EP 5: Near-Earth Space I & Planets and Small Bodies II

Time: Tuesday 16:15–18:15 Location: ZHG005

EP 5.1 Tue 16:15 ZHG005

Preliminary Results of the CHerenkov Atmospheric Observation System (CHAOS) from the 2024 Balloon Experiments for University Students (BEXUS) Campaign — •Hannes Ebeling, Pierre Bornfleth, and Ava Pohley — Christian-Albrechts-Universität zu Kiel

The Earth is continuously exposed to high-energy charged particles, so-called Galactic Cosmic Rays (GCRs). When these particles hit the Earth's atmosphere, they create a cascade of secondary particles. CHAOS uses a new detector design to measure the different particle species of the primary GCRs above the so-called Regener-Pfotzer Maximum. To perform these measurements, a combination of multiple solid state detectors and a bismuth germanium oxide (BGO) scintillator is used to measure the energy depositions of the particles. The use of an additional aerogel Cherenkov scintillator allows to separate between electrons and protons. Because electrons are much lighter than ions, electrons with energies above $\sim 1.1\,\mathrm{MeV}$ will trigger the Cherenkov detector whereas ions with the same energy are much slower and will not trigger the detector. Developed by a team of students at the Department for Extraterrestrial Physics at Kiel University, CHAOS flew on a stratospheric balloon as part of the BEXUS programme in fall 2024. In this talk I present the preliminary results from CHAOS's balloon flight.

EP 5.2 Tue 16:30 ZHG005

Investigation of the occurrence of significant deviations in the magnetopause location: Solar wind and foreshock effects — •Niklas Grimmich[1], Adrian Pöppelwerth[1], Martin Owain Archer[2], David Gary Sibeck[3], Ferdinand Plaschke[1], Wenli Mo[4], Vicki Toy-Edens[4], Drew Lawson Turner[4], Hyangpyo Kim[5], and Rumi Nakamura[5] — [1]Institut für Geophysik und Extraterrestrische Physik, Technische Universität Braunschweig, Braunschweig, Germany — [2]Department of Physics, Imperial College London, London, UK — [3]NASA Goddard Space Flight Center, Greenbelt, Maryland, USA — [4]Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA — [5]Space Research Institute, Austrian Academy of Sciences, Graz, Austria

Recent studies have shown that some effects of upstream conditions on the location of the magnetopause may still be poorly understood, as deviations between empirical models and in situ observations are quite common. Using data from three multi-spacecraft missions to near-Earth space (Cluster, THEMIS and MMS), we can investigate the occurrence of these magnetopause observations. We test whether the deviant magnetopause crossings are statistically associated with foreshocks and/or different solar wind types, and show that in at least 40% of the cases the foreshock can be responsible for the large deviations in magnetopause position. In addition, two distinct classes of solar wind are found to be more frequently associated with the occurrence of magnetopause deviations: the "fast" solar wind and the solar wind plasma associated with transient events.

Invited Talk EP 5.3 Tue 16:45 ZHG005

Heliosphere as a natural laboratory of turbulence and plasma nonlinearities — •Yasuhito Narita — Institut für Theoretische Physik, Technische Universität Braunschweig, Braunschweig, Germany

Heliosphere is a spatially extended domain of the solar plasma expanding radially away from the Sun with a supersonic speed, and has a length scale of about 100 astronomical units. The heliosphere serves as the largest laboratory of turbulence to us, in which various complex and irregular motions of plasma and magnetic field can be studied in detail using in-situ spacecraft. Understanding the nonlinear processes constituting heliospheric plasma turbulence has immediate implications to various research fields in space and astrophysics: turbulent dynamo mechanism generating a large-scale magnetic field, acceleration and scattering of cosmic rays, and mass and angular momentum transfer problem particularly important in the rotating system like accretion disks. Early spacecraft measurements in 1960s hinted that the heliospheric plasma is apparently in the fully-developed turbulent state, for the energy spectrum of the magnetic field fluctuations is reminiscent of the inertial range of fluid turbulence. While a number of spacecraft observations, theoretical modelings, and numerical simulations successfully contributed to build a rough picture of plasma turbulence in the heliosphere, many questions remain still unanswered. I review recent observational studies of heliospheric turbulence focusing on the inner heliosphere such as Parker Solar Probe, Solar Orbiter, and BepiColombo cruise to Mercury, and also review critically theoretical pictures and concepts.

