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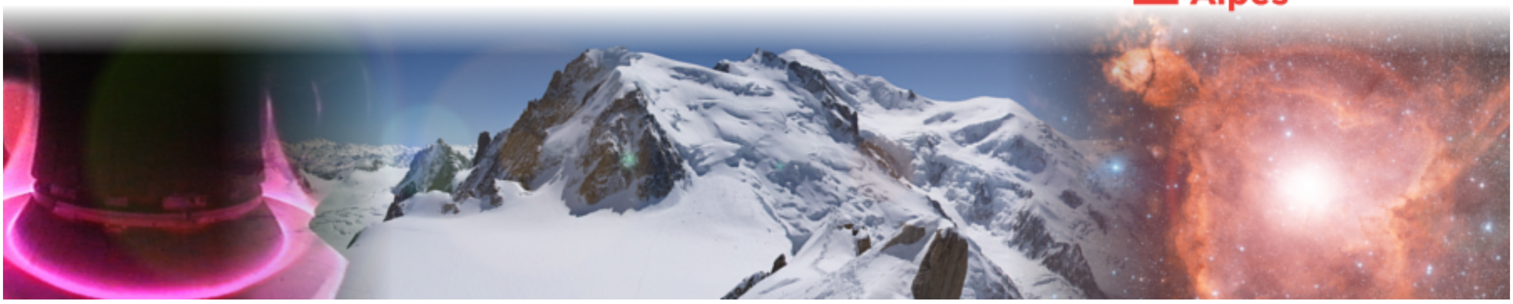

The expanding universe of plasma physics

POSTER ABSTRACT BOOK

Ben Alterman

University of Michigan

Solar wind protons are regularly measured in non-equilibrium states. These can appear as a high-velocity shoulder on the proton velocity distribution function and can be characterized by a maxwellian population called the proton beam differentially streaming with respect to the bulk or proton core. We compare proton beam differential flow with the well studied alpha particle differential flow to better understand the relationship between differential flow and the Alfvén waves typically associated with it. We restrict our analysis to collisionally young solar wind to minimize the impact of Coulomb collisions and better approximate conditions close to the Sun.

Patrick Astfalk

Max-Planck-Institute for Plasma Physics, Garching, Germany

Kinetic instabilities in non-Maxwellian plasmas

Nonthermal deviations of velocity distribution functions from an isotropic Maxwell-Boltzmann can provide a source of free energy and drive a rich variety of velocity space instabilities. We recently developed a fully kinetic dispersion relation solver which is able to process arbitrary gyrotropic velocity distributions. We apply this new code to distributions obtained from spacecraft measurements and simulation data to carry out realistic investigations of velocity space instabilities in collisionless space plasmas such as the ion firehose instability and the right-hand resonant ion beam instability. We compare the results to corresponding bi-Maxwellian models and we extend the analysis to quasilinear theory to study the instabilities' saturation due to resonant pitch-angle scattering.

Xi Bai

Institut de Recherche en Astrophysique et Planétologie

Analysis of thick, finite, and non-planar field-aligned currents in the polar regions with Swarm magnetic field measurements

The calculation of field aligned currents and the study of their morphology has long been a crucial problem in space plasma physics. The most commonly used method is to use the magnetic field vector measurement of a single satellite, deducing a proper background, to approximately calculate the current density under the assumption of the planar and infinite current sheet. When multipoint measurements are available (Cluster, Swarm) the curl of magnetic field also could be a better estimation to infer the field-aligned current density (Curlometer technique). In this work, we take advantage of the two Swarm satellites flying side by side (Swarm A and C) to establish a model of finite, thick, and non-planar current sheet. We should present the underlying formalism of our model and its capabilities: not only does it derive the magnitude of the current, but also the morphology parameters of the current sheet, including curvature, radius and spatial extent.

