PEM10-01 Room:414 Time:April 29 14:15-14:35

Modeling Turbulence in Space Plasmas

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Space plasmas are magnetized and in turbulent states. I will briefly introduce properties of turbulence in a strongly magnetized medium. Turbulence in space plasmas is involved with various length scales. In general, different descriptions should be used for different scales. On large scales, plasma turbulence can be described in the framework of magnetohydrodynamics (MHD). In the first par of the talk, I will focus on MHD turbulence in the presence of a strong mean field. I will discuss energy cascade and structure of turbulence in this regime. On the other hand, on small scales near the proton gyro-scale, we cannot use MHD. In the second part of the talk, I will discuss how we can treat magnetized turbulence on small scales. I will also discuss properties and scaling relations of waves and turbulence in this regime.

Keywords: turbulence, MHD, waves, magnetic field

PEM10-02 Room:414 Time:April 29 14:35-14:50

Nonlinear evolution of envelope-modulated Alfvenic turbulence in expanding accelerating solar wind plasmas

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It is well known that low-frequency Alfvenic turbulence is ubiquitously observed in solar wind plasmas. There is great interest in nonlinear evolution of the Alfvenic turbulence, since the observational studies clarified that the Alfvenic turbulence disappear with the increasing heliocentric distance and the fully-developed turbulence becomes dominant. Although most past studies on Alfvenic turbulence assumes uniform background plasmas and magnetic fields, the effects of the inhomogeneity may not be negligible in the inner-heliosphere, in which several future spacecraft missions are planned. It is important that even if the wave reflection due to the inhomogeneity is negligible, the inhomogeneity of background plasmas and magnetic field may affect the nonlinear interaction among waves through contraction and reflection of the waves and the radial dependence of the back ground parameters such as the Alfven velocity and the ion cyclotron frequency. In the present study, the nonlinear evolution of low-frequency, quasi-parallel propagating Alfvenic turbulence is studied by using the two-dimensional hybrid accelerating expanding box model. The dependence of the nonlinear evolution of Alfvenic turbulence on the effects of the inhomogeneity is discussed.

Keywords: solar wind, Alfvenic turbulence, ion kinetics

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PEM10-03 Room:414 Time:April 29 14:50-15:10

Development and Properties of Compressible MHD Turbulence in High-Beta Plasmas

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Many cosmic plasmas, including those in the solar wind and extra-galactic environments, are high beta = $P_g/P_B>1$, so that as turbulence develops, magnetic stresses are, at least initially, weak. As the turbulence evolves, magnetic stresses become increasingly important on scales below the driving scales. Depending on the initial field strength and topology this evolution can take many large-scale eddy times to reach saturation. Even in subsonic turbulence, shocks can form and influence turbulence evolution and properties. We have carried out an extensive set of high resolution compressible MHD simulations of the evolution of such turbulence for a range of initial magnetic field strengths and topologies. Here we report on their properties and the astrophysical implications of those properties. This work is supported at the University of Minnesota by the US National Science Foundation and the Minnesota Supercomputing Institute.

Keywords: MHD Turbulence, High Beta Plasma

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PEM10-04 Room:414 Time:April 29 15:10-15:30

Instabilities and turbulence near the heliopause

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Recent observations from the Voyager 1 spacecraft show that it is sampling the local interstellar medium (LISM). This is quite surprising because no realistic, steady-state model of the solar wind (SW) interaction with the LISM gives the inner heliosheath width as narrow as 30. This includes such models that assume a strong redistribution of the ion energy to the tails in the pickup ion distribution function. We show that the heliopause (HP), which separates the SW from the LISM, is not a smooth tangential discontinuity, but rather a surface subject to Rayleigh-Taylor-type instabilities which can result in the LISM material penetration deep inside the SW. We also show that the HP flanks are always subject to a Kelvin-Helmholtz instability. The instabilities are considerably suppressed near the HP nose by the heliospheric magnetic field in steady-state models, but reveal themselves in the presence of solar cycle effects. We argue that Voyager 1 may be in one of such instability regions and therefore observing plasma densities much higher than those in the pristine SW. These results may be an explanation of the Voyager 1 early penetration into the LISM. We also show that there is a possibility that the spacecraft may enter the SW again before it finally leaves the heliosphere.

We demonstrate a spontaneous transition to chaotic behavior in the heliosheath region covered by the heliospheric current sheet. Additionally, we analyze the behavior of the heliopause in the heliotail and show that it becomes violently unstable beyond 1000 AU, which results in the interpenetration of the solar and interstellar plasma.

