Geophysical Research Abstracts
Vol. 20, EGU2018-16947, 2018
EGU General Assembly 2018


# Hybrid simulations of plasma turbulence in support of space missions: a direct quantitative comparison with MMS observations

Luca Franci (1), Julia Stawarz (2), Simone Landi (3), Petr Hellinger (4), Christopher H. K. Chen (1), David Burgess (1), Emanuele Papini (3), Lorenzo Matteini (5), Andrea Verdini (3), James L. Burch (6), Barbara L. Giles (7), Olivier Le Contel (8), Per-Arne Lindqvist (9), Robert E. Ergun (10), and Christopher T. Russell (11)

(1) School of Physics and Astronomy, Queen Mary University of London, London, UK, (2) Space and Atmospheric Physics Group, Imperial College London, London, UK, (3) Dipartimento di Fisica e Astronomia, Università degli Studi di Firenze, Firenze, Italy, (4) Astronomical Institute, CAS, Prague, Czech Republic, (5) LESIA-Observatoire de Paris, Meudon, France, (6) Southwest Research Institute, San Antonio, Texas, USA, (7) NASA, Goddard Space Flight Center, Greenbelt, Maryland, USA, (8) Laboratoire de Physique des Plasmas, Paris, France, (9) School of Electrical Engineering, KTH Royal Institute of Technology, Stockholm, Sweden, (10) Laboratory of Atmospheric and Space Sciences, University of Colorado Boulder, Boulder, Colorado, USA, (11) Department of Earth, Planetary and Space Physics, University of California, Los Angeles, California, USA

In-situ observations from solar and heliospheric space missions indicate that kinetic interactions are fundamental in determining the small-scales plasma dynamics and the evolution of the turbulent cascade. In order to understand how astrophysical turbulence operates, observational data need to be directly compared with theoretical models and numerical data. We present a direct, quantitative comparison between specific observations of plasma turbulence associated with a Kelvin-Helmholtz instability (KHI) on the Earth's magnetopause from the Magnetospheric Multiscale (MMS) mission and high-resolution numerical simulations performed ad-hoc with the hybrid (kinetic ions, fluid electrons) code CAMELIA. Although the large-scale driver of the turbulent cascade is different (a KHI event in observations and Alfvènic-like fluctuations in simulations), adjusting the three main plasma parameters (the level of magnetic fluctuations, the ion and the electron betas) to the observed values is sufficient to recover an unprecedented remarkable agreement of the spectral properties, both qualitative and quantitative. We reproduce the same shape and level of the magnetic and electric fluctuations over two full decades in wavenumber, including the scale of the spectral break between fluid and kinetic scales and the spectral indices in both ranges. Among other things, our results confirm that: (i) the turbulent cascade organizes itself independently of the large-scale driver, (ii) the ion beta controls the break and the slope of the magnetic field spectrum at sub-ion scales, while the electron beta controls the level of the electric field spectrum at sub-ion scales, (iii) the hybrid model is comprehensive enough to accurately characterize the turbulent cascade around ion scales and to model the transition between the fluid and the kinetic regime. We also investigate the spectral properties of other fields and the intermittency properties and discuss similarities and differences.