Extraterrestrial Physics Division
Fachverband Extraterrestrische Physik (EP)

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Overview of Invited Talks and Sessions

(Lecture hall KH 01.019; Poster Redoutensaal)

Plenary Talk of the Extraterrestrial Physics Division

PV III	Mon	11:45–12:30	AudiMax	**Copernicus Revisited: is the Earth special?** — •Laura Kreidberg

Invited Talks

EP 1.1	Mon	14:45–15:15	KH 01.019	**Nuclear Astrophysics and Gamma Rays: From Space to Earth** — •Thomas Siegert
EP 4.1	Wed	11:00–11:30	KH 01.019	**Assessing the immediate dynamical and long-term radiative effects of the Hunga Tonga Hunga Ha'apai volcanic eruption using state-of-art active and passive ground-based remote sensing** — •Gunter Stober
EP 6.1	Wed	13:45–14:15	KH 01.019	**Simulation of the photosphere and chromospheres of sunspots** — •Aswathi Krishnan Kutty, Robert H. Cameron, Damien Przybylski, Tanayveer Bhatia, Sami K. Solanki
EP 6.2	Wed	14:15–14:45	KH 01.019	**Dynamics of a solar prominence simulated with MURaM** — •Lisa-Marie Zessner, Robert Cameron, Sami Solanki, Damien Przybylski
EP 8.1	Thu	11:00–11:30	KH 01.019	**Solar and heliospheric studies with the LOFAR radio telescope** — •Christian Vocks
EP 10.1	Fri	9:00– 9:30	KH 01.019	**The diversity of low mass exoplanets** — •Kristine Lam
EP 11.1	Fri	11:00–11:30	KH 01.019	**Iron and the search for life on Mars** — •Christian Schröder

Sessions

EP 1.1–1.3	Mon	14:45–15:45	KH 01.019	**Astrophysics I**
EP 2.1–2.7	Mon	16:15–18:00	KH 01.019	**Astrophysics II**
EP 3.1–3.5	Tue	11:00–12:15	KH 01.019	**Astrophysics III**
EP 4.1–4.3	Wed	11:00–12:00	KH 01.019	**Near-Earth Space**
EP 5	Wed	12:30–13:45	KH 01.019	**Members' Assembly**
EP 6.1–6.6	Wed	13:45–15:45	KH 01.019	**Sun and Heliosphere I**
EP 7.1–7.2	Wed	16:15–18:45	Redoutensaal	**Poster Session**
EP 8.1–8.5	Thu	11:00–12:30	KH 01.019	**Sun and Heliosphere II**
EP 9.1–9.6	Thu	13:45–15:15	KH 01.019	**Sun and Heliosphere III**
EP 10.1–10.5	Fri	9:00–10:30	KH 01.019	**Exoplanets and Astrobiology**
EP 11.1–11.4	Fri	11:00–12:25	KH 01.019	**Planets and Small Bodies**

Members' Assembly of the Extraterrestrial Physics Division

Wed 12:30–13:45 KH 01.019

EP 1: Astrophysics I

Time: Monday 14:45–15:45 Location: KH 01.019

Invited Talk EP 1.1 Mon 14:45 KH 01.019

Nuclear Astrophysics and Gamma Rays: From Space to Earth — •Thomas Siegert — JMU Würzburg

Gamma rays provide a unique window on nuclear processes occurring throughout the Universe, directly tracing radioactive isotopes and matter antimatter annihilation. In this talk, I will review key results from gamma-ray line spectroscopy in space, focusing on observations from 22 years of the now completed ESA satellite mission INTEGRAL. Measurements of radioactive isotopes, such as 26Al and 60Fe, reveal ongoing nucleosynthesis in the Galaxy and connect stellar explosions to traces found on Earth, including signatures preserved in ocean crust sediments. In this context, the long-standing puzzle of the Galactic 511 keV positron annihilation emission is also discussed. NASA's Compton Spectrometer and Imager (COSI) mission, scheduled for launch in 2027, is expected to significantly advance MeV measurements thanks to its increased sensitivity and imaging capabilities. I will introduce the Compton telescope concept and highlight open questions addressed by COSI, such as the role of massive stars and supernovae in Galactic feedback. Finally, I will show how analysis and imaging techniques developed for space-based gamma-ray astronomy are now being applied on Earth, enabling isotopic imaging of radioactive residues in nuclear facilities and related environments.

EP 1.2 Mon 15:15 KH 01.019

Contribution of Stellar flares to the 511keV galactic positron budget — •Saurabh Mittal and Thomas Siegert — Julius-Maximilian-Universität, Würzburg

The origin of the Galactic 511 keV positron annihilation line has been a mystery for five decades. One proposed explanation is positron production in stellar flares, motivated by the detection of the 511 keV line in solar flares and by the association of this emission with old stellar populations. In this work, we explore this scenario using two complementary approaches. First, we build a theoretical model to estimate the quasi-persistent 511 keV emission from flaring stars. Starting from solar flare observations, we construct empirical scaling relations between flare energy and 511 keV luminosity and extend them to Galactic stellar populations using flare-frequency-energy distributions for different spectral types. In parallel, we analyze INTEGRAL/SPI data in the 511 keV band using combinations of known point sources and simple spatial templates, such as disk and bulge components modeled as two-dimensional Gaussians. We also test alternative descriptions in which no bulge template is assumed and the emission is instead described by a disk component together with a population of globular clusters, scaled by their masses and distances. This ongoing work aims to assess whether stellar flares can plausibly account for the observed Galactic 511 keV emission.

EP 1.3 Mon 15:30 KH 01.019

On the cosmic-ray diffusion tensor in dynamical galactic halos — Jens Kleimann[1], •Horst Fichtner[1], Michael Stein[2], Ralf-Juergen Dettmar[2], Dominik Bomans[2], and Sean Oughton[3] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Germany — [2]Astronomisches Institut, Ruhr-Universität Bochum, Germany — [3]Department of Mathematics, University of Waikato, New Zealand

Galactic halos separate the interstellar from the intergalactic medium. One question related to their physics is: How are cosmic rays transported within these dynamic regions of low density plasma permeated by a turbulent magnetic field? An understanding of cosmic-ray transport in galactic halos is of significance for explaining, e.g., the radio continuum measurements of synchrotron radiation from energetic electrons. Of central importance for the transport is the spatial diffusion tensor of cosmic rays, which can be computed in an ab-initio manner if the turbulence in the background medium is known. After a 'hydrodynamic validation', which revealed a persistent instability of the near-axis flow and could be traced to the galaxy mass, we present numerical solutions of the Reynolds-averaged single-fluid MHD equations. This way we obtained the physical properties of both large-scale MHD and small-scale turbulent quantities and, by employing a state-of-the-art nonlinear theory, the coefficients of parallel and perpendicular diffusion. The simulation results reveal variations in turbulence quantities in a dynamical halo that translate in a significant variation of the corresponding diffusion tensor of cosmic rays.

EP 2: Astrophysics II

Time: Monday 16:15–18:00 Location: KH 01.019

EP 2.1 Mon 16:15 KH 01.019

Modeling the low-ionization broad-line region in a sample of OI/CaII emitters detected by VLT/MUSE and DESI — •Tianyu Zhao — Institut für Astrophysik Georg-August-Universität Göttingen Friedrich-Hund-Platz 1 D-37077 Göttingen Germany

Broad emission-line (BEL) profiles in active galactic nuclei (AGN) contain information about the structure and kinematics of the broad-line region (BLR), where these lines are emitted, as the BEL shape is governed by the BEL-emitting gas moving in the potential of the supermassive black hole (SMBH). The study of BEL profiles is thus a powerful tool to study accretion processes onto SMBHs. However, for the largest part of the AGN population, it is impossible to directly *read-of* information from the line profiles as additional effects such as turbulence or optical-depths effects distort the clear kinematic signature of the moving BLR gas. Only recently, the profiles of O I 8446 and the near-infrared Ca II triplet have been recognized as a powerful diagnostic tool for BLR kinematics, because these line presumably arise in the dense atmosphere/corona of the accretion disk. Novel studies suggest, that these line are not significantly influenced by internal turbulence, thus clearly revealing the kinematic signature*namely double-peaked profiles*of a line-emitting BLR disk. In this master*s thesis, I aim to extend the sample of known OI and Ca II emitters with complex, i.e., not single-peaked, profiles, and constrain the kinematics of the OI/CaII-emitting regions.