Vinodh Kumar Bandaru

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MHD modelling of relativistic runaway electrons in tokamak plasmas

When a disruption occurs in a tokamak plasma, it is quickly cooled to much lower temperatures and a significant fraction of the electron current is converted to relativistic runaway electrons. These electrons can be a severe problem in the next level of tokamaks (such as ITER), due to the severe localized damage that they cause to the first wall. This necessitates understanding their evolution and the effect on plasma instabilities. The present work focuses on the numerical modeling of runaway electron evolution in the framework of reduced MHD and its implementation into the JOREK code.

Pallavi Bhat

Plasma Science and Fusion Centre, MIT, Boston, US.

We study the plasmoid instability in the semi-collisional (SC) regime, i.e. $\delta_{SP} > \rho_S > \delta_{in}$ where δ_{SP} is Sweet-Parker current sheet width, ρ_S is the ion sound Larmor radius and \delta_{in} is width of boundary layer that arises in the plasmoid instability analysis, using simulations of a reduced gyrokinetic formalism (Zocco & Schekochihin 2011) with the code Viriato. The SC regime allows for plasmoid instability to arise at lower values of the Lundquist number than in the magnetohydrodynamic case, thus enabling numerical investigations with more modest resolution requirements. We map out the SC regime in a phase space governed by Lundquist number S and the ratio of the system size to the ion (sound) Larmor radius, L/ρ_S and show that the instability is obtained when $(L/\rho_S)^(8/5) < S < (L/\rho_S)^2$, and at values of S as low as ~ 200, as predicted by theory (Loureiro & Uzdensky, 2016). We also investigate the scaling behaviour of the instability growth rate and the fastest growing mode, as well as its effect on the global reconnection and energy dissipation rates.

Victor Désangles

Laboratoire de Physique de l'Ens de Lyon

<u>Experimental control of drift waves dynamics using emissive cathodes</u>

Plasma parameters fluctuations are known to be the cause of strong transport perpendicular to the confinement field in hot plasma devices. These instabilities also appear in smaller linear devices on which excitation and mitigation of drift waves have been studied using different setups such as polarized cold grids, electro-magnetic drive or concentric annular cold electrodes [1, 2]. We study the control of these instabilities using plasma potential shaping from strongly emissive cathodes in the Von-Kàrmàn Plasma experiment (VKP).
VKP is a cylindrical, low pressure, high density plasma experiment with axial confinement field [3]. The rotation profile of the plasma is controlled using hot emissive cathodes biased rel- atively to the experiment wall or to cold anodes. Current emission from biased cathodes dramatically changes the radial gradients of plasma density and plasma potential, which therefore modifies the plasma rotation. We report on the influence of this controlled rotation on the dynamics of drift waves.

[1] G. R. Tynan *et al.*, Plasma Phys. Control. Fusion 51, 113001 (2009)
[2] T. Klinger *et al.*, Plasma Phys. Control. Fusion 39, B145-B156 (1997)
[3] N. Plihon et al., J. Plasma Phys. 81, 345810102 (2017)

Elisa De Giorgio

University of Calabria (UNICAL), Cosenza (Italy) &
PhD invited student at ENS Lyon and Ecole Centrale de Lyon

<u>Study of Coherent Structure Formation in 2D MHD Turbulence</u>

Through high resolution 2D MHD simulations we analyse the formation of coherent structures induced by nonlinear interactions in turbulent flows. These coherent structures are locally (at small scales) identified by spatial intermittent behaviour and their properties are guided by the conservation of ideal quadratic (rugged) invariants of the 2D incompressible MHD equations. Different spatial regions are displayed in correspondence of the locally correlations predicted using the variational principles associated to the rugged invariants. These local correlated structures are produced rapidly, as soon as the turbulence is fully developed.

