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 in-situ 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.