EP 2.2 Mon 16:30 KH 01.019

A Three-Dimensional Tomographic Map of Galactic Cosmic-Ray Proton Density — •Hanieh Zandinejad and Torsten Ensslin — Max Planck Institute for Astrophysics, Karl-Schwarzschild-Str. 1, 85741 Garching

Cosmic rays (CRs) are a ubiquitous non-thermal component of the interstellar medium in the Galaxy. While their number density can be inferred from local measurements on Earth, their three-dimensional distribution has largely been explored through simulations. A data-driven three-dimensional map of CRs is therefore essential to better understand their spatial distribution and the locations of their sources.

We infer the spatial distribution of cosmic-ray protons (CRp) by exploiting diffuse gamma-ray emission produced in inelastic hadronic collisions of CRs with interstellar gas. Using gamma-ray data from the Fermi Large Area Telescope together with a three-dimensional gas map, we reconstruct the CRp density in a morphological matching approach based on numerical methods from information field theory. The resulting three-dimensional CRp density is obtained as an ensemble of posterior samples, whose variance quantifies statistical uncertainties and whose mean is consistent with local cosmic-ray proton measurements.

In this talk, I will outline the construction of the prior model, present the morphological matching approach, and discuss the resulting three-dimensional CRp density map, highlighting current challenges in cosmic-ray tomography and the status of the project.

EP 2.3 Mon 16:45 KH 01.019

Accretion Regimes of Neutrino-Cooled Flows onto Black Holes — •Javiera Hernández Morales[1] and Daniel Siegel[1,2] — [1]University of Greifswald — [2]University of Guelph

Neutrino-cooled accretion disks can form in the aftermath of neutron-star mergers as well as during the collapse of rapidly rotating massive stars and the accretion-induced collapse of rapidly rotating white dwarfs. At sufficiently high accretion rates, electrons present in the disk become degenerate, which leads to the neutronization of the accreting plasma and makes these astrophysical systems promising sources of rapid neutron-capture nucleosynthesis (the r-process). We present a one-dimensional, general-relativistic, viscous-hydrodynamic model of neutrino-cooled accretion disks around black holes. We chart the composition of the accretion flow and systematically explore a vast parameter space of accretion rates of $\dot{M} \sim 10^{-6} - 10^{6} M_{\odot}\,\mathrm{s}^{-1}$, black hole masses of $M_{\bullet} \sim 1 - 10^{4} M_{\odot}$, dimensionless spins of $\chi_{\bullet} \in [0, 1)$, and α-viscosity values of $\alpha \sim 10^{-3} - 1$. We find that outflows from such disks are promising sites for r-process nucleosynthesis up to $M_{\bullet} \lesssim 3000 M_{\odot}$. These give rise to lanthanide-bearing 'red' super-kilonovae transients mostly for $M_{\bullet} \lesssim 200 - 500 M_{\odot}$ and lanthanide-suppressed 'blue' super-kilonovae for larger $M_{\bullet}$. Proton-rich outflows can develop specifically for large black hole masses ($M_{\bullet} \gtrsim 100 M_{\odot}$) in certain accretion regimes, which may give rise to proton-rich isotopes via neutrino-induced proton-capture nucleosynthesis (the νp-process). We test some of these scenarios by following the trajectories of potential disk winds with the nuclear reaction network WinNet.

EP 2.4 Mon 17:00 KH 01.019

R-process nucleosynthesis in collapsar accretion disk outflows and cosmic chemical evolution — •Aman Agarwal[1] and Daniel Siegel[1,2] — [1]Institute of Physics, University of Greifswald, D-17489 Greifswald, Germany — [2]Department of Physics, University of Guelph, Guelph, Ontario, Canada, N1G 2W1

The collapse of rapidly rotating massive stars ("collapsars"; $M_{\mathrm{ZAMS}} \lesssim 40 M_{\odot}$ at birth) are leading models for long gamma-ray burst (GRBs) central engines and promising sources of neutron-rich environments for r-process nucleosynthesis. Here, we extend the range of collapsars and explore collapsar accretion disk flows around black holes of mass $M_{\bullet} = 3 - 3000\ M_{\odot}$ using long-term, three-dimensional general-relativistic magnetohydrodynamics simulations with weak interactions and find that the accretion flows neutronize above an "ignition" accretion rate $\dot{M}_{\mathrm{ign}}$. We present remarkable agreement between our simulations and the analytic result $\dot{M}_{\mathrm{ign}} \propto \alpha^{5/3} M_{\bullet}^{4/3}$ with α_{eff} being the effective Shakura-Sunyaev viscosity. We demonstrate by semi-analytical modeling that stellar models of $\sim 250 - 10^{5}\ M_{\odot}$ mass can give rise to BHs of $M_{\bullet} \sim 30 - 1000\ M_{\odot}$ accreting at $\dot{M} \gtrsim \dot{M}_{\mathrm{ign}}$, yielding $\sim 10 - 100\ M_{\odot}$ of r-process elements per event. We highlight their potential as multi-messenger sources of optical/IR transients ("super-kilonovae") and gravitational waves (GWs) for third-generation (3G) GW detectors. Using a one-zone chemical evolution model and a projection of future 3G GW and abundance observations, we demonstrate a correlation technique to infer the percentage contribution of multiple sources to galactic and cosmic r-process enrichment.

EP 2.5 Mon 17:15 KH 01.019

Differential Rendering of the Night Sky in Imaging Atmospheric Cherenkov Telescopes — •Gerrit Roellinghoff and Stefan Funk — Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany

Imaging Atmospheric Cherenkov Telescopes detect Cherenkov light against an irreducible optical background stemming from the night sky, e.g. from stars, airglow, zodiacal light and moonlight. We present a differentiable forward model for predicting this pixel-wise night sky background. The model includes single-scattering atmospheric radiative transfer and ray-traced instrument responses and spectrally models major contributors. Automatic differentiation enables gradient computation with respect to physical parameters such as aerosol optical depth and pointing offsets. This allows for efficient recovery of atmospheric and instrumental parameters from measured data, providing a new approach to instrument calibration for current and future IACT arrays.

EP 2.6 Mon 17:30 KH 01.019

Bayesian imaging of cosmic-ray air showers — •Mrinal Jetti — Max Planck Institute for Astrophysics, Karl-Schwarzschild-Str. 1, 85748 Garching, Germany

High-energy cosmic rays interacting with Earth's atmosphere generate cascades of secondary particles known as extensive air showers. The electromagnetic component of these showers, consisting primarily of electrons, positrons, and photons, emits coherent, pulsed radio signals. Imaging air showers via their radio emission to infer the shower's structure and its development and, ultimately, the properties of the primary cosmic-ray particle remains a long-standing problem, with several classical reconstruction methods having been developed.

This project aims to image extensive air showers using their radio emission, measured as time-dependent electric field traces recorded by ground-based antenna arrays. The air shower is modeled as a system of relativistically moving current distributions that give rise to the observed radio signal. Using Bayesian inference within the framework of Information Field Theory, implemented within the Python package NIFTy (Numerical Information Field Theory), the inverse problem of reconstructing the underlying current distributions from the measured electric field traces is addressed.

EP 2.7 Mon 17:45 KH 01.019

Observations of the dark matter halo of the Andromeda Galaxy with INTEGRAL/SPI — •Laura Eisenberger, Thomas Siegert, Saurabh Mittal, Rudi Reinhardt, Dimitris Tsatsis, Niklas C. Bauer, Patrik Ehrmann, and Manja Zimmerer — Julius-Maximilians-Universität Würzburg, Fakultät für Physik und Astronomie, Institut für Theoretische Physik und Astrophysik, Lehrstuhl für Astronomie, Emil-Fischer-Str. 31, 97074 Würzburg

The Andromeda galaxy (M31) is a promising target for the indirect search of dark matter (DM) due to its proximity and expected massive DM halo. It functions as test case for a Milky Way (MW) like galaxy as the isotropic emission from the MW halo itself cannot be measured without large efforts with coded mask telescopes. Since weakly interacting massive particles also produce a significant flux of secondary MeV photons from inverse Compton scattering and positron annihilation, γ-ray observations in the MeV range are a powerful probe of DM with a wide mass range from MeV up to TeV.

