Cluster observation of mirror turbulence at the magnetopause: constraints for kinetic modelling

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The magnetosheath plasma is observed to be highly turbulent in the range of ULF frequencies [1]. Implications of these fluctuations for the magnetopause reconnection issue are emphasized. In the most general case, when the plasma beta is larger than unity, the ULF magnetosheath turbulence has been shown to be dominated by the so-called "mirror mode". It means that, due to ion temperature anisotropy, the energy is injected at fairly large scales (~2000 km) on this mode via the kinetic mirror instability. Thanks to the Cluster four point measurements, it is now possible to investigate how this energy cascades toward small scales with details never attainable hitherto. The magnetic field data, from STAFF and FGM experiments, are used and analyzed thanks to the k-filtering technique [2,3]. The index of the spatial power law spectrum is determined, and the anisotropy of turbulence is investigated as a function of the main local directions: magnetic field, magnetopause normal and plasma flow. A strong anisotropy is evidenced [4], quite different from any existing model of developed turbulence. For the scales accessible with the actual Cluster separation (~ 100 km), it is shown that 1) at the smallest wave numbers (largest scales), the energy is transferred mainly on the same mirror mode as it is injected, but also that 2) when going to increasing wave numbers, other modes appear successively, Hall-MHD modes first, ion cyclotron waves afterward. At scales smaller than 100 km, which are not presently accessible, the cascade certainly goes on and is very likely to imply other (electron) modes. There is no theory available, up to now, to model such a non linear cascade, neither a fortiori to extrapolate it towards the short scales where it is expected to lead to reconnection. Nevertheless, we will discuss the constraints brought by these results for future theoretical modelling. The possibility of joining the kinetic nature of the mode, at least at the injection scale, and the fluid-like behaviour of the non linear cascade will be discussed, and the interest of some mixed "fluid-kinetic" plasma descriptions, which are presently developed, will be presented.

References

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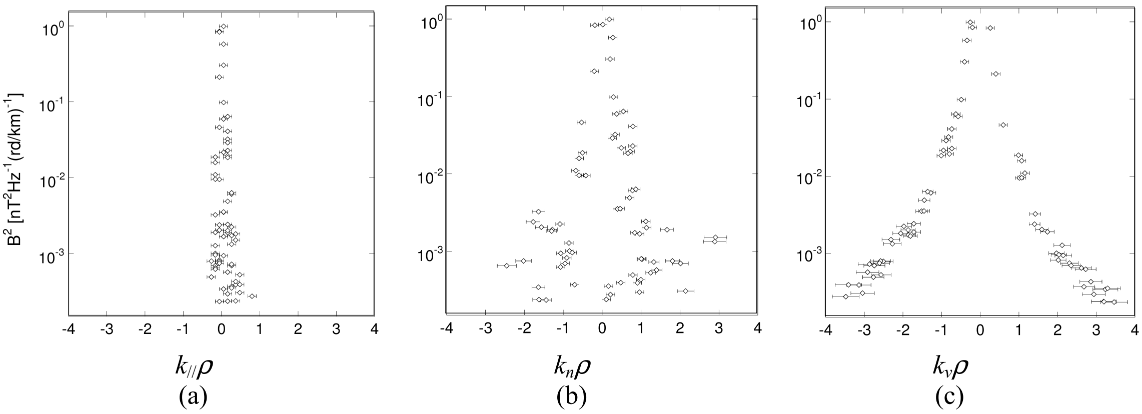

The k-spectra along three different directions: (a) static magnetic field; (b) magnetopause normal; (c) flow