



## **Interest of the multipoint multi-instrument Cross-Scale Mission concept for the study of turbulence in space plasmas**

J.-L. Pinçon (1), T. Dudok de Wit (1), V. Krasnoselskikh (1), F. Sahraoui (2), A. Roux (2), N. Cornilleau-Wehrin (2)

(1) LPCE/CNRS, Orléans, France, (2) CETP/IPSL/CNRS, Vélizy, France

In the frame of the European Space Agency's call for mission concepts related to the Cosmic Vision programme, Cross-Scale has given rise to a strong interest in the community. The goal of Cross-Scale is to unveil the physics underlying magnetic reconnection, collisionless shocks and turbulence. As clearly shown by Cluster, to fully understand the physics underlying these processes, simultaneous measurements of plasma particles and fields have to be performed over each of the fundamental scales: electron, ion, and MHD fluid. The Cross-Scale mission concept involves a formation of 3 nested sets of 4 spacecraft orbiting the Earth with separations tuned to the 3 relevant scales in space plasmas.

To illustrate the need for such a mission and its interest regarding the study of space plasma turbulence, Cluster estimates of the wave vector spectrum associated with homogeneous magnetic field turbulence in the magnetosheath are presented. The obtained spectra suggest that a turbulent cascade is occurring. However Cluster can only cover a limited range of scales at a given time. The only way to cover the various plasma fundamental scales with Cluster is by combining wave vector spectra obtained from magnetic field data sets performed at different times and for different plasma parameters and solar wind conditions. Any physical conclusion derived from these combined spectra is necessarily linked to very demanding and unrealistic assumptions. The instantaneous spatial coverage over about three decades provided by Cross-Scale is the only way to solve this problem.

Another lesson learnt from Cluster is that the understanding of space plasma turbulence requires to take into account energy transfers associated to both wave-wave

and wave-particle interactions. The extended instantaneous spatial coverage of Cross-Scale with the corresponding electric and magnetic field measurements, combined with high time resolution particle observations, will allow for the first time to probe the contribution of the kinetic energy of particles and of the electromagnetic energy cascade in wave vector spectra. We will discuss how Cross-Scale multi-instrument and multipoint measurements require advanced data analysis techniques, based on distribution functions and higher order statistics, to provide us with answers regarding the nature and direction of the energy cascade in homogeneous turbulent collision free plasmas.