We use the spectrum obtained from SPI observations of the M31 region including M33 in order to constrain different DM models. We model the halos of M31 and M33 as extended emission and take the uncertainty of the DM distribution into account by considering different density profiles and substructure boosting. From the 511 keV line from positron annihilation, we estimate the pair production rate in M31 to put a lower mass limit on thermal DM. With forthcoming missions like COSI-SMEX, a coherent multi-galaxy analysis promises to significantly improve upon existing DM constraints.

EP 3: Astrophysics III

Time: Tuesday 11:00–12:15 Location: KH 01.019

EP 3.1 Tue 11:00 KH 01.019

mw-atlas: Towards the three-dimensional shape of the Milky Way Galaxy in Gas and Dust — •Fabian Polnitzky, Laurin Söding, and Philipp Mertsch — RWTH Aachen University

From our position inside the Milky Way, we have a unique vantage point which obscures the galaxy's overall shape. Despite decades of research, no definite answer has been found regarding its exact structure. In recent years, the focus has shifted towards three-dimensional spatial mapping of the galaxy, in comparison to two-dimensional observations of the sky, leading to the discovery of previously unknown features such as the Radcliffe Wave.

To construct these maps, we require new observational data, but more importantly, new statistical techniques that bridge the transition from two to three dimensions. A promising avenue for this is information field theory, which was successfully used to map the spatial distribution of parts of the Milky Way.

Components, that are mapped in three dimensions now, include neutral hydrogen gas across the entire galaxy and interstellar dust in the local neighbourhood of the sun. In my talk, I will provide an overview of the techniques used to create these maps, summarize our current understanding, and highlight what we know about them. I will also discuss how combining neutral hydrogen gas and interstellar dust can further improve our three-dimensional view of the Milky Way, by leveraging correlations between them.

EP 3.2 Tue 11:15 KH 01.019

mw-atlas: Inferring the Milky Ways gravitational potential from stellar streams — •Matthias Hübl and Philipp Mertsch — RWTH Aachen University

The Milky Ways gravitational potential governs the large scale dynamics and imprints itself on the movement of gas, dust and stars around the Galactic center. Stellar streams, groups of stars that were stripped from a common progenitor cluster, can be seen as tracer particles within this potential that have very similar kinematic properties. Seen as elongated features along the sky, they almost perfectly map out orbits, and with the abundance of high quality astronomical data taken in recent years, it is now feasible to use them to constrain the Milky Ways gravitational potential in unprecedented ways. Using powerful and flexible methods like geometric variational inference, it is possible to infer the potential without fixing its exact shape to a rigid analytical form. This way we are able to constrain the deviation of the gravitational potential from a perfectly spherical one, namely its triaxiality, and thus the shape of the Galaxies dark matter halo within our Bayesian framework.

EP 3.3 Tue 11:30 KH 01.019

An in-depth characterization of fiber-to-chip coupling interfaces in arrayed waveguide spectrographs for astronomy — •Tim Schleifer[1,2], Aashia Rahman[2], Kalaga Madhav[2], Michael Gensch[1,3], and Andreas Stoll[2] — [1]Technische Universität Berlin, Berlin, Germany — [2]Leibniz-Institut für Astrophysik Potsdam, Potsdam, Germany — [3]DLR Institute of Space Research, Berlin, Germany

Astrophotonics offers a pathway toward miniaturized and highly stable astronomical instruments for next-generation telescopes. A chip-based arrayed waveguide grating (AWG) acts as the main dispersive element in an astrophotonic spectrograph, with a key limitation arising at the fiber-to-chip interface, where coupling losses can critically impact overall throughput. Characterizing and optimizing this interface is essential to ensuring efficient light transfer. This work focuses on the development of a warm astrophotonic spectrograph based on an AWG with a 16-fiber input array coupled to the AWG chip. A silica-on-silicon AWG chip with 15 input waveguides and a diced output facet was used. The resulting echellogram was recorded using a C-RED 2, an infrared camera used in astronomy. A detailed characterization of fiber-to-chip coupling that includes theoretical models, simulations, and experimental measurements was done for a single fiber coupled to an input waveguide of the AWG. Subsequently, all 16 input waveguides were individually assessed to evaluate performance variations across the array. Future work includes a characterization of throughput and spectral resolution followed by an on-sky test to demonstrate the feasibility of a multi-fiber astrophotonic spectrograph.

EP 3.4 Tue 11:45 KH 01.019

Langmuir waves in astrophysical Druyvesteyn plasmas — Simon Tischmann[1], Rudi Gaelzer[2], Dustin Lee Schroeder[1], Marian Lazar[3], and •Horst Fichtner[1] — [1]Theoretische Physik IV, Ruhr-Universit\"at Bochum, Germany — [2]Instituto de Fisica, Unicersidade Federal do Rio Grande do Sul, Brazil — [3]Centre for Mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Belgium

We present a new model for linear dispersion studies in astrophysical plasmas, by introducing astrophysical Druyvesteyn plasmas. This model can reproduce not only high-energy tails, as observed in situ in the solar wind, but also low-energy flat-tops of the velocity distributions, like those of electrons in interplanetary shocks. The dispersion relation of longitudinal waves is derived in terms of the newly introduced Druyvesteyn dispersion function. The dispersion curves as well as damping rates of high-frequency Langmuir waves are numerically computed for the isotropic case using the ALPS code, and their analytical approximations are provided in the limit of weak damping. This way we offer a new tool for modeling longitudinal waves, and in particular Langmuir waves, that may be useful for other astrophysical systems which are in non-equilibrium states as evidenced by direct insitu measurements, like the solar corona and planetary environments, as well as by indirect observations of nonthermal sources of waves and emissions.

EP 3.5 Tue 12:00 KH 01.019

Adequate Coordinate System for Space Navigation — •Hans-Otto Carmesin — Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen — Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade

The International Astronomical Union (IAU) realized, that the coordinate systems of relativity theory are insufficient for space navigation. Therefore, the IAU proclaimed the problem of finding an adequate coordinate system (ACS).

Here, that problem is solved:

(1) A measurement procedure is presented.

(2) For each Point P, an ACS and its velocity $\vec{v}_{ACS,\underline{CS}}$ relative to an arbitrary coordinate system (CS) are deduced.

(3) The ACS is confirmed by an observation at Earth and at space.

(4) The universal zero of the fractional kinematic time difference $\delta t_{kin,fractional}$ is derived.

(5) For each Point P, the fractional kinematic time difference $\delta t_{kin,fractional}$ is derived and predicted.

Carmesin, H.-O. (2025): On the Dynamics of Time, Space and Quanta. Berlin: Verlag Dr. Köster.

Carmesin, H.-O. (2025): Construction of a Physically Adequate Coordinate System with Help of an Observation on Earth's Ground. J Geosci Earth Planet Syst, 1(1), pp. 01-12.

EP 4: Near-Earth Space

Time: Wednesday 11:00–12:00 Location: KH 01.019

Invited Talk EP 4.1 Wed 11:00 KH 01.019
Assessing the immediate dynamical and long-term radiative effects of the Hunga Tonga Hunga Ha'apai volcanic eruption using state-of-art active and passive ground-based remote sensing — •Gunter Stober — University of Bern, Institute of Applied Physics, Bern, Switzerland — Oeschger Center for Climate Change Research, Bern, Switzerland

The Hunga Tonga Hunga Ha'apai (HTHH) volcanic eruption on 15th January 2022 launched atmospheric gravity waves (GW) traveling around the entire globe, reaching altitudes up to the mesosphere/ lower thermosphere (MLT) and even beyond that height. These GW had unprecedentedly high phase speeds of 170-240 m/s and reached amplitudes of 40- 50 m/s in the zonal and meridional wind components. Global available meteor radar observations of MLT winds together with multistatic meteor radar networks and high-resolution gravity wave modeling with the High Altitude Mechanistic Circulation Model (HIAMCM) reveal the global propagation of the volcanic GW and their global propagation for more than 24 hours.

