Comment on “Evidence of a Cascade and Dissipation of Solar-Wind Turbulence at the Electron Gyroscale”

O. Alexandrova, S. D Bale, C. Lacombe

Comment on "Evidence of a Cascade and Dissipation of Solar-Wind Turbulence at the Electron Gyroscale"

In this journal, Sahraoui *et al.* [1]. (hereafter S09) report measurements of the electron "dissipation" range of magnetohydrodynamic turbulence in the solar wind by showing a clear break in the magnetic spectrum at 35 Hz, close to the electron scales.

In this Comment we show that the data used by S09 are contaminated by electron beams due to the location of the spacecraft in the terrestrial electron foreshock region. For the time interval analysed by S09, the enhanced field-aligned electron flux is visible in Fig. 1(a) around 100 eV. These electron beams can be unstable to Langmuir waves, 'beam modes' [2], and whistler waves [3]. Figure 1(b) shows the clear signature of a beam mode around and below the plasma frequency, visible in the range 10–20 kHz. In Fig. 1(c) we calculate the depth D (in Earth radii R_E) of the magnetic connection to the bow shock of the spacecraft for a paraboloidal model of the shock [4] with a nose at $14.6R_E$: for $D < 0$, the spacecraft is in the free solar wind; for $D > 0$, the spacecraft is in the foreshock. One concludes that Cluster is most of the time within the foreshock region, with small time intervals in the free solar wind.

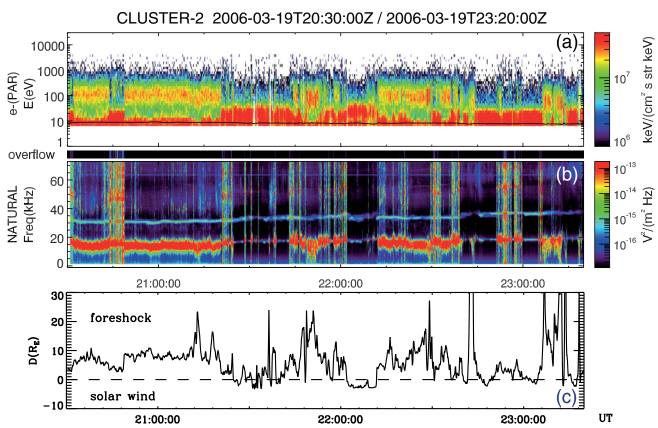

FIG. 1 (color online). The time period studied in S09: (a) spectrogram of field-aligned electron energy; (b) electric noise spectrogram. The enhancements of suprathermal electron flux and the wave energy near 20 kHz are signatures of the foreshock. (c) The depth of the magnetic connection of Cluster.

