EP 4: Sun and Heliosphere II

Zeit: Mittwoch 11:30–13:00 Raum: HS 19

EP 4.1 Mi 11:30 HS 19

Realistic solar modulation of cosmic rays in a semi-analytical framework — •Marco Kuhlen and Philipp Mertsch — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Germany

When galactic cosmic rays enter the heliosphere they encounter the solar wind with its frozen-in magnetic field, which can modulate the cosmic ray flux in the heliosphere up to energies as high as 50 GeV. This problem is oftentimes treated in the simple force field approximation that characterises the modulation effects in a single parameter. However, this simplicity is at the cost of reducing the dimensionality of the problem and ignoring important transport processes like drifts in the inhomogeneous large-scale field. Predictions from force-field models are also in tension with recent time-dependent data from experiments like PAMELA and AMS-02. In this work, we present a new and straightforward extension to the force field model that takes into account charge sign dependent modulation due to drifts in the heliospheric magnetic field. We compare our semi-analytical results both to time-dependent data and to a numerical solution of the full transport equation and find good agreement.

EP 4.2 Mi 11:45 HS 19

Qualitative test particle simulations of pitch angle modifications due to Alfvénic waves — •Duncan Keilbach, Lars Berger, Verena Heidrich-Meisner, and Robert F. Wimmer-Schweingruber — Institut für Experimentelle und Angewandte Physik, Christian Albrechts Universität zu Kiel

We simulate the interaction of singly charged oxygen ions (treated as test particles) with Alfvénic cyclotron waves. In contrast to our preceding work, the pitch angle distribution of the test particles is not becoming isotropized when interacting with an intermittent mono-frequent wave field. Rather, the pitch angle distribution is governed by stationary patterns after an initial broadening. And that broadening has shown to be mainly a function of wave frequency and amplitude, as well as the phase difference between particle gyration and wave oscillation. A systematic study of these parameters may reveal insights about wave particle interactions on microscopic scales. E.g. resonances have shown to be less sharp than expected. Particles reacting strongest to the wave are found in a broad frequency area around first order resonance. The area's width is a function of the wave amplitude. Our approach is readily expandable to include a multitude of different modifications to the simulated magnetic field like the interaction with multiple wave frequencies or a change of the background magnetic field's strength and direction. It is also possible to include the interaction with multiple waves of e.g. varying frequencies and amplitudes.

EP 4.3 Mi 12:00 HS 19

Kinetic Solar Wind Models — •Sophie Aerdker — Ruhr-Universität Bochum

The processes of proton heating in the solar wind have not been determined yet but one possibility is the interaction with resonant ion-cyclotron waves. A kinetic model based on the Boltzmann-Vlasov equation is presented which takes the wave-particle interaction into account, so that the temporal evolution of the proton velocity distribution function can be calculated. The wave-particle interaction leads to diffusion in the velocity space, forming resonant shells whose shapes depend on the dispersion relation. Thus, the resulting velocity distribution function is expected to be deformed compared to the initial Maxwellian condition. The resonance condition as well as the dispersion relation of the ion-cyclotron waves are simplified in order to reduce the computational effort. The advantages and limitations of this new approach are tested and the results are compared to existing models.

EP 4.4 Mi 12:15 HS 19

On the entropy of plasmas described with regularized κ-distributions — •Horst Fichtner[1], Klaus Scherer[1], Marian Lazar[1,2], Hans Fahr[3], and Zoltan Vörös[4] — [1]Institut für Theoretische Physik IV, Ruhr-Universität Bochum, Germany — [2]Centre for Mathematical Plasma Astrophysics, Katholieke Universiteit Leuven, Belgium — [3]Argelander Institut für Astronomie, Universität Bonn, Germany — [4]Space Research Institute, Austrian Academy of Sciences, Graz, Austria

Recently, the debate about the physics foundations of so-called (standard) κ-distributions (SKDs), which describe plasma constituents with power-law velocity distributions, has intensified. Amongst other critical features, the extensitivity of entropy has been questioned in the context of a theoretical foundation for the SKDs. In classical thermodynamics the entropy is an extensive quantity, i.e. the sum of the entropies of two subsystems in equilibrium with each other is equal to the entropy of the full system consisting of the two subsystems. We demonstrate here, by employing the recently introduced *regularized κ-distributions* (RKDs) that entropy can be defined as an extensive quantity even for such power-law-like distributions that truncate exponentially.

EP 4.5 Mi 12:30 HS 19

Linear Dispersion Theory with Regularised κ-Distributions: Overcoming Defiencies of Standard κ-Distributions — •Edin Husidic — Institut für Theoretische Physik, Lehrstuhl IV: Plasma-Astroteilchenphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany

The velocity distributions of the plasma populations in the solar wind deviate from Maxwellian distributions, showing enhanced suprathermal tails, which can be well described with the standard κ-distribution function (SKD). However, due to diverging velocity moments, the SKD is only defined for values $\kappa > 3/2$. To remove this unphysical characteristic and the limitations of the SKD, the regularised κ-distribution function (RKD), for which all velocity moments converge and which can reproduce as limiting cases both the bi-Maxwellian and the SKD, has been introduced recently (Scherer et al. 2018). Using the grid-based kinetic dispersion relation solver LEOPARD (Astfalk and Jenko 2017), for the first time the dispersion curves and the growth and damping rates of different plasma instabilities are computed for plasma populations characterised by RKDs. The results are compared to those obtained earlier for SKDs. The implications of the study and newly opened perspectives by use of the RKD are discussed.

EP 4.6 Mi 12:45 HS 19

Thermal Atmospheric Neutron Observation System Junior Flight Results — •Lisa Romaneehsen, Friederike Schattke, Marc Hansen, Patrick Pohland, Jonas Zumkeller, Bernd Heber, and Robert Wimmer-Schweingruber — Christian-Albrechts- Universität zu Kiel, Institut für Experimentelle und Angewandte Physik, Abteilung Extraterrestrische Physik, Deutschland

The Earth is continuously exposed to high energy charged particles from galactic cosmic rays. Due to galactic cosmic rays interacting with atmospheric particles, secondary neutrons are generated. Those are moderated to thermal energies below 0.025 eV through elastic scattering. The main objective of the Thermal Atmospheric Neutron Observation System (TANOS) is to measure the flux of thermal neutrons in the stratosphere. In order to measure these low energy neutrons we make use of the conversion electrons resulting through thermal neutron capture in Gadolinium. Gadolinium is particularly suitable for the experiment due to its high cross section of 49000 barn. To validate this method we built, tested, and launched a simplified version of the TANOS detector on a weather balloon in September 2018. The balloon reached a height of 39 km and crossed the Pfotzer maximum at 20 km. However, the analysis of the neutron channel can be contaminated by x-rays. In this talk we will present and discuss the results of the flight.