However, the larger impact of the HTHH eruption is caused by the released water vapor. The volcanic plume injected about 13 Tg of water vapor into the stratosphere and mesosphere. Due to residual circulation, this water vapor is now distributed around the globe and observed by both ground-based and space-borne sensors. Here, we present observations of ground-based and balloon-borne sensors to measure the excess water vapor due to HTHH in the middle atmosphere.

EP 4.2 Wed 11:30 KH 01.019
Midlatitude impact of the extreme geomagnetic storm of May 10/11, 2024 — •Miriam Sinnhuber[1], Chao Yue[2], and Yuxuan Li[2] — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]Peking University, Bejing, China

On May 10-11, two CMEs arriving within few hours initiated the first extreme geomagnetic storm since the Halloween storm of October/November 2003. Polar lights were clearly visible well into midlatitudes, down to the Alps in Germany. Here, we use fluxes of precipitating electrons from the Chinese FengYun 3E satellite to derive rates of midlatitude ionization. These ionization rates are discussed and compared to observations of NO and N2O in the mesosphere obtained from the ACE-FTS/SCISAT.

EP 4.3 Wed 11:45 KH 01.019
EPP-NOy Upper-Boundary Condition, validation and long-term trends — •Stefan Bender[1], Bernd Funke[1], Manuel López Puertas[1], Gabriele Stiller[2], Peter Bernath[3], and Christopher Boone[3] — [1]IAA-CSIC, Granada, Spain — [2]KIT, Karlsruhe, Germany — [3]University of Waterloo, Waterloo, Canada

Polar winter descent of NOy produced by energetic particle precipitation (EPP) in the mesosphere and lower thermosphere affects polar stratospheric ozone by catalytic reactions. This, in turn, may affect regional climate via radiative and dynamical feedbacks. NOy observations by MIPAS/Envisat during 2002–2012 have provided observational constraints on the solar-activity modulated variability of stratospheric EPP-NOy. These constraints have been used to formulate a chemical upper boundary condition (UBC) for climate models in the context of solar forcing recommendations. We have updated the UBC with the recently released, reprocessed MIPAS version 8 data. We compare this updated NOy UBC model to data from the ACE-FTS solar occultation instrument which has been providing measurements since 2004 and is still actively providing data today. This 20+-year, long-term dataset will enable us to assess the validity of the assumptions underlying the UBC model, such as its climatological approach. Any deviation will enable us to assess the projected, climate-change induced changes in middle atmospheric transport, e.g. via the Brewer-Dobson circulation.

EP 5: Members' Assembly

Time: Wednesday 12:30–13:45 Location: KH 01.019

All members of the Extraterrestrial Physics Division are invited to participate.

EP 6: Sun and Heliosphere I

Time: Wednesday 13:45–15:45 Location: KH 01.019

Invited Talk EP 6.1 Wed 13:45 KH 01.019
Simulation of the photosphere and chromospheres of sunspots — •Aswathi Krishnan Kutty, Robert H. Cameron, Damien Przybylski, Tanayveer Bhatia, and Sami K. Solanki — Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Goettingen

Sunspots are one of the most prominent features of the solar surface and are characterized by a dark central core called the umbra, which is surrounded by a collection of filamentary structures called the penumbra. The penumbra is on average considerably brighter than the umbra but darker than the surrounding quiet Sun. At the photospheric level, the nearly horizontal Evershed flow is directed outward from the outer edge of the umbra along penumbral filaments. On the other hand, in the chromosphere, the flow is reversed and the plasma flows inwards towards the umbra. Radiative magneto-hydrodynamic (rMHD) codes have simulated sunspots in the upper convection zone and photosphere (Heinemann et al., 2007; Rempel et al., 2009). However, simulations of sunspots that include a realistic treatment of the chromosphere and corona have not yet been performed. The structure and evolution of the chromospheric field will be important in understanding magnetic reconnection and processes that are important for flare initiation. In this talk, I will present the first simulations of sunspots that reach layers above the solar photosphere.

Invited Talk EP 6.2 Wed 14:15 KH 01.019
Dynamics of a solar prominence simulated with MURaM — •Lisa-Marie Zessner, Robert Cameron, Sami Solanki, and Damien Przybylski — Max Planck Institute for Solar System Research, Göttingen, Germany

Solar prominences are cool and dense plasma clouds suspended in the hot solar corona, supported by the solar magnetic field. These complex and dynamic structures exhibit various types of mass motion and exchange mass with the solar surface and the surrounding atmosphere. Understanding the nature and origin of these dynamics is an important part of solar prominence research.

We use the 3D radiative magnetohydrodynamic code MURaM to simulate the formation and properties of solar prominences in a dipped magnetic arcade configuration. The prominence formation process starts by injection of cool and dense plasma seeds from the chromosphere into the corona. These injections are accompanied by photospheric flux cancellation and reconfigurations of the magnetic field above the surface. The subsequent mass build-up of the prominence is a combination of these continued cool injections and condensation of hot plasma. The resulting prominence structure is dynamic, featuring differently oriented structures and drainage to the surface. In this talk, we present the evolution of individual injection events that feed the prominence, as well as the motion and dynamics of the prominence plasma.

EP 6.3 Wed 14:45 KH 01.019
The Current Layer Missing in the Standard Model of Photospheric Flux Cancellation and CME Initiation — •Bernhard

Kliem — Institute of Physics and Astronomy, University of Potsdam

Flux cancellation, driven by flows that converge at the polarity inversion line (PIL), is a common process in the evolution of photospheric magnetic flux. The standard model of photospheric flux cancellation predicts the formation and growth of a magnetic flux rope above the PIL, low in the corona (van Ballegooijen & Martens 1989). Consequently, the cancellation process is considered a pathway to CME initiation by magnetohydrodynamic (MHD) instability, which requires a flux rope to exist at the onset point. Recent MHD simulations of flux cancellation additionally reveal the formation of a vertical current layer or sheet between the PIL and the forming flux rope. This allows for CME initiation by tearing of the vertical current layer, which forms a plasmoid (seed flux rope) during the initiation of a subsequent eruption and is known as the reconnection model for CME initiation. MHD simulations of flux cancellation will be presented, which address the initiation of eruption by MHD instability vs. reconnection and its parametric dependence. Some runs reveal the formation of plasmoids in the slow-rise phase, merging with the main forming flux rope. This could be a model of confined precursor flares and can lead to a non-equilibrium state of the main rope prior to its eruption.

EP 6.4 Wed 15:00 KH 01.019

Strongly localized heating in polytropic expanding stellar wind models — •Lukas Westrich[1,2], Bidzina Shergelashvili[1,2,3,4], and Horst Fichtner[1] — [1]Theoretical Physics IV, Ruhr-Universität Bochum, Universitätsstrasse 150, 44780 Bochum, Germany — [2]Centre for Computational Helio Studies, Faculty of Natural Sciences and Medicine, Ilia State University, Cholokashvili Ave. 3/5, 0162 Tbilisi, Georgia — [3]Evgeni Kharadze Georgian National Astrophysical Observatory, M. Kostava street 47/57, 0179 Tbilisi, Georgia — [4]Institut für Weltraumforschung, Österreichische Akademie der Wissenschaften, Schmiedlstrasse 6, 8042 Graz, Austria

In this talk, we present novel polytropic, expanding solar wind models that include a strongly localized heating source. After introducing the (quasi-)discontinuous solar wind models, we discuss the polytropic index and its use as a simplified description of the energy balance in the expanding plasma. In addition to the *background* energy-balance process captured by the polytropic index and for a few solutions a Hollweg type like heat conduction, we introduce a strongly localized heating mechanism - possibly due to acoustic waves - and construct new polytropic stellar wind models, both analytical and numerical. These new stellar wind models may be of particular interest in light of recent Parker Solar Probe observations, which reveal strongly varying wind streams and the presence of acoustic waves close to the Sun.

