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Nonlocal interactions in the Earth magnetosheath: supersonic coherent structures as drivers of anomalous dynamics and intermittent turbulence

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We present multipoint spacecraft measurements in the magnetosheath (MSH) by Cluster, Double Star, THEMIS, Interball, Geotail etc., demonstrating that coherent structures with magnetosonic Mach number up to 3 – High Kinetic Pressure Jets (HKPJ) – provide the cross-system means for normal and anomalous boundary dynamics. The latter anomalous dynamics includes spacecraft MSH crossings in few minutes, while usually it takes hours. The fastest HKPJ with the ram pressure over that of the solar wind one in up to 6 times, lead to the long-range correlations between processes at magnetopause and bow shock, as well as between upstream and downstream MSH.

We discuss this anomalous MSH dynamics in view of both solar wind and intrinsic MSH features, including the MSH plasma flow stratification and boundary crossings at eigen frequencies of $\sim$ 1-4 mHz. Usually the anomalous MSH dynamics is triggered by hot flow anomalies (HFA) generated by interaction of interplanetary discontinuities with bow shock. We also discuss another mechanisms as well, including foreshock and parallel shock processes.

We demonstrate an appearance of the fast MSH and HKPJ, related with HFA, both near bow shock and magnetopause. The HFA represent local obstacles for solar wind, and the multi-point data suggest the local flow balance causing the HKPJ generation.

In the case of developed turbulent zones near the MSH boundaries, namely HKPJ provide the multifractal and intermittent properties of turbulence.

The HKPJ look to be universal means for establishing of new equilibriums between flowing plasmas, which looks suggestive also for astrophysical and fusion applications.