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Cluster, Interball and Geotail data: evidence for superdiffusion

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Multipoint spacecraft measurements in the magnetosheath (MSH) provide an opportunity to investigate the processes that lead to super-diffusion. On the basis of Cluster, Interball and Geotail observations in the MSH we display an evidence for the temporary existence of superdiffusion as well in the region close to the BS as near the MP. Disturbed zones of duration of up to 2 hours are regularly detected in the MSH, preferably downstream of the quasi-parallel and oblique BS. These zones are similar to high-latitude MSH near the MP, known as the 'turbulent boundary layer' (TBL), which is the result of the interaction of the MSH flow with the throat of the cusp. In both these disturbed zones the field and plasma fluctuations have comparable intensity and similar spectral properties. Determination of the structure functions of the magnetic field and ion flux also reveals similar multifractal and intermittent properties. The same holds for fitting a Log-Poisson cascade model. Resonant perturbations at few mHz are amplified here, while decay processes identified from bi-coherent phase coupling are substantial only in the TBL close to the MP. We find that about 20% of the intense ram pressure bursts which are known as 'plasma jets', should impact at the MP. They provide the flank magnetosphere with a superdiffusive population. These intermittent or transient jets have ram pressure several times that of the SW. Since in the jets the dynamic pressure does not decrease but rises instead, this contradicts the MHD predictions for the transformation of SW kinetic energy into thermal energy at the BS. Estimates of the time scaling for the diffusion coefficient in the highly fluctuating jet region yields strong indications for the presence of super-diffusion. Obviously the jets serve to dissipate the kinetic energy in the boundary layers. This seems to be typical for collisionless boundary layers in the astrophysical plasma as well as and in laboratory plasmas.
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