EP 6.5 Wed 15:15 KH 01.019

Solar wind heat flux with kappa distributions — •Klaus Scherer[1], Marian Lazar[2], Horst Fichtner[1], and Lukas Westrich[1] — [1]Institut für Theoretische Physik, Lehrstuhl IV: Plasma-Astroteilchenphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [2]Centre for mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Celestijnenlaan 200B, 3001 Leuven, Belgium

In the collisionless solar wind between 0.3 and 5 au, the proton usually have Maxwellian velocity distributions, while the electron distributions exhibit extended tails in the anti-sunward direction and a (spherical) cut-off towards the Sun. In case such electron distributions are assumed to be Maxwellians the resulting heat flux was modelled and discussed in Hollweg (1974). We apply this approach replacing the Maxwellian by a Kappa distribution, using both the classical standard Kappa distribution (SKD) and the newer regularized Kappa distribution (RKD). In contrast to SKDs, RKDs allow the calculation of the heat flux for any positive value of the kappa parameter. We present (semi-)analytical results and employ them in a one-dimensional hydrodynamic model of the solar wind expansion to show the impact of the distribution function on the magnitude of the heat flux.

EP 6.6 Wed 15:30 KH 01.019

On the complexity of plasma instabilities in the solar wind: Three electron-component formalism of heat-flux instabilities — •Dustin Lee Schröder[1], Marian Lazar[1,2], and Horst Fichtner[1] — [1]Ruhr-Universität Bochum — [2]Katholieke Universiteit Leuven

Despite the fact that electrons observed in-situ in space plasmas have three major components, the quasithermal core, and the suprathermal halo and strahl, the analysis of instabilities triggered by kinetic anisotropies (such as a relative drift of the strahl) generally considers only two of these components. We aim to demonstrate that a realistic modeling, with all three components, is achievable, in the present analysis focusing on heat-flux instabilities. In the absence of particle-particle collisions, these instabilities are responsible for the regularization of the heat flux carried mainly by suprathermal electrons. The velocity distributions of the electron populations are modeled according to in-situ observations, with a Maxwellian core and κ-distributed halo and strahl components. We exploit new advanced numerical codes (DIS-K and ALPS), capable of solving the linear dispersion and stability properties of such plasma systems. The unstable solutions differ significantly from those obtained with simplified models with only two components. The growth rates now predict the excitation and interplay of two unstable modes, whistler heat-flux and/or firehose heat-flux instabilities. The two instabilities are triggered by the two relative drifts, core-strahl and halo-strahl, and may have new consequences in the regularization of the heat-flux.

EP 7: Poster Session

Time: Wednesday 16:15–18:45 Location: Redoutensaal

EP 7.1 Wed 16:15 Redoutensaal

Towards Ultra-Broadband Terahertz Time-Domain Spectroscopy for Space Research — •Bruno Broer[1,2], Dominic Azih[1,2], Yookyung Ha[2,1], Jonas Woeste[1,2], Emma Kinne[1,2], Sergey Pavlov[2], Oliver Gueckstock[3], Tom Seifert[3,4], Nikola Stojanovic[2], Tobias Kampfrath[3,4], and Michael Gensch[1,2] — [1]Technical University of Berlin, Straße des 17. Juni 135, 10623 Berlin, Germany — [2]German Aerospace Center (DLR), Institute of Space Research, Rutherfordstr. 2, 12489 Berlin, Germany — [3]Free University Berlin, Arnimallee 14, 14195 Berlin, Germany — [4]TeraSpinTec GmbH, Lüneburger Str. 26, 10557 Berlin, Germany

Femtosecond lasers have in recent years been shown to be compact, robust and space qualified, in particular regarding their radiation hardness [1]. This opens up opportunities for compact Terahertz Time-Domain Spectroscopy (THz TDS) systems to detect gases (e.g. CO_2) and solids on planetary missions. By avoiding cryogenically cooled direct detectors and bulky opto-mechanics of conventional instruments e,g. in Fourier Transform Infrared systems, THz TDS becomes of high interest for in-situ sensing applications requiring robustness, compactness and high energy/mass efficiency. Here we show our progress en route to a THz TDS setup for space applications with a bandwidth of over 30 THz and a frequency resolution of below 100 GHz.

[1] J. Lee, K. Lee, Y. Jang et al. "Testing of a femtosecond pulse laser in outer space" Scientific Reports 4, 5134 (2014)

EP 7.2 Wed 16:15 Redoutensaal

Time-Domain Spectroscopy Techniques for the Identification of Minerals and Gases in Space Research — •Emma Kinne[1,2], Yookyung Ha[1,2], Sergey G. Pavlov[2], Jonas Woeste[1,2], Dominic Azih[1,2], Bruno Broer[1,2], Nikola Stojanovic[2], and Michael Gensch[1,2] — [1]Technische Universität Berlin, Berlin, Germany — [2]DLR Institute of Space Research, Berlin, Germany

On planetary missions, the identification of gases and the characterization of solids by their spectroscopic fingerprint are typically performed by infrared and/or Raman spectrometers. The advent of space-qualified femtosecond lasers enables to perform the same task by a new class of time-domain techniques which have the potential to be much more robust, compact and sensitive. Methods such as Time-Domain Raman Spectroscopy (TDRS) and Rotational Coherent Raman Scattering (RCRS) retrieve Raman-active fingerprints of solids and molecules, respectively. Recently, we reported TDRS to be a viable alternative to continuous wave Raman spectroscopy in identifying minerals [1]. Here, we demonstrate that the same experimental setup, that is used for TDRS, can detect molecular species via RCRS. We report measured rotational revival signatures from N_2 and O_2 at room temperature and atmospheric pressure. Simulations using the LIMAO software further show that this setup could detect a wide range of molecular species under extraterrestrial conditions.

[1] Y. Ha, et. al., Time-Domain Raman Spectroscopy: An Emerging Technique in Space Exploration? J. Raman Spectrosc. 56 (2025)

EP 8: Sun and Heliosphere II

Time: Thursday 11:00–12:30 Location: KH 01.019

Invited Talk EP 8.1 Thu 11:00 KH 01.019
Solar and heliospheric studies with the LOFAR radio telescope — •Christian Vocks — Leibniz-Institut für Astrophysik Potsdam (AIP), Potsdam, Germany

LOFAR is a radio interferometer observing in two frequency bands, 10 - 90 MHz and 110 - 250 MHz. As a software telescope, it offers great flexibility and various simultaneous observing modes. Solar radio radiation in the low and high band originates from the upper and middle corona, respectively. Thermal bremsstrahlung of the quiet solar corona provides information on coronal structure and temperatures. Non-thermal plasma emission of energetic electrons from solar flares or coronal mass ejection (CME) shock fronts makes LOFAR well suited for solar activity studies. Observations of type III radio bursts, caused by energetic electron beams, provide information on source locations relative to EUV and X-ray sources, as well as on electron and radio wave propagation in the corona. "beam-formed" images of type II bursts reveal electron acceleration at CME shock fronts.

Since the lowest LOFAR frequencies correspond to the upper corona and transition into the solar wind, LOFAR is an ideal instrument for Space Weather studies. Joint observing campaigns with Solar Orbiter and Parker Solar Probe allow for tracing space weather events from their coronal source through the inner heliosphere on their way towards Earth. LOFAR is currently undergoing the upgrade to LOFAR2.0 with simultaneous low- and high-band observations and improved imaging capabilities. Space Weather studies with LOFAR2.0 will be complementary to the upcoming SKA that covers frequencies above 50 MHz.

EP 8.2 Thu 11:30 KH 01.019
Transition of energetic electrons from the solar corona into interplanetary space — •Lilly Zeberer — Universität Potsdam, Institut für Physik und Astronomie, Potsdam, Germany

Solar radio bursts are a phenomenon on the Sun that is closely related to solar flares. They are caused by accelerated energetic particles traveling away from the Sun and are divided into different types. Focusing on type III bursts, their most important feature is the rapid frequency drift from high to low frequencies, corresponding to height in the corona. Using LOFAR data as well as data from the Parker Solar Probe (PSP) FIELDS instrument suite, this work aims to improve a chosen heliospheric density model, especially in the transition region from the solar corona into interplanetary space. Heliospheric density models are an important tool in interpreting radio data, even though the heliosphere is highly structured and they cannot be global. This work uses fitting of the frequency drift of type III radio bursts in combined dynamic spectra of LOFAR and PSP data to then calculate source velocities and observe how they behave as the particles move away from the Sun.

