group, University of Helsinki) Ganymede is the only Solar System moon that maintains an intrinsic magnetosphere. Large-scale dynamics in Ganymede's magnetic system are thought to be driven by plasma-magnetic interactions on the moon's upstream magnetopause. Two most significant interactions are magnetic reconnection and Kelvin-Helmholtz (K-H) instability, but their natures remain poorly understood at Ganymede. In this study, we assess the onset conditions and characteristic rates for magnetic reconnection and K-H instability using an analytical model of Ganymede's upstream magnetopause. Magnetic reconnection can occur wherever Ganymede's magnetic field is partly antiparallel to the external Jovian magnetic field regardless of the moon's orbital position, hence the reconnection structure (steady X-lines, widespread flux-transfer events, etc) cannot be constrained. However, the average reconnection rate is dependent on Ganymede's

	position relative to Jupiter's plasma sheet and thus effectively driven by Jupiter's rotation. Linear K-H instability growth is expected to be viable along Ganymede's magnetopause flanks, with ~5% inter-flank rate asymmetry due to the finite Larmor radius effect arising from heavy plasma ions present near the magnetopause. Based on a comparison with Mercury's magnetopause, nonlinear K-H instability growth will likely be suppressed by frequent reconnection events, which are expected to be dominant drivers of Ganymede's magnetospheric dynamics. Lastly, we evaluate the impact of upstream reconnection on magnetic flux transport, and other general time-dependent aspects of the moon's magnetosphere. Our findings will be relevant for planning of the upcoming Jupiter Icy Moons Explorer mission.
12:05-12:20	**Variability of the interplanetary magnetic field as a driver of electromagnetic induction in Mercury's interior** **S. Zomerdijk-Russell**[1], A. Masters[1] and D. Heyner[2] ([1]The Blackett Laboratory, Imperial College London, London, UK, [2]Institute for Geophysics and extraterrestrial Physics, Technische Universität Braunschweig, Braunschweig, Germany) Corresponding author email: sophia.zomerdijk-russell16@imperial.ac.uk Mercury's magnetosphere is a unique and dynamic system, primarily due to the proximity of the planet to the Sun and its small size. Interactions between solar wind and embedded Interplanetary Magnetic Field (IMF) and the dayside Hermean magnetosphere drive an electric current on the system's magnetopause boundary. So far, electromagnetic induction due to magnetopause motion in response to changing external pressure has been a valuable technique for delineating planetary interiors. Here we assess the impact a changing IMF direction has on the Hermean magnetopause currents, and the resulting inducing magnetic field. Observations made by MESSENGER during subsolar magnetopause boundary crossings in the first 'hot season', were used to demonstrate the importance of the IMF direction to Mercury's magnetopause currents. Our 16 boundary crossings show that introduction of external IMFs change the magnetopause current direction by 10° to 100°, compared to the case where only the internal planetary field is considered. Analytical modelling was used to fill in the bigger picture and suggests for an east-west reversal of the IMF, typical of the heliospheric current sheet sweeping over Mercury's magnetosphere, the inducing field at Mercury's surface caused by the resulting magnetopause current dynamics is on the order of 10% of the global planetary field. These results suggest that IMF variability alone has an appreciable effect on Mercury's magnetopause current and generates a significant inducing magnetic field around the planet. The arrival of the BepiColombo mission will allow this response to be further explored as a method of probing Mercury's interior.
