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CLUSTER observations in the magnetosheath: anisotropies of wave vector distributions of the turbulence at proton scales

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In the magnetosheath, the distribution of the wave vectors k of the electromagnetic fluctuations is highly anisotropic at electron scales ($kc/\omega_{pe} \simeq 0.3$ to 30): the k-distribution peaks for k perpendicular to the magnetic field B (Mangeney et al., Lacombe et al., 2006). This result has been obtained by an analysis of the intensity δB^2 of the fluctuations at a given frequency: in the STAFF-SA frequency range (8 Hz to 4 kHz), δB^2 depends on the angle Θ_{BV} between B and the flow velocity V, i.e. depends on the Doppler shift. This dependence gives an indication on the direction of k. A wavelet analysis of the FGM fluctuations (during 6 non-consecutive hours, over 3 days) allows to determine the intensity of the transverse (Alfvénic) fluctuations $\delta B_\perp^2$ and the intensity of the compressive (mirror) fluctuations $\delta B_\parallel^2$, between 0.001 Hz and 10 Hz, i.e. at proton scales. Above $\simeq$ 0.1 Hz, we find that $\delta B_\perp^2$ is larger than or equal to $\delta B_\parallel^2$. At a given frequency, $\delta B_\perp^2$ and $\delta B_\parallel^2$ still depend on Θ_{BV}, i.e. on the Doppler shift, for $kc/\omega_{pi} \simeq 0.1$ to 10 ($kc/\omega_{pe} \simeq 0.003$ to 0.3). This leads to conclude that the k-distribution of the compressive fluctuations $\delta B_\parallel^2$ peaks for k perpendicular to B, for kc/ω_{pi} larger than 0.1 or 0.3, up to $kc/\omega_{pi} \simeq 10$. The k-distribution of the Alfvénic fluctuations $\delta B_\perp^2$ also peaks for k perpendicular to B, except in the range $kc/\omega_{pi} \simeq kr_{gi} \simeq 0.2$ to 0.6: in this range, the k-distribution is more isotropic because unstable Alfvén Ion Cyclotron waves can be generated by the proton temperature anisotropy, with k mainly parallel to B. We compare these results with those obtained with the k-filtering method by Sahraoui et al. (2006), and with the properties of the Alfvén vortices observed by Alexandrova et al. (2006).