EP 8.3 Thu 11:45 KH 01.019
Advances in ground-based space weather monitoring with compact CALLISTO — •Daniela Banyś[1], David Wenzel[1], Lutz Heinrich[1], Frank Tandler[1], and Christian Monstein[2] — [1]Institute for Solar-Terrestrial Physics, German Aerospace Center (DLR e.V.), Germany — [2]Ricerche Solari Locarno IRSOL, Switzerland

DLR has installed various compact CALLISTO receivers as part of the Solar Ionosphere Global Network (SIGN), equipped with spectrometers covering 10-80 MHz, 45-860 MHz, and 1000-1600 MHz in Wairakei, New Zealand. Together with the existing SIGN station in Neustrelitz, Germany, this network provides almost 24/7 continuous observations of solar radio bursts, enabling detailed studies of flare-accelerated electrons and coronal mass ejections. The CALLISTO receivers have been optimized in hardware and software to increase signal-to-noise ratio, simplify maintenance, and improve comparability. Furthermore, a filtering technique has been developed that harmonizes frequency spectra, removes noise, and reduces radio frequency interferences (RFIs), producing cleaner data for automated burst identification and classification.

This setup demonstrates the potential of compact, ground-based CALLISTO stations for continuous solar monitoring and reliable space weather event analysis.

EP 8.4 Thu 12:00 KH 01.019
Probing Flare Energy Release with STIX Hard X-ray Lightcurves — •Oliver Flor — Leibniz Institute for Astrophysics Potsdam, Potsdam, Germany — University of Potsdam, Potsdam, Germany

Investigating hard X-ray (HXR) emission provides valuable insights into the energy release and particle acceleration mechanisms inherent to the flaring process. We present a statistical study of the HXR lightcurves of all flares with GOES classification M5 or larger of the current solar cycle that were observed by Solar Orbiter STIX with sufficient counts above 25keV.

Using a suite of timeseries analysis tooles such as Gaussian Decomposition and Wavelet analysis, we investigate how the number of HXR peaks, as well as their periods and amplitudes and the presence of potential quasi periodic pulsations (QPPs) vary across a decade of flare magnitudes.

The results of this data analysis allow us to explore the physical implications of detecting multiple HXR bursts within individual flares. Specifically, we investigate how characteristic timescales and potential QPPs may reflect underlying processes, such as repetitive magnetic reconnection or oscillation of MHD waves, thereby expanding our understanding of energy release during solar flares.

EP 8.5 Thu 12:15 KH 01.019
Constraining ion acceleration in behind-the-limb gamma-ray flares with Fermi-LAT, SolO/STIX, and ground-based radio observations — •Alexander Warmuth — Leibniz-Institut für Astrophysik Potsdam (AIP), Potsdam, Germany

Compared to energetic electrons in solar flares, which can be readily observed in hard X-rays and radio, our understanding of energetic ions is severely deficient. Our main diagnostics for ions are gamma-ray observations, which remain challenging. A particularly intriguing case are behind-the-limb (BTL) gamma-ray flares, where the flare is occulted as seen from Earth, but nevertheless gamma-ray emission is detected by near-Earth spacecraft. Here, we investigate the relationship between the gamma-ray emission measured with Fermi-LAT, hard X-ray observations from STIX on Solar Orbiter, and ground-based radio observations, for small sample of BTL gamma-ray flares. In all events, type II radio bursts were present that were synchronized in time with the gamma-ray emission. Conversely, we find a significant delay between the impulsive phase of the flare as recorded by STIX and the gamma-ray emission. These findings support the notion that the highly relativistic ions that produce the gamma-rays in BTL flares are accelerated at CME-driven propagating coronal shock waves rather than in large-scale coronal loops.

EP 9: Sun and Heliosphere III

Time: Thursday 13:45–15:15 Location: KH 01.019

EP 9.1 Thu 13:45 KH 01.019

Langmuir waves in astrophysical Druyvesteyn plasmas — Simon Tischmann[1], Rudi Gaelzer[2], Dustin Lee Schroeoder[1], Marian Lazar[3], and •Horst Fichtner[1] — [1]Theoretische Physik IV, Ruhr-Universit\"at Bochum, Germany — [2]Instituto de Fisica, Universidade Federal do Rio Grande do Sul, Brazil — [3]Centre for Mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Belgium

We present a new model for linear dispersion studies in astrophysical plasmas, by introducing astrophysical Druyvesteyn plasmas. This model can reproduce not only high-energy tails, as observed in situ in the solar wind, but also low-energy flat-tops of the velocity distributions, like those of electrons in interplanetary shocks. The dispersion relation of longitudinal waves is derived in terms of the newly introduced Druyvesteyn dispersion function. The dispersion curves as well as damping rates of high-frequency Langmuir waves are numerically computed for the isotropic case using the ALPS code, and their analytical approximations are provided in the limit of weak damping. This way we offer a new tool for modeling longitudinal waves, and in particular Langmuir waves, that may be useful for other astrophysical systems which are in non-equilibrium states as evidenced by direct insitu measurements, like the solar corona and planetary environments, as well as by indirect observations of nonthermal sources of waves and emissions.

EP 9.2 Thu 14:00 KH 01.019

The accuracy of REleASE forecasts for different heliographic longitude distances — H. Dröge[1], A. Posner[2], •B. Heber[1], M. Malandraki[3], M. Karavolos[3], and L. Tsipis[3] — [1]Christian-Albrechts-Universität zu Kiel (CAU), Kiel, Germany — [2]NASA — [3]National Observatory of Athens, Greece

Forecast systems and predictions of hazardous Solar Energetic Particle (SEP) events are needed to support space missions. Especially in view of future plans for human exploration of Mars, a radiation protection strategy needs to be implemented with the goal of reliably providing advance warning of sudden radiation hazards. REleASE utilises the close correlation between near-relativistic electrons and the slower protons to provide, on average, one hour of advance warning of particle events observed close to earth. Originally, REleASE used real-time data from SOHO/EPHIN and later ACE/EPAM (HESPERIA/REleASE) to issue short-term warnings before a significant flux increase of 20 − 50 MeV protons. The method was adapted to work with the HET and SEPT instruments onboard STEREO-A, and an operational STEREO/REleASE system was created. With two REleASE systems now operational, we have the possibility to directly compare forecasts from different points in the heliosphere. Human explorers following Hohmann trajectories to and from Mars will be up to 22° away in longitudinal magnetic connection distance from the alert system. We used the 2022 to 2025 passage of STEREO-A by Earth to test whether remote REleASE forecasts can provide timely and sufficiently accurate information for the location of another spacecraft.

EP 9.3 Thu 14:15 KH 01.019

Unusual Sun-Earth magnetic connections during relativistic solar particle events — K.-L. Klein[2], •B. Heber[1], M. Hörlöck[1], S. Jensen[1], P. Kühl[1], and H. Sierks[3] — [1]Christian-Albrechts-Universität zu Kiel (CAU), Kiel, Germany — [2]LIRA, Observatoire de Paris, France — [3]MPI für Sonnensystemforschung, Göttingen, Germany

The Sun accelerates charged particles sometimes to relativistic energies during eruptive events. leading to so called 'Ground-Level Enhancement' (GLE). Observations of the solar atmosphere at EUV, X-ray, and radio wavelengths provide insight into the dynamics of the coronal magnetic structures during eruptive flares. The timing of the onset of a GLE with respect to the solar eruption is therefore a primary diagnostic tool for identifying the time and place where the relativistic protons are released. Recent numerical simulations suggest that gradient and curvature drifts near and in the heliospheric current sheet may be essential for relativistic protons to reach the Earth when the eruption occurs far from the footpoint of the magnetic field line connecting the Earth with the Sun. If drifts favor protons at Earth, they should hinder electrons. In contrast to this prediction, relativistic electron observations during GLEs between 1991 and 2025 show that the first electrons arrive at Earth within a few minutes of the GLE onset. We present an alternative scenario where radio observations suggest a transient magnetic connection established between the Earth and an eruptive region behind the solar limb.