Keywords: ISM: kinematics and dynamics, ISM: magnetic fields, solar wind, Sun: heliosphere, turbulence

PEM10-05 Room:414 Time:April 29 15:30-15:45

Wave reflection-driven accretion in active solar-type star winds

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In MHD simulations for winds from active solar-type stars by Suzuki et al.(2013), intermittent but long-time accretion phenomena were observed even though the Poynting flux associated with Alfven waves is directed outward. In this talk, we present the detailed mechanism how this counter-streaming accretion takes place. Alfven waves generated from a stellar surface are stochastically trapped in a transient density hole, and the magnetic pressure with the waves further dig the density hole. Eventually, this hole works as an efficient mirror against out-going Alfven waves. As a result, out-going waves are reflected and the reflected component excites counter streaming flow.

Keywords: Wave, MHD, stellar wind, accretion

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PEM10-06 Room:414 Time:April 29 15:45-16:00

Physical Picture of 2-1/2D Driven Collisionless Magnetic Reconnection

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The physical picture of how electrons and ions flow, how the electric and magnetic fields change, and how particles gain energy will be presented for the 2-1/2D collisionless driven magnetic reconnection. The 2-1/2 dimensional collisionless reconnection studies are performed using the particle simulation PASMO code [1] and theoretical analysis. In particular, we will provide the physical mechanism of how the poloidal current (including the Hall current in the downstream region) is generated and how the electrostatic potential is produced in the poloidal plane. The physical picture of how the quadrupole magnetic field and electrostatic potential are generated in the 2-dimensional (poloidal) plane is different from the one presented by Uzdensky and Kulsrud.[2]

[1] H. Ohtani and R. Horiuchi, Plasma Fusion Res., 4, 024 (2009)
[2] D. A. Uzdensky and R. M. Kulsrud, Phys. Plasma, 13, 062305 (2006)

Keywords: magnetic reconnection, numerical simulation, space plasma, laboratory experiment

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PEM10-07 Room:414 Time:April 29 16:15-16:35

Turbulence and shocks in high-beta plasmas

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High-beta plasmas are common in astrophysical environments, such as the intracluster medium (ICM) of galaxy clusters and the interplanetary medium (IPM) of the solar system. Observations and theoretical arguments suggest that the plasmas in such environments are in the state of turbulence, where highly nonlinear and complex physics is involved. Here we report high-resolution simulations to study the turbulence in high-beta plasmas. Along with the properties of the turbulence, we discuss the role of shocks and the energy dissipation.

Keywords: turbulence, shock wave, high-beta plasma

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PEM10-08 Room:414 Time:April 29 16:35-16:50

Acceleration and Diffusion of Cosmic Rays in Supernova Remnants in a Multi-Phase interstellar Medium

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Supernova remnants (SNRs) are one of the most powerful cosmic phenomena and are thought to be the dominant source of Galactic cosmic rays (CRs). A recent report by Funk et al. (2013) has shown an unequivocal signature of pion-decay in the gamma-ray spectra of SNRs. This provides strong evidence that high-energy protons are accelerated in SNRs. On the other hand, Fukui et al. (2012) showed that pion-decay from protons dominates in emission from SNR RX J1713 based on the spatial correlation of gamma-rays and molecular line emission. The actual gamma-ray emission from pion-decay should depend on the diffusion of CRs in a multi-phase interstellar medium with molecular clouds (Inoue et al. 2012). In order to quantitatively describe the diffusion of high energy CRs from acceleration sites, we have performed test particle numerical simulations using a three-dimensional magnetohydrodynamics (MHD) simulation data cube provided by Inoue et al. (2012). In this presentation, we analyze a realistic diffusion coefficient of cosmic rays in simulated SNRs, and discuss the possible implications for X-ray and gamma-ray observations.

Keywords: Supernova Remnants, Diffusion of Cosmic Rays, Acceleration of Cosmic Rays, Pion-decay

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PEM10-09 Room:414 Time:April 29 16:50-17:05

Superdiffusion in turbulence and shock acceleration

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Cosmic ray (CR) transport and acceleration are determined by the properties of turbulent magnetic field. We use the models of magnetohydrodynamic turbulence that were tested in numerical simulation, in which turbulence is injected at large scale and cascades to to small scales. I shall address, in particular, the cross field transport of CRs. I shall demonstrate both analytically and numerically that particles are superdiffusive on small scales. We consider both super- and sub-Alfvenic cases. In the sub-Alfvenic case, the transport in the perpendicular direction is proportional with M_Aˆ4, consistent with our earlier analytical prediction. Implication for shock acceleration is discussed and we show that the difference between acceleration at perpendicular shock and parallel shock is marginalized in the presence of superdiffusion.

Keywords: turbulence, superdiffusion, particle, shock, acceleration, transport