EP 5.4 Tue 17:15 ZHG005

Kinetic simulations of Helium in the Hermean plasma environment — •Fabio Prencipe[1,2], Markus Fränz[1], Harald Krüger[1,3], Norbert Krupp[1], Daniel Heyner[2], and Ferdinand Plaschke[2] — [1]Max-Planck-Institute for Solar System Research, Göttingen, Germany — [2]Institute of Geophysics and Extraterrestrial Physics, TU Braunschweig, Braunschweig, Germany — [3]Planetary Exploration Research Center, Chiba Institute of Technology, Narashino, Japan

Helium was first detected in the Hermean exosphere by the Mariner 10 spacecraft. Sources of the Hermean helium population include outgassing, capture of solar wind He^{2+}, and interstellar pickup He^{+}. Different processes can lead to a change in ionization of helium, e.g. photoionization by solar radiation. Ionized helium can be convected and lost from the plasma environment because of the interaction of the Hermean magnetic field with the solar wind. The abundances of the different helium species in the different Hermean regions are an indicator of the respective dominant helium sources and losses.

The aim of this study is to model the different species of helium in the Hermean magnetosphere in preparation for the arrival of the ESA spacecraft Bepi Colombo. Simple MHD simulations of Mercury's magnetosphere are combined with kinetic simulations of helium atoms. The kinetic simulations include ionization and loss processes in order to investigate the evolution of the different helium species. A statistical analysis of the helium atoms is used to study the ratios of the helium species in the different regions of the Hermean environment.

EP 5.5 Tue 17:30 ZHG005

Solar wind velocity reconstruction at Mercury using MESSENGER bow shock and magnetopause crossings. — •Daniel Heyner[1], Lars Klingenstein[1], Kristin Pump[1], Sae Aizawa[2], Daniel Schmid[3], and Ferdinand Plaschke[1] — [1]IGEP, TU Braunschweig, Braunschweig, Germany. — [2]LPP, CNRS-Ecole Polytechnique-Sorbonne Université, Paris, France. — [3]IWF, Austrian Academy of Sciences, Graz, Austria

The solar wind plays a critical role in shaping planetary magnetospheres, particularly Mercury's, which is highly sensitive due to its weak intrinsic magnetic field and proximity to the Sun. Solar wind flow speed influences the magnetosphere's aberration angle, tilting it relative to the Mercury-Sun line, and the subsolar standoff distances of both the bow shock and magnetopause.

This study reconstructs solar wind speeds using bow shock and magnetopause crossings observed by MESSENGER's magnetometer. By fitting empirical models to the aberration angle and treating subsolar standoff distances as parameters, we reveal a strong correlation that prevents independent determination of these values. Combining multiple crossings allows us to constrain the aberration angle more effectively. Here, we present the first statistical results, comparing them to average boundary shapes and positions, offering insights into Mercury's magnetospheric dynamics.

EP 5.6 Tue 17:45 ZHG005

Investigation of Mercury's Bow Shock Crossings — •Kristin Pump, Daniel Heyner, and Ferdinand Plaschke — Institut für Geophysik und extraterrestrische Physik, TU Braunschweig

Mercury's intrinsic magnetic field is an obstacle to the supermagnetosonic solar wind and thus a bow shock and magnetopause form. The characteristics of the magnetopause depend on various parameters such as the heliocentric distance (~ pdyn) and the IMF orientation. In theory the bow shock shape and location depend on the Mach number which could not be shown for Mercury's bow shock with in-situ data so far.

In this study we analyze bow shock crossings observed by MESSENGER. From the magnetic shock parameters, we retrieve the Mach number (as a function of plasma beta). This enables new possibilities of evaluating the shape and location of Mercury's bow shock under different upstream conditions. We demonstrate our analysis by showing some specific cases and provide a statistical overview. We compare our findings to heliospheric MHD simulations and Parker Solar Probe measurements. The discovered relationship between the bow shock position and solar wind conditions can enhance our comprehension of the highly dynamic processes in Mercury's space environment.

Poster pitch: EP 10.10 (Bender), EP 10.11 (Pöppelwerth), EP 10.12 (Kleimann)