EP 9.4 Thu 14:30 KH 01.019

First look at the solar cosmic ray event on 11 November 2025 as measured by neutron monitors — •Christian Steigies[1], Lukas Bäni[2], and Rolf Bütikofer[2] — [1]Christian-Albrechts-Universität zu Kiel, Germany — [2]Universität Bern, Switzerland

On 11 November 2025, the global network of neutron monitors measured an increase in the count rate caused by solar cosmic rays. This event was number 77 of solar cosmic rays observed at ground since 1942: GLE77. It was caused by an X5 class flare at 10:10 UTC and is comparable in size to the last major GLE on 6 December 2006 (GLE70). Since some neutron monitor stations at low latitudes, such as Mexico, also observed a significant increase in the count rate during GLE77, the energy spectrum was harder than during GLE70 and during the very large GLE69 on 20 January 2005. Based on the neutron monitor measurements, we estimated the characteristics of solar cosmic rays during the maximum phase of GLE77. This allows to assess the maximum additional radiation exposure at flight altitude caused by solar cosmic rays during GLE77.

EP 9.5 Thu 14:45 KH 01.019

Single Detector Counter Cross-Calibration – SOHO, Chandra/EPHIN, and AMS-02 Results — L. Romaneehsen[1], •B. Heber[1], M. Dumbović[2], M. Hörlöck[1], M. Köberle[1], P. Kühl[1], and A. Papaioannou[3] — [1]Christian-Albrechts-Universität zu Kiel (CAU), Kiel, Germany — [2]University of Zagreb, Faculty of Science, Zagreb, Croatia — [3]National Observatory of Athens, Greece

Here we demonstrate that single-detector counter rates from the Electron, Proton, and Helium Instrument (EPHIN) onboard *SOHO* and *Chandra* provide a reliable and stable proxy for monitoring Galactic Cosmic Rays (GCRs). Using detailed GEANT4 simulations, the response of the EPHIN SSD-F detector is shown to be dominated by protons and helium nuclei with energies above approximately 50 MeV, corresponding to an effective rigidity of about 2.15 GV.

A direct cross-calibration between SOHO/EPHIN and AMS-02 proton and helium fluxes is performed for the period 2011–2019 and reveals an excellent agreement. Small systematic differences between SOHO and Chandra EPHIN measurements are attributed to different spacecraft geometries and shielding environments. Nevertheless, both instruments show consistent long-term trends and accurately reproduce the solar-cycle modulation of GCRs observed by AMS-02.

This study has received funding from the EU's Horizon 2020 research and innovation program under grant agreement No. 101004159 (SPEARHeAD). The SOHO/EPHIN is supported under Grant 50 OC 2102 by the German BMFW through DLR.

EP 9.6 Thu 15:00 KH 01.019

Cross calibration of SOHO ~ 1 GV proton and helium fluxes with PAMELA and AMS-02 — Malte Hörlöck[1], •Bernd Heber[1], Marlon Köberle[1], Patrick Kühl[1], Lisa Romaneesen[1], and Athanasios Papaioannou[2] — [1]Christian-Albrechts-Universität zu Kiel (CAU), Kiel, Germany — [2]National Observatory of Athens, Greece

Reliable measurements of Galactic Cosmic Rays (GCRs) and Solar Energetic Particles (SEPs) require well-calibrated spaceborne particle instruments. This study presents a cross-calibration of the Electron, Proton and Helium Instrument (EPHIN) aboard SOHO with high-precision proton and helium measurements from PAMELA and AMS-02. The analysis extends the established ΔE–ΔE technique to later mission phases, accounting for detector aging and changes in instrument response after 2017.

A GEANT4-based model of EPHIN, including a simplified representation of the SOHO spacecraft, is used to derive energy response functions for penetrating protons and helium nuclei. Simulated detector responses based on force-field*modulated GCR spectra reproduce the observed EPHIN energy-loss distributions within about 30%. Effective energies and fluxes are obtained using a bow-tie inversion method and compared with AMS-02 and PAMELA observations during quiet solar conditions. The results show agreement within the combined systematic uncertainties, demonstrating that SOHO/EPHIN continues to provide valuable and reliable energetic particle measurements for long-term heliospheric studies.

EP 10: Exoplanets and Astrobiology

Time: Friday 9:00–10:30 Location: KH 01.019

Invited Talk EP 10.1 Fri 9:00 KH 01.019
The diversity of low mass exoplanets — •Kristine Lam — Institut für Weltraumforschung, Deutsche Zentrum für Luft- und Raumfahrt (DLR)

Exoplanet discoveries and characterisation have revealed astonishing diversity. With the improved capability of observing facilities, an increasing number of low mass exoplanets are being characterised to unprecedented precision. In this talk, I will review the current exoplanet demographics with a focus on low mass exoplanets detected by transit and radial velocity surveys. We will dive into different exoplanet populations (super-Earths, sub-Neptunes, ultra-short-period planets, water worlds) and the various physical processes that could have sculpted each class of exoplanets. I will also give an overview of upcoming space- and ground-based telescopes and their expected impact on demographic studies and our understanding of exoplanetary systems and their evolution pathways.

EP 10.2 Fri 9:30 KH 01.019
Investigating the exoplanet HD88986 b by using TESS & CHEOPS space telescope data. — •Danial Almasian — Shahid Beheshti University, Tehran, Iran

The discovery of transiting planets with orbital periods exceeding 40 days has been exceptionally rare among the 5000+ planets identified to date. This dearth of findings poses a significant challenge to studying planetary demographics, formation, and evolution. In this study, we report detecting and characterizing HD88986 b, a potentially transiting sub-Neptune with the longest orbital period of any known transiting small planet. Our analysis drew on a combination of two sectors of TESS data and a 7-day observation from CHEOPS. Additionally, TLS was utilized for the analysis of HD88986 data. Our findings indicate that HD88986 b, exhibiting two likely single transits on sector 21 and sector 48, both consistent with the predicted transit time from the RV model, is a likely transit candidate. The wide orbit of HD88986 b suggests that the planet did not experience significant mass loss due to XUV radiation from its host star, likely retaining its original composition and offering insights into its formation. Furthermore, the cold nature of HD88986 b, owing to its extended orbital period, presents exciting prospects for future studies on the characterization of its cold atmosphere composition.

EP 10.3 Fri 9:45 KH 01.019
Does atmospheric composition actually trace planet formation? Results from observing aligned vs misaligned hot Jupiters as a testbed — •Eva-Maria Ahrer[1], James Kirk[2], and BOWIE-ALIGN collaboration[3] — [1]Max Planck Institute for Astronomy, Heidelberg, Germany — [2]Imperial College London, London, UK — [3]Bristol, Oxford, Warwick, Imperial, Exeter +

I will present the JWST program 'BOWIE-ALIGN', dedicated to test our understanding of planet formation with measurements of the composition of exoplanetary atmospheres, specifically hot Jupiters. It is unclear what variations in atmospheric chemistry can be attributed to different planet formation histories, made even more difficult by uncertainties in planetary evolution.

In our study, we compare the composition of a sample of seven hot Jupiters, where half their orbits are aligned and the other half misaligned relative to their host stars* spin axes. It is believed that aligned hot Jupiters around F stars are the outcome of disc migration, while misaligned ones arise from high-eccentricity migration. With this program we investigate whether these two subsets of exoplanets that are expected to have had very different formation pathways show any significant differences in their atmospheric composition.

I will summarise the observations of these seven hot Jupiters with JWST NIRSpec/G395H, and the outcome of this program. Specifically I will address if atmospheric composition using JWST can be used to make inferences about formation.

