SYGP 3: Contributed Talks

Time: Monday 16:30–19:00 Location: V55.22

SYGP 3.1 Mon 16:30 V55.22

Dynamos in convectively driven turbulence — •Wolf-Christian Müller[1] and Manfred Schüssler[2] — [1]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching — [2]Max-Planck-Institut für Sonnensystemforschung, Max-Planck-Str. 2, 37191 Katlenburg-Lindau

Different efforts to increase the understanding of magnetic field amplification in magnetohydrodynamic turbulence in the framework of the inter-institutional research initiative of the Max-Planck-Institutes for Plasma Physics and Solar System Research are presented. This talk focuses on basic turbulence properties which are also of importance from an astrophysical viewpoint, like the impact of physical modelling on turbulent dynamos, turbulent energy transport, and Lagrangian as well as dynamo-related characteristics of convective MHD turbulence.

SYGP 3.2 Mon 16:45 V55.22

Velocity-space diffusion of solar wind protons in oblique waves and weak turbulence — •Eckart Marsch and Sofiane Bourouaine — Max-Planck-Institut für Sonnensystemforschung, 37191 Katlenburg-Lindau

The fast solar wind is permeated by all kinds of plasma waves which have a broad range of wavelengths and occur on many different scales. Kinetically, a plasma wave induces ion-wave interactions which can within quasilinear theory be described as a diffusion process. The impact this may have on the shape of the proton velocity distribution function (VDF) is studied. We first analyse theoretically some of the possible kinetic effects of the waves on the ions. Then the model predictions are compared with the detailed in-situ plasma measurements made by the Helios spacecraft in 1976 at 0.3 AU and found to comply favourably with resonant diffusion of protons in obliquely propagating magnetohydrodynamic waves. In particular, the shape at the edges of the VDFs at positive proton velocities in the wind frame can well be explained by cyclotron-resonant diffusion of the protons in oblique fast magnetoacoustic and Alfven waves propagating away from the Sun.

SYGP 3.3 Mon 17:00 V55.22

Electron transport in the fast solar wind — •Håkan Smith[1,2], Eckart Marsch[1], and Per Helander[2] — [1]Max-Planck-Institut für Sonnensystemforschung, Katlenburg-Lindau — [2]Max-Planck-Institut für Plasmaphysik, Greifswald

A conventional fluid approach is in general insufficient for a correct description of electron transport in weakly collisional plasmas such as the solar wind. The classical Braginskii or Spitzer-Härm theory is only valid when the Knudsen number (mean free path divided by length scale of density or temperature variation) is less than 0.01. For realistic Knudsen numbers in the solar wind, the electron distribution function develops a suprathermal tail, and the departure from a local Maxwellian can be significant at the energies which contribute the most to the heat flux moment. In the present study we solve the Fokker-Planck equation for electrons in one spatial dimension and two velocity dimensions. The equation is solved by means of a finite element method in energy and pitch-angle, and finite differences in the spatial dimension. The ion temperature and density profiles are assumed to be known, but the electric field is calculated self-consistently to guarantee quasi-neutrality. It is found that the heat flux and the thermal force are both around half their respective Braginskii values. Moreover, the particle and heat fluxes are sensitive to the applied boundary condition at the outer boundary and to the ion coronal temperature profile. The heating of electrons purely by collisions with ions is inefficient because of the low collisionality. To obtain coronal electron temperatures of 1 MK one needs very hot (around 3 MK) ions.

SYGP 3.4 Mon 17:15 V55.22

numerical modeling of ion distribution functions in presence of ion-cyclotron waves — •Omar Maj[1,2], Roberto Bilato[2], Marco Brambilla[2], and Eckart Marsch[1] — [1]Max-Planck-Institut für Sonnensystemforschung, D-37191 Katlenburg-Lindau, Germany — [2]Max-Planck-Institut für Plasmaphysik, D-85748 Garching, Germany

The kinetic physics of ions in presence of ion-cyclotron (IC) waves constitutes a topic of great interest for both fusion and space plasma physics.