Vamsee Krishna Jagarlamudi

Lab. de Physique et Chimie de l'Environnement et de l'Espace
LPC2E / CNRS and University of Orléans

We are focused on understanding the radial evolution of magnetic field tur- bulence in the inner heliosphere, for this purpose we use the "HELIOS" data. We use Helios data because it is the mission which has been closest to the Sun till date and it was always in equatorial plane. So, Helios is the best mission to understand the radial evolution of the magnetic field turbulence in the inner heliosphere. We use power spectral density (PSD) as one of the tools to understand the magnetic field turbulence evolution and we are in- terested in the physics going on in the low frequency regions of the spectrum as most of the energy is concentrated in those regions. Analysis has been carried on separately for the fast (> 600km/s) and slow (< 350) winds at different positions. We observe a frequency break in the fast wind and this frequency break is found to be dynamic, evolving with the radial distance, i.e. moving towards to lower and lower frequencies as we move radially away from the sun and it follows a power law. In slow solar wind, frequency breaks have not been observed as the slow wind is very well evolved. As the helios data has lot of gaps we use other techniques such as auto-correlation function analysis to understand the effects of technique used on the data.

Leonardo Krapp

Niels Bohr Institute - University of Copenhagen

Numerical implementation of Ohmic diffusion, ambipolar diffusion and the Hall effect on an MHD code.

The evolution of the magnetic field in a plasma is subject to non-ideal effects when the gas is not fully ionized. In the framework of Magnetohydrodynamics (MHD), the numerical solution of the full induction equation, including Ohmic diffusion, ambipolar diffusion and the Hall effect, is a challenging problem and subject of active developments. In this presentation, I will summarize a series of tests that validate the implementation of the three non-ideal terms in the MHD code FARGO3D. The main tests include: two different schemes for the super-time-stepping (for Ohmic and Ambipolar diffusion) and the evolution of the Magneto-Rotational Instability (MRI) under the Hall effect.

Kyle Martin

Astronomy and Astrophysics Department, University of Glasgow

Rayleigh Taylor Instabilities in inhomogeneous plasma

The Rayleigh Taylor Instability is a well-known fluid instability observed in a variety of environments, including gas and magnetised plasma mixes such as tokamak edge plasmas and the solar atmosphere. The instability dynamics can have significant effects on the broader gas-plasma evolution: for example, in the context of injecting cryogenic fuel pellets into tokamak plasmas, the inhomogeneous pressure environment can cause significant distortion of the partially ionized ablation plume from the pellet; similar effects can be seen from Sun-grazing cometary impact. The instability is traditionally associated with the dynamics of a dense fluid overlying a less dense one, in the presence of a uniform gravitational field. In our context, the influence of the non-scalar, non-uniform pressure gradient arising from a strong, unidirectional magnetic field near the pellet has an analogous effect to a spatially varying gravitational field that varies along the interface. We present these findings with an emphasis on the instability envelope and the influence of an inhomogeneous pressure gradient.

Salome Mtchedlidze
Faculty of Exact and Natural Sciences, Tbilisi State University, Georgia

Gravitational stability of non-radial modes in asymmetric dark matter halo

We analyze the Jeans instability of compressible gravitating media in the external asymmetric gravitational potential. The problem can be used to analyze the dynamics of star formation in galaxies, where local gravitational stability is significantly modified by the cold dark matter halo of the galaxy. For this purpose we expand density and gravitational potential into spherical harmonics and study the linear stability criteria of the non-radial modes. Density is split into background and perturbed components, while gravitational potential is composed from background and perturbed potential of baryonic matter, as well as external constant dark matter component. We derive the dispersion equation of the non-radial modes in general case. Assuming marginal gravitational stability of spherically symmetric modes we derive the stability criteria for non-radial modes. Thus, any asymmetry of mass distribution of stars in a galaxy may be used to constraint symmetry (asymmetry) properties of the galactic dark matter halo.