EP 10.4 Fri 10:00 KH 01.019
High-Resolution 3D Corona–Wind Models for Exoplanet Space Weather Around Solar-Type Stars — •Yuehong Chen and Julián Alvarado-Gómez — Leibniz Institute for Astrophysics Potsdam, Potsdam, Germany

Space-weather conditions experienced by exoplanets are strongly influenced by the state of the host-star corona and its magnetized wind. Existing studies typically constrain either coronal X-ray emission (spatially unresolved) or stellar winds (difficult to observe), and rarely connect both within a fully three-dimensional (3D) framework. Here we use the Space Weather Modeling Framework with the Alfvén Wave Solar Model (SWMF-AWSoM), driven by global convective dynamo-generated surface magnetic maps, to model fully 3D solar-type stellar coronae and winds spanning rotation rates 1.0–23.3 $\Omega_\odot$. Our models reproduce dense (1–2 orders of magnitude above solar) and ultra-hot ($\sim 10\,\mathrm{MK}$) coronae at high spatial resolution. We further show that enhanced coronal activity is accompanied by stronger winds, leading to elevated wind pressures that shape exoplanetary space environments. As illustrative cases, we evaluate wind pressures for super-Earth candidates Kepler-1638 b and Kepler-452 b, and find that an Earth-like dynamo can plausibly sustain magnetopauses of $r_M \simeq 5$–$10\,R_p$ under quiescent wind conditions. Overall, given the limited ability of current instrumentation to characterize exoplanet high-energy irradiation and particle environments in detail, our framework provides observation-informed inputs for exoplanet space-weather and habitability studies around solar-type stars.

EP 10.5 Fri 10:15 KH 01.019
Detectability of Atmospheric Climate and Biosignatures with the Large Interferometer for Exoplanets (LIFE) for terrestrial-type Exoplanets — •John Lee Grenfell[1,2], Benjamin Taysum[1], Iris van Zelst[1,3], Franz Schreier[1,4], Hamish Innes[1,2], Alexis Smith[1], Szilard Csizmadia[1], Nicolas Iro[1], Sarah Rugheimer[5,6], Thea Kozakis[7], Eleonora Alei[8], Lena Noack[2], Tim Lichtenberg[9], Sascha Quanz[8,10], Konstantin Herbst[1,11], Miriam Sinnhuber[12], Andreas Bartenschlager[12], Juan Cabrera[1], and Heike Rauer[2,13] — [1]Inst. Space Science, DLR, Berlin, Germany — [2]Inst. Geologische Wissenschaften, Freie Uni. Berlin, Germany — [3]Centre for Astronomy and Astrophysics, TU Berlin, Germany — [4]DLR-IMF, Oberpfaffenhofen, Germany — [5]Dept Physics and Astronomy, York Uni., Canada — [6]Inst. Astronomy, Uni. Edinburgh, Scotland, UK — [7]IAA-CSIC, Granada, Spain — [8]ETH-IPA, Zürich, Switzerland — [9]Kapteyn Astron. Inst., Uni. Groningen, The Netherlands — [10]ETH, Dept. Earth Plan. Sci., Zürich, Switzerland — [11]PHAB, Uni. Oslo, Norway — [12]KIT, Karlsruhe, Germany — [13]DLR Markgrafenstr. 37, Berlin, Germany

We investigate the detectability of atmospheric biosignatures with the LIFE mission. Starting with the modern Earth we model the climate, photochemistry and spectra of Earth-like planets over a range of insolation, gravity, humidity, albedo, atmospheric mass and carbon dioxide abundances and investigate detectability of key atmospheric species by LIFE for Earth-like planets assumed to lie at 10pc for the LIFE (20-day viewing) baseline case.

EP 11: Planets and Small Bodies

Time: Friday 11:00–12:25 Location: KH 01.019

Invited Talk EP 11.1 Fri 11:00 KH 01.019

Iron and the search for life on Mars — •Christian Schröder — Max Planck Institute for Solar System Research, Göttingen, Germany

Iron is a major rock-forming element. Because it is redox-active, it connects the geosphere with (bio)geochemical cycles of the CHNOPS elements essential to life. Compared to Earth, Mars has accreted from a more oxidized reservoir and therefore retained more iron in its mantle. This iron remains mobile in aqueous systems because Mars' atmosphere and water have never been fully oxygenated. Iron thus plays a dominant role in the search for life on the Red Planet when assessing its habitability as well as the preservation and detection of potential biosignatures. For example: Serpentinization of iron-bearing olivine can generate organic molecules through Fisher-Tropsch type synthesis; minerals indicating iron redox cycling provide strong potential biosignatures; reactive iron mineral phases sequester and preserve organic carbon compounds as potential biosignatures over geological timescales; but iron may also hamper the detection of organic compounds with GCMS or Raman spectroscopy. This presentation will put recent results into the context of the current state of international Mars exploration.

EP 11.2 Fri 11:30 KH 01.019

Sonar Simulations of the TRIPLE Forefield Reconnaissance System with COMSOL — •Julien Leroux, Alexandros Deslis, Ömer Altug, Jan Audehm, Mia Giang Do, Lars Heuermann, Dirk Heinen, Lukas Michels, Andreas Nöll, Christopher Wiebusch, and Simon Zierke — Physics Institute IIIb, RWTH Aachen, Germany

The TRIPLE (Technologies for Rapid Ice Penetration and Subglacial Lake Exploration) project line was initiated by the German Space Agency at DLR in order to pioneer the exploration of subglacial oceans on icy moons such as Europa and Enceladus, in the search for extraterrestrial life. In TRIPLE, we explore numerous technologies to safely navigate a melting probe through the ice cover. The melting probe must be able to detect hazards such as debris or crevasses, as well as locating an anchoring point at the water-ice boundary below the glacier. For this, the TRIPLE Forefield Reconnaissance System (TRIPLE-FRS) employs a combination of radar and sonar integrated into the melting head of the probe. This system must preserve the melting head's narrow profile, high melting speed, and maximize the reconnaissance performance. For the optimization of the sonar system, we perform finite element simulations using COMSOL. We present the latest results from these studies.

EP 11.3 Fri 11:45 KH 01.019

Characterising and Evaluating Acoustic Transducers in Water for TRIPLE-FRS — •Alexandros Deslis, Ömer Altug, Jan Audehm, Mia Giang Do, Dirk Heinen, Lars Heuermann, Julien Leroux, Lukas Michels, Andreas Nöll, Christopher Wiebusch, and Simon Zierke — III. Physikalisches Institut B - RWTH Aachen University

The TRIPLE project line, initiated by the German Space Agency at DLR, aims to develop technologies for the exploration of subglacial ocean worlds on moons of the outer solar system, in the search for extraterrestrial life. TRIPLE consists of three core components: a melting probe for penetrating the ice, an autonomous underwater exploration vehicle, and an astrobiological laboratory for sample analysis. One key subsystem of the melting probe is the Forefield Reconnaissance System (FRS), which enables the detection of obstacles within the ice as well as the identification of the ice-water boundary. It includes a sonar which employs a piezoelectric tonpilz transducer to both emit and receive acoustic signals. Several transducer designs were evaluated in water in the laboratory. Here, we compare key acoustic parameters, such as sending and receiving performances, across these designs in search for the most promising setup for the mission's needs. This presentation introduces the methods and presents results of these studies.

EP 11.4 Fri 12:00 KH 01.019

Time-Variability of the Galactic Positron Annihilation Signal — •Rudi Reinhardt and Thomas Siegert — Julius-Maximilians-Universität Würzburg, Würzburg, Germany

The interactions of low-energy cosmic-rays with asteroids might lead to a measurable variable gamma-ray foreground emission within our Solar system. Siegert (2024) modeled the spatial distribution of all relevant asteroid populations (Main Belt Asteroids, Jovian and Neptunian Trojans and the Kuiper Belt) to calculate their appearances by line-of-sight integrations. The signal is expected to vary in time due to the relative motion of Earth and the asteroids. In this work we used 20 yr of INTEGRAL/SPI data to search for this time-variable foreground albedo in both, the 511 keV line and the ortho-Positronium (oPs) continuum. Since the Galaxy is bright in the bulge at 511 keV, we can determine its variability on a two year timescale, which allows us to constrain the possible contributions from all asteroid families. Our analysis shows no significant emission signal for all considered populations. However, we find a significant 511 keV signal in the vicinity of the Galactic center, which may mimic variable diffuse emission unless its time variability is taken into account. In a 20x20 deg2 region around the Galactic center, we find several point-like hotspots which coincide spatially with the distribution of globular clusters. Preliminary results of GEANT4 simulations of electromagnetic and hadronic interactions of cosmic-rays with asteroids agree with contemporaneous simulations by DeGaetano et al. (2023) using FLUKA, with fluxes being several orders of magnitude smaller than previously estimated.

Poster Pitch: EP 25 (Broer), EP 26 (Kinne)