12:20-13:00	**LUNCH – Preceded by short poster presentations**
13:00-13:15	***Heavy positive ion groups in Titan's ionosphere: Cassini Plasma Spectrometer IBS observations*** **Richard Haythornthwaite** (UCL Mullard Space Science Laboratory, UK) Titan is the largest moon of Saturn and has a thick extended atmosphere along with a large ionosphere. The ionosphere has been shown to contain a plethora of hydrocarbon and nitrile cations and anions. Data from the Cassini Plasma Spectrometer Ion Beam Spectrometer (CAPS IBS) sensor have been examined for 5 close encounters of Titan during 2009 to examine heavy positive ions. During the Titan flybys Cassini had a high velocity (~6 km/s) relative to the low ion velocities (< 230 m/s) observed in the ionosphere. The ions were also cold, having ion temperatures around 150K. These factors meant that the ions appeared as a

	supersonic beam in the spacecraft frame and that their measured energies appear at kinetic energies associated with the spacecraft velocity and the ion mass, therefore the measured energy/charge spectra can be converted to mass/charge spectra. Positive ions with masses between 170 and 310 u/q are examined with ion mass groups identified between 170 and 275 u/q. Ion mass groups are identified up to 275 u/q with ion groups below 250 u/q having clear structure with a 12-14 u/q spacing between group peaks, indicating a carbon or nitrogen backbone. The ion group peaks are found to be consistent with masses of polycyclic aromatic hydrocarbon (PAH) and polycyclic aromatic nitrogen heterocyclics (PANH). Peaks identified up to 275 u/q have masses consistent with containing 3, 4 or 5 fused rings. Some of the peaks observed between 275 and 310 u/q are consistent with 5 and 6 ringed structures. The ion groups in this study are the heaviest positive ion groups examined so far from in-situ ion data at Titan. Our findings further the understanding of the link between low mass ions and high mass negative ions, as well as the formation of aerosols and tholins in Titan's atmosphere.
13:15-13:30	***Cooling of electrons at a weakly outgassing comet*** **P. Stephenson**[1], M. Galand[1], J. Deca[2], P. Henri[3,4], G. Carnielli[1] ([1]Department of Physics, Imperial College London, London, UK; [2]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, Colorado; [3]Lagrange, OCA, CNRS, UCA, Nice, France; [4]LPC2E, CNRS, Orleans, France) The Rosetta mission escorted comet 67P/Churyumov-Gerasimenko for two years along its orbit from August 2014. This was the first mission to observe a comet from a close and continuous perspective. During the mission, a cold population of electrons (<1eV) was measured around the comet by the Langmuir Probe (RPC/LAP; Engelhardt et al., 2018) and by the Mutual Impedance Probe (RPC/MIP; Wattieaux et al, 2020; Gilet et al., 2020). Both of these instruments were part of the Rosetta Plasma Consortium (RPC). Electrons within the coma are typically produced at ~10eV through ionization of the neutral gas, by absorption of extreme ultraviolet photons or energetic electron impact. The cold electron population is formed by cooling the newly born cometary electrons from 10eV, via collisions with the cometary neutral gas. It was expected that cold electrons would be observed close to perihelion, due to the high neutral density. However, the cold electrons were persistent at times when the neutral gas was thought to be orders of magnitude too thin (outgassing rate, Q < 1026 s-1) to cool the electrons efficiently. As such, the common assumption of radially outflowing electrons is insufficient to explain these observations. We have developed a test particle model, which is the first 3D collisional model of electrons at a comet. We use electric and magnetic fields, generated by a 3D fully kinetic, but collisionless, Particle-in-Cell model of the solar wind and cometary ionosphere, as an input to the test particle model (Deca et al., 2017; 2019). A pure water neutral coma with 1/r2 dependence (where r is the cometocentric distance) and realistic electron-neutral collisions are combined with the fields to simulate the trajectories of electrons in the cometary environment. Multiple electron-neutral collision processes are incorporated, including elastic scattering as well as excitation and ionization of the water molecules. Based on this original test particle model, we demonstrate that electrons are efficiently trapped in the inner coma by an ambipolar electric field, and therefore are more likely to undergo collisions. We show that even at low outgassing rates (Q = 1026 s-1), electron-neutral collisions have a significant impact on the electron energy distribution within the coma and that the cometary electrons undergo substantial cooling.

