P 22: Helmholtz Graduate School for Plasma Physics II

Time: Thursday 10:30–12:30 Location: SPA HS202

Invited Talk P 22.1 Thu 10:30 SPA HS202

Cosmic rays — •Reinhard Schlickeiser — Institut für Theoretische Physik, Lehrstuhl IV: Weltraum- und Astrophysik, Ruhr-Universität Bochum, 44780 Bochum

Cosmic rays denote a population of cosmic charged particles with individual particle energies up to 10^{20} eV. The nonthermal emission processes of cosmic ray nucleons and electrons dominate the photon emission in many astrophysical sources. In the tutorial the fundamentals of cosmic ray astrophysics are reviewed, stressing the importance of electromagnetic acceleration and transport processes in magnetized systems (as the interplanetary and interstellar medium) with ordered magnetic fields $B_0 \gg \delta B \gg \delta E$ being much greater than the turbulent magnetic and electric field components. The ordering $B_0 \gg \delta B \gg \delta E$, necessary for explaining the observed near isotropy of cosmic rays, is the basis for a perturbation scheme leading to the modified diffusion-convection cosmic ray transport equation that describes all electromagnetic acceleration and transport processes discussed today. In unmagnetized cosmic systems (such as the intergalactic medium) a similar peturbation scheme based on $\delta B \gg \delta E$ can be developed. Understanding cosmic $(\delta B, \delta E)$-fluctuations in space plasmas therefore is of crucial importance e.g. the role of collective and noncollective modes and wave-like, weakly-propagating and aperiodic fluctuations. The similarities and differences to the transport theory in magnetized fusion plasmas are highlighted.

Topical Talk P 22.2 Thu 11:15 SPA HS202

Block Structured Grids for GENE (Gyrokinetic Electromagnetic Numerical Experiment) — Hans-Joachim Bungartz[2], Tobias Görler[1], •Denis Jarema[2], Frank Jenko[1], Tobias Neckel[2], and Daniel Told[1] — [1]Max-Planck-Institut für Plasmaphysik, EURATOM-Assoziation, Boltzmannstraße 2, D-85748 Garching — [2]Scientific Computing in Computer Science, Technische Universität München, Boltzmannstraße 3, 85748 Garching

In its global version, GENE computes the evolution of the particles distribution function in a five-dimensional space, whose geometrical part spans over a large part of a plasma confinement device. The temperature of the plasma may vary strongly inside the confinement device, leading to different properties of the background distribution functions in the velocities space. More specifically, in regions of high temperature, there are more particles showing high velocity values, corresponding to a distribution function with long wings and a smooth peak at the mean velocity value, whereas the distribution function for regions of relatively low temperature displays a sharp peak. Constructing a rectangular Cartesian grid requires thus a big interval of velocity values to account for the fast particles and a fine resolution to resolve the sharp peak. This leads to a considerable increase in the number of points of the five-dimensional regular grid, and makes computations slow and inefficient. We develop block-structured grids that are adjusted to the temperature profiles and have a significantly reduced number of points in comparison to rectangular grids, resulting in faster global plasma gyrokinetic simulations.

Topical Talk P 22.3 Thu 11:40 SPA HS202

Interaction between the neoclassical equilibrium and ITG turbulence in gyrokinetic simulations — •Michael Oberparleiter and Frank Jenko — Max-Planck-Institut für Plasmaphysik, EURATOM-Assoziation, Boltzmannstraße 2, D-85748 Garching

While the fundamental theory of neoclassical transport in magnetic confinement devices was established decades ago, it still holds a number of relevant open questions. We use the gyrokinetic code Gene to investigate a potential interaction mechanism between turbulent and neoclassical physics via modifications of the zonal flow pattern by the neoclassical radial electric field. As a model system, an external sinusoidal electrostatic potential is imposed on ITG turbulence in the flux tube limit. This allows us to study the impact of long and intermediate wavelength radial electric fields on turbulent structures for a wide range of paremeters. Based on these results radially global simulations with and without neoclassical effects are performed to investigate the impact of the true neoclassical radial electric field. Additionally, we test some of the analytical propositions how neoclassical transport is modified near the magnetic axis, where the orbit width becomes of the order of the minor radius of the flux surface. In particular, a heat source localised on the axis is used to show the nonlocality of the ion heat transport.

Topical Talk P 22.4 Thu 12:05 SPA HS202

Nonuniversal power-law spectra in turbulent systems — •Vasil Bratanov[1], Frank Jenko[1], David Hatch[2], and Michael Wilczek[3] — [1]Max-Planck-Institut für Plasmaphysik, EURATOM-Assoziation, Boltzmannstraße 2, D-85748 Garching — [2]Institute for Fusion Studies, University of Texas at Austin, Austin TX 78712, USA — [3]Department of Mechanical Engineering, The Johns Hopkins University, 3400 NorthCharles Street, Baltimore MD 21218, USA

Turbulence is generally associated with universal power law spectra in scale ranges without significant drive or damping. Although many examples of turbulent systems do not exhibit such an inertial range, power law spectra may still be observed. In search for simple models exhibiting such a behavior, we first consider a modified version of the Kuramoto-Sivashinsky equation. By means of semi-analytical and numerical studies, one finds power laws with nonuniversal exponents at high wave numbers if the ratio of nonlinear and linear time scales is (roughly) scale-independent. As a further step we examine a two-dimensional fluid model with intrinsic drive and an additional cubic nonlinearity possessing a damping effect. Our analysis reveals again nonuniversal power laws that depend on the linear parameters.