Luka Poniatowski
Faculty of Exact and Natural Sciences, Tbilisi State University, Georgia

Visco-rotational shear instability of differentially rotating granular disks

we present the study of instabilities in granular media rotating around the central gravitating object, considering rheological properties of such flows. The flows are studied within the rhoelogical viscosity model, which considers dependence of viscosity parameter on local pressure and shear rate. Dynamics of spiral waves is studied within the described approximation. Linear, spiral rheological incompressible instability is found: that sets in when at constant pressure viscosity increases faster than the square of local strain rate. It was shown that the most unstable modes are nearly uniform in the vertical direction and they operate at small radial scales. Found instability may play critical role in formation and acceleration of formation of observable structures in planetary rings, protoplanetary discs.

Nicolas Scepi
Institut de Planétoilogie et d'Astrophysique de Grenoble

Effects of Convection and Resistive MHD on the Transport of Angular Momentum in Cataclysmic Variables in Local Shearing Box Simulations

Using the PLUTO code, we perform a set of 3D radiative magneto-hydrodynamic (MHD) simulations in local, vertically stratified shearing box to study the magneto-rotational instability (MRI) turbulence in dwarf novae systems. We solve the radiative transfert in the limited flux approximation and we impose a zero vertical magnetic net flux. We are interested in the dependance of the pressure normalized turbulent transport of angular momentum by the MRI in the disk, quantified by the Shakura Sunyaev viscosity α, with the thermodynamic properties of the disk. This known, it will be easier to reproduce the observed light curves of dwarf novae. We first neglect non-ideal MHD and study the effect of thermal convection in various conditions of temperatures and density. We find an enhancement of α when the disk is convectively unstable which is correlated to the ratio of convective transport to radiative transport of energy. We probe the robustness of this feature using two sets of simulations, one with vertical outflow boundaries and another with vertical periodic boundaries. Then, we switch to resistive MHD, as Ohmic dissipation is non negligible in the zones where the magnetic Reynolds number Rm of the disk is below 10,000, zones where the temperature is typically around 3000-5000K. We find that in this conditions the diffusion of the magnetic field is too large for MRI to sustain turbulent transport of the angular momentum. This result is of great importance as it shows that accretion in the disk might not be explained only by MRI turbulence.

Domenico Trotta
Astronomy Unit, Queen Mary University of London

Electron acceleration at quasi-perpendicular shocks: the role of shock surface fluctuations in 1D, 2D and 3D simulations.

D.Trotta, D.Burgess

Short abstract:"Energetic electrons play an important role in many astrophysical environments, and are commonly observed in space plasmas.
Shock accelerated electrons, and the electron super-halo of the solar wind, are both examples of systems where a significant electron population
can be accelerated out of the thermal distributions (up to 2 - 20 keV). Shocks are known as very good particle accelerators, and if one is interested in electron acceleration at shocks, both the proton and the electron scales must be resolved: this yields to serious computational problems. Therefore, we confront the problem of electron acceleration at quasi-perpendicular shocks using a combination of hybrid Particle-in-Cell and test particle simulations.
We study a range of different shock types in 1D, 2D and 3D. For high Mach numbers, the shock front has a dynamic rippled character: we are interested in investigating how this feature can affect the electron acceleration. Has already been shown, by means of 2D hybrid PIC combined with test particle simulations, that the rippled character of the shock has an important influence on the electron energisation at quasi-perpendicular shocks, yielding to remarkably higher maximum energies than fast Fermi acceleration. We investigate for the first time how shock surface fluctuations influence electron acceleration in three dimensions, and we give a complete comparison for the 1D, 2D and 3D cases. Throughout this study, we use velocity space distributions in order to identify the observational signatures of the acceleration process.

Menglong Zhao
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Kinetic effects of electron parallel transport in SOL with KIPP-SOLPS coupling code

Abstract: The kinetic Code for Plasma Periphery (KIPP) has been coupled to SOLPS code in order to study the kinetic effects on the edge plasmas systematically. The fluid model in SOLPS is already highly sophisticated with self-consistent recycling and sputtering model and atomic physics as well which are most difficult and time consuming part in kinetic codes. KIPP-SOLPS coupling code allow us to investigate electron kinetic effects without losing sophisticated fluid model.