13:30-13:45	***Observations of a gap in the dust tail of C/2014 Q1 (PanSTARRS)*** **Qasim Afghan**, Geraint H. Jones and Oliver Price (UCL Mullard Space Science Laboratory, UK) A gap in the dust tail of long period comet C/2014 Q1 (PanSTARRS) has been observed in images taken shortly after the comet's perihelion on 6th July 2015. This gap presents itself as a wedge-shaped region devoid of dust, with dust either side of this gap. Initially, it was thought by observers that this was a common separation of the dust tail and the dust trail that lies along the comet's orbital path. Analysis of the dust tail was done using the Finson-Probstein model: the dust tail was simulated using this model, and the simulated tail was overlaid onto images of the dust tail for comparison. Further analysis was done by transforming the image and plotting it in dust beta vs. ejection time coordinate space, a novel analysis method developed by Oliver Price [1]. The results of the study show that none of the dust lies along the comet's orbital path, confirming that both sections of dust were part of the dust tail. A gap, devoid of dust, separates these two sections. The edges of this gap are bounded fairly accurately by lines of constant dust ejection time, corresponding to dust that should have been ejected between July 6th and July 12th. This suggests that cometary activity between these two dates was drastically reduced, although the cause of this is still unknown. The gap was analysed from amateur astronomer images, the only extensive image dataset available for this comet, between July and September 2015. The gap was visible throughout this observation period, and its shape and structure remained constant. This is the first time this feature has ever been identified in a cometary dust tail, and the cause of this feature is still uncertain. The lack of an extensive dataset for this comet has hindered the investigation of the formation mechanism for this feature, however recently this feature has now been found in other cometary dust tails. Future work on these comets, combined with the C/2014 Q1 analysis, could provide more insight into how this feature is formed.
13:45-14:00	***The future evolution of planetary magnetospheres: connecting solar system and extrasolar system science*** **Dimitri Veras** (University of Warwick), Aline A. Vidotto (Trinity College Dublin) How planetary magnetospheres evolve after the Sun turns off of the main sequence has relevant applications for extrasolar planetary systems, particularly with respect to habitability. Here we determine how the size of planetary magnetospheres evolve over time from the end of the main sequence through to the white dwarf phase due to the violent winds of red giant and asymptotic giant branch stars. By using a semi-analytical prescription, we investigate the entire relevant phase space of planet type, planet orbit and stellar host mass. We find that the planetary magnetosphere will always be quashed at some point during the giant branch phases unless the planet's magnetic field strength is at least two orders of magnitude higher than Jupiter's current value. We also show that the time variation of the stellar wind and density does not allow a magnetosphere to be maintained at any time for field strengths less than 10-5 T (0.1 G). This lack of protection hints that habitable planets orbiting white dwarfs would have been previously inhospitable.

14:00-14:15	***Planet-induced radio emission from the coronae of M dwarfs*** **Robert Kavanagh** (Trinity College Dublin, Ireland) There have recently been detections of radio emission from low-mass stars, some of which are indicative of star-planet interactions. Motivated by these exciting new results, here we present stellar wind models for the two active planet-hosting M dwarfs Prox Cen and AU Mic. Our models incorporate large-scale photospheric magnetic field maps, reconstructed using the Zeeman-Doppler Imaging method. We use our models to assess if planet-induced radio emission could be generated in the coronae of the host stars, through a mechanism analogous to the sub-Alfvénic Jupiter-Io interaction. For Prox Cen, we do not find any feasible scenario where the planet can induce radio emission in the star's corona, as the planet orbits too far from the star in the super-Alfvénic regime. However, in the case that AU Mic has a mass-loss rate of 27 times that of the Sun, we find that both planets b and c in the system can induce radio emission from 10 MHz – 3 GHz in the corona of the host star for the majority of their orbits, with peak flux densities of 10 mJy. Our predicted emission bears a striking similarity to that recently reported from GJ 1151, which is indicative of being induced by a planet. Detection of such radio emission would allow us to place an upper limit on the mass-loss rate of the star, and also constrain the magnetic field strength of the planet that induces the emission.