On one hand, IC waves constitute an important heating mechanism in present-day magnetic fusion experiments, and appropriate numerical tools, based on the quasi-linear theory, have been developed for the quantitative description of their resonant interaction with magnetically-confined ions.

On the other hand, in situ measurements of ion distribution functions in the solar wind exhibit the typical signature of resonant interactions with a spectrum of waves at the ion cyclotron frequency. Such IC waves can provide both energy and momentum to the plasma, and, thus, are presently considered one of the main theoretical paradigms to explain the heating of the solar corona to the observed temperature and the acceleration of the solar wind out of the gravitational well of the Sun.

The purpose of this work is to apply numerical modeling tools developed for fusion plasmas to coronal plasmas, with the ultimate goal of understanding how well the quasi-linear theory can account for the observed shape of ion distribution functions.

SYGP 3.5 Mon 17:30 V55.22

The effect of small guide fields on the stability and bifurcation of collisionless current sheets — Kuang Wu Lee[1], Jörg Büchner[1], and •Frank Jenko[2] — [1]Max-Planck-Institut für Sonnensystemforschung, 37191 Katlenburg-Lindau, Germany — [2]Max-Planck-Institut für Plasmaphysik, Garching, Germany

Our recent investigation of modified Harris current sheet shows that, indeed, a current sheet bifurcation instability dominated by the electron dynamics. In the course of the nonlinear instability evolution a bifurcated current sheet structure is naturally evolving from an unstable single-peaked current sheet [Lee & Büchner 2012]. In space plasmas, however, in addition to the anti-parallel magnetic field that maintains the current sheet equilibrium, embedded current-aligned guide fields have to be taken into account. The understanding of the guide field influence on the current sheet bifurcation, which should be considered in the electron kinetic scale, is nevertheless poor. In fusion research typically very strong guide fields are present in the current direction. However, very often at the Sun and in the heliosphere the guide fields are relatively small, of the order of the antiparallel components. Also, instead of the commonly assumed single-peaked current concentrations frequently bifurcated current sheets (BCS) were observed. Hence, we conducted two-dimensional particle-in-cell (PIC-) code simulations to investigate the influence of a relatively small guide field on the stability of current sheets and the formation of BCS. A statistical mechanics analysis of the influence of a guide field dependence will be presented, and the electron dominant turbulent process will be discussed.

SYGP 3.6 Mon 17:45 V55.22

Gyrokinetic simulations of magnetic reconnection — •Daniel Told[1], Moritz Johannes Pueschel[1,2], Frank Jenko[1], and Jörg Büchner[2] — [1]Max-Planck-Institut für Plasmaphysik, EURATOM Association, D-85748 Garching, Germany — [2]Max-Planck-Institut für Sonnensystemforschung, D-37191 Katlenburg-Lindau, Germany

Fast magnetic reconnection, believed to be a mechanism for rearranging the magnetic topology and creating energetic particles in many astrophysical and laboratory plasmas, is investigated with the nonlinear gyrokinetic code GENE. After some code-code benchmarking, extensive linear studies are presented, covering all relevant parameter dependencies of two-dimensional slab reconnection. The results are shown to agree well with a standard fluid model, if its assumptions are strictly fulfilled. In many realistic applications, however, the results deviate substantially, stressing the need for a generalized model or numerical simulations.

Nonlinear simulations are performed for two scenarios: decaying and driven turbulence. In the former case, the initially injected energy cascades towards the largest scales of the system and forms isotropic field structures after the transient turbulent phase. On the other hand, if the system is driven through a Krook-type term in the gyrokinetic Vlasov equation, a fully turbulent, quasi-stationary state develops. In this case, structures and islands are formed whose properties depend significantly on the drive strength. In both cases, the creation of significant parallel electric fields, largely due to magnetic flutter, is observed.

SYGP 3.7 Mon 18:00 V55.22

3D gyrofluid simulations of explosive collisionless reconnection — •Alessandro Biancalani[1,2] and Bruce D. Scott[1] —

[1]Max-Planck-Institut für Plasmaphysik, Euratom Association, D-85748 Garching, Germany — [2]Max-Planck-Institut für Sonnensystemforschung, Katlenburg-Lindau, Germany

The nonlinear dynamics of collisionless reconnecting modes is investigated, in the framework of a three-dimensional gyrofluid model. This is the relevant regime of high-temperature plasmas, where reconnection is made possible by electron inertia and has higher growth rates than resistive reconnection. The presence of a strong guide field is assumed, in a background slab model wih Dirichlet boundary conditions in the direction of nonuniformity. Values of ion sound gyro-radius and electron collisionless skin depth much smaller than the current layer width are considered. Strong acceleration of growth is found at the onset to nonlinearity, while at all times the energy functional is well conserved. Nonlinear growth rates more than one order of magnitude higher than linear growth rates are observed when entering into the small-Δ' regime.

SYGP 3.8 Mon 18:15 V55.22

A dedicated laboratory experiment on magnetic reconnection — •Adrian von Stechow[1], Hannes Bohlin[1], Olaf Grulke[1], and Thomas Klinger[1,2] — [1]Max-Planck-Institut für Plasmaphysik, EURATOM Assoziation, Greifswald — [2]Ernst Moritz Arndt-Universität Greifswald

Magnetic reconnection is a process in which a topological rearrangement of magnetic fields results in energy release on small length and time scales. This process takes place in the current sheet which forms at the boundary between opposed magnetic fields as can be found in fusion experiments as well as in space plasmas. The diagnostic of these phenomena is restricted either by technical limitations or harsh environments. In contrast, low temperature plasma experiments provide a wide range of well-defined plasma parameters which enables a controllable reconnection environment and bridges the gap between space and fusion experiments. Detailed spatiotemporal studies of microscopic plasma dynamics are of great significance, especially in the collisionless regime, in which the reconnection rate deviates considerably from that obtained in classical resistive MHD models. Here, small-scale effects such as kinetic instabilities and anomalous resistivity are believed to play an important role. To enable diagnostic access to these effects, the linearly magnetized plasma device VINETA has been upgraded. The addition of a new module of large dimensions allows for a closed reconnection field line configuration. The present status of this new dedicated reconnection experiment is presented along with planned measurement campaigns for the future.

SYGP 3.9 Mon 18:30 V55.22

Numerical simulations of expanding magnetic flux ropes — •Jürgen Dreher[1], Thomas Tacke[1], and Richard Sydora[2] — [1]Theoretische Physik, Ruhr-Universität Bochum — [2]University of Alberta, Edmonton, CA

Magnetic flux ropes play an essential role in astrophysical phenomena like solar prominences and mass ejections. The laboratory experiment FlareLab, which aims at investigating the behavior of such magnetized, current-carrying plasma arches, has recently been equipped with a new plasma source to control different magnetic field configurations.

We report on numerical simulations that are carried out complementary to the experiment in order to identify the relevant processes that lead to the observed morphology and dynamics under varying conditions. Starting with a low-pressure MHD model, we investigate the signatures of kink-like perturbations during the expansion phase as well as the influence of finite resistivity on the evolution and compare this with actual measurements. Further refinement of the simulation model towards a better match of the laboratory conditions, like including finite pressure and the Hall effect, will also be discussed.

SYGP 3.10 Mon 18:45 V55.22

Energy release in a solar coronal bright point region obtained through a new parallel implementation of LINMOD3D — •Eric Adamson[1], Jörg Büchner[1], and Antonius Otto[2] — [1]Max-Planck-Institut für Sonnensystemforschung, Katlenburg-Lindau, Germany — [2]Geophysical Institute, University of Alaska Fairbanks, Fairbanks,USA

LINMOD3D is a numerical simulation code for the investigation of the solar coronal plasma dynamics. Due to the strong inhomogeneities and interscale coupling effects inherent to the system, large grids and parallel computing are required in order to ensure proper numerical solution of the field and fluid equations. LINMOD3D has recently been optimized for its more efficient use on parallel computer architectures. This improvement allows a high spatial resolution and a stable run to track a long evolution of the solar atmosphere. We present results of LINMOD3D simulations addressing the effects of various parameter variations on the energy budget of the solar corona.