14:15-14:30	**BREAK**
14:30-14:45	***Peeking inside the Black Box: Interpreting Deep Learning Models for Exoplanet Atmospheric Retrievals*** **Kai Hou Yip**, Quentin Changeat, Nikolaos Nikolaou, Mario Morvan, Billy Edwards, Ingo P. Waldmann (University College London, UK) Deep learning algorithms are growing in popularity in the field of exoplanetary science due to their ability to model highly non-linear relations and solve interesting problems in a data-driven manner. Several works have attempted to perform fast retrieval of atmospheric parameters with the use of machine learning algorithms or deep neural networks (DNNs). Yet, despite their high predictive power, DNNs are also infamous for being 'black boxes. It is their apparent lack of explainability that makes the astrophysics community reluctant to adopt them. What are their predictions based on? How confident should we be in them? When are they wrong and how wrong can they be? In this work, we present a number of general evaluation methodologies that can be applied to any trained model and answer questions like these. In particular, we train 3 different popular DNN architectures to retrieve atmospheric parameters from exoplanet spectra and show that all 3 achieve good predictive performance. We then present an extensive analysis of the predictions of DNNs, which can inform us among other things of the credibility limit for atmospheric parameters for a given instrument and model. Finally, we perform a sensitivity analysis to identify to which features of the spectrum the outcome of the retrieval is most sensitive. We conclude that for different molecules, the wavelength ranges to which the DNNs predictions are most sensitive, indeed coincide with their characteristic absorption regions. The methodologies presented in this work help to improve the evaluation of DNNs and to grant interpretability to their predictions.

14:45-15:00	***Introduction to SWIMMR*** **Gerard Hutchinson**[1], Ian McCrea[1], Simon Machin[2], Will Thomas[2], Pat McKenzie[2], Alex Barnes[2] & Nick Barnes[2] ([1] RAL Space, STFC-UKRI, Harwell Campus, Oxfordshire OX11 0QX, [2] The Meteorological Office, FitzRoy Road, Exeter, Devon EX1 3PB) SWIMMR (Space Weather Instrumentation, Measurement, Modelling and Risk) is a £20 million, four-year programme, funded through STFC and NERC, which will improve the UK's capabilities for space weather monitoring and prediction. SWIMMR will develop and deploy new instruments, models and services to support the UK space weather community and the Met Office Space Weather Operations Centre. The STFC funded elements of the SWIMMR programme are: S1: In-situ radiation measurements for space and aviation S2: Support for technology testing and modelling S3: Support for the transition from Research to Operations S4: Forecasting from the Sun to L1 S5: Support for a ground radiation monitoring network S6: Production of an updated space weather impact study The talk will briefly introduce the SWIMMR (Space Weather Instrumentation, Measurement, Modelling and Risk) programme, with particular emphasis on the Space Weather modelling and development part of the programme: Support for the transition from Research to Operations. The primary objectives specific to SWIMMR Research to Operations are: • Establish a world leading UK system for space weather modelling and forecasting • Develop a framework for supporting the transition of space weather models and data sets from research in the academic community to operational use for space weather forecasting • This framework will allow verification & validation and reliability testing to be done by model developers in their own institutions.
15:00-15:30	***Tools for Science Public Outreach (INVITED)*** **Rosie Cane** and Tony Thompson (Thompson STEM Management) The Europlanet 2024 Research Infrastructure (RI) provides free access to the world's largest collection of planetary simulation and analysis facilities. The project is funded through the European Commission's Horizon 2020 programme and runs for four years from February 2020 until January 2024. The Transnational Access (TA) programme supports all travel and local accommodation costs for European and international researchers to visit over 40 laboratory facilities and 6 Planetary Field Analogues (PFA). As part of the education and inspiration tasks associated with Europlanet 2024 RI, we have produced two sets of classroom resources aimed at age 10-14 year olds. Following studies such as Salimpour et al 2020, highlighting the extent to which astronomy has been incorporated into school curriculums, we have chosen to highlight three subject areas with lower representation in high schools into all resources: physics, space exploration and astrobiology. The first resources have been produced around Europlanet PFA sites, relating the conditions found within these sites to astrobiology and the habitability of Mars. These

	resources link in with common areas found in worldwide STEM curriculums, such as volcanism, pressure, pH and evaporation. To achieve this, we have filmed lab-based demonstrations and included them in a classroom lesson plan alongside teachers' notes. In addition, each lesson plan focuses on how the conditions of the PFAs could affect the habitability of Mars. An Italian version of the resources has been produced by EduINAF with the addition of brief video-lessons. English versions were released on a weekly basis from mid-March through April with opportunities for training sessions to support teachers wishing to engage with these resources. Resources have also been created based around the habitability of the icy moons of the Solar System, following a similar format to the aforementioned resources. This includes links to engineering and European missions to explore these locations. This, again, includes lab-based demonstrations in a classroom lesson plan alongside teachers' notes. An additional project, Sense the Universe, has been funded through the Europlanet 2020 Public Engagement Funding Scheme. This project showcases free, easy-to-make sensory learning activities using common household items to reduce barriers to learning. This project has been trialled at Cardiff Science Festival and activities are currently under development.
15:30-16:00	***ORBYTS – Planetary Science Research-with-Schools Projects (INVITED)*** Presented by **William Dunn** (UCL-MSSL, UK), but noting that this is a huge collaboration of (70+) scientists and teachers and hundreds of school students, and so I hope to do some modicum of justice to all of the incredible work undertaken by all those involved. Teachers D. Fleming and W. Whyatt respectively say: "This project has surpassed anything I could have possibly imagined - not only have our students been consistently blown away by the science of other planets, it has helped them better understand the value of their own one. ORBYTS is definitely one of the coolest things I've been exposed to in my 15 year career." "It's clear to me that the ORBYTS project has been the most successful project we have been fortunate to work with and its importance cannot be overstated." So what is ORBYTS, how is it having such a profound impact on school students and what makes teachers think it's quite so cool? ORBYTS is a movement organised by space researchers and teachers that creates partnerships between scientists and schools. This provides school students with relatable science role models while empowering them to conduct their own original space research projects. This structure of regular interventions, inspirational role models and active ownership of scientific research is proving to be transformative; dispelling harmful stereotypes and profoundly shifting perceptions of science and scientists. It is proving to be particularly impactful for groups historically excluded from science. For example, our partner schools report 100% increases in girls uptake of A-level physics, following participation in an ORBYTS project at GCSE. Given that ORBYTS builds a symbiosis between research and schools, since 2018, it has enabled 150+ UK state school students to author publications (10s of planetary papers) - most of these student-authors are pupil premium and/or widening participation students. In 2021, our fantastic planetary researchers partnered with school students to support research-with-schools projects on: exoplanets, aurorae, AI and machine learning, magnetospheres, Mars' atmosphere and space environment, cometary tails, space weather and X-ray observations of planets. In this talk, I'll showcase a whistle-stop tour through some of these projects, where possible letting recorded presentations by the schools do the talking. I'll overview the process of creating projects, the general

	structure and timeline of them and what our evaluation data shows about the value of different aspects of the programme on students, teachers and researchers. I'll also speak briefly on the best practice seminars/workshops on inclusivity, teaching, communication and management training that we offer for interested researchers and on how we pay PhD students for their time producing and delivering projects. While through 4 years delivering over 100 research-with-schools projects, we have begun to build solid foundations of best practice, we are constantly seeking to improve the programme and to collaborate and partner with new people to improve the science experiences of everyone involved – we hugely welcome any contact about ORBYTS.
16:00-16:30	***ExoClock – A citizen science project to monitor transiting exoplanets (Invited)*** **Angelos Tsiaras** (University College London, UK) The ExoClock Project (www.exoclock.space) is an open, integrated, and interactive platform, designed to maintain the ephemerides of the exoplanets that will be observed by the Ariel. Ariel is ESA's medium class space mission prepared for launch in 2028. The main aim of the mission is to characterise a large number of exoplanets to better understand their nature. ExoClock aims to provide transit mid-time predictions for Ariel by collecting all currently available data (literature observations, observations conducted for other purposes, both from ground and space) and by efficiently planning dedicated efforts to follow-up the Ariel targets. ExoClock is open to contributions from a variety of audiences — professional, amateur and industry partners — aiming to make the best use of all available resources towards delivering a verified list of ephemerides for the Ariel targets before the launch of the mission. Here I will present the strategies and tools implemented in ExoClock, the current status of the project and the results included in our first two publications.
Poster 1	***Destination: Space! A Virtual Flash Talk Series*** **K. Shirley**, H. Cotterill, S. Tedaldi, T. Warren, H. Bates, R. Spry, & N. Bowles (University of Oxford, UK) Introduction: During the series of national lockdowns, interacting onsite with local schools became difficult and increased the demand for virtual content. To meet this challenge, we created an online programme entitled "Destination: Space", aimed at showcasing the current planetary research conducted within the Atmospheric, Oceanic, and Planetary Physics (AOPP) department at the University of Oxford. Over six weeks, school students from the UK and around the globe joined us on an out-of-this-world journey exploring space and planetary physics. Destination: Space has introduced students to fascinating areas of science, including the search for water on the Moon, meteorites and sample return missions, and whether there really could be other life out there in the universe. Talks were hosted online in a live webinar-style, where the audience could interact with and ask questions of the scientists involved in each event. The series consisted of four short seminars, one game show style event, and one purely question and answer panel session. The seminar sessions consisted of a short talk delivered by AOPP scientists focused on their research with time for audience questions. The game show event was loosely based on the "Would I lie to you?" BBC hit television show and had the scientists presenting short statements and inviting the audience to determine whether it was fact or fiction. This format encouraged audience participation and debate through the webinar chat feature. Due to the large number of questions we

	were unable to get to during the seminar sessions, a Q&A panel was added to the series. Reception: The Destination: Space programme was advertised well in advance of its commencement through the Oxford Physics Outreach department mailing lists connected to local schools, and through social media accounts. Over 750 audience members attended the series with an additional 1000+ viewers watching the recorded versions on YouTube as of time of writing. Project Assessment: For the seminar sessions, polls were used to assess the audience's knowledge before and after the talk, with the majority self-reporting an increase in understanding of the topic and overall positive comments from the audience, including several emails from teachers supporting the project. The game show session incorporated polls throughout to encourage an interactive event, and showed the audience actively debating in the chat and reaching the right answer 85% of the time. Responses to this event were overwhelmingly positive and many cited the interactivity as enhancing their experience. Overall polling showed support for the programme and calls for similar series covering other space topics. We will look to create another series for the upcoming school year, and to create more activities for teachers to use in conjunction with the programme. The recorded programme can be found here: https://www.youtube.com/playlist?list=PLUX8glPeEnsK2Qu97enFmpXuIoMrw7Pdm
Poster 2	***Compressibility of the Jovian magnetosphere*** **Dimitrios Millas** (University College London, UK) *Abstract as per talk listed above (11:35-11:50)*
Poster 3	**Variability of the interplanetary magnetic field as a driver of electromagnetic induction in Mercury's interior** **S. Zomerdijk-Russell**[1], A. Masters[1] and D. Heyner[2] ([1]The Blackett Laboratory, Imperial College London, London, UK, [2]Institute for Geophysics and extraterrestrial Physics, Technische Universität Braunschweig, Braunschweig, Germany) *Abstract as per talk listed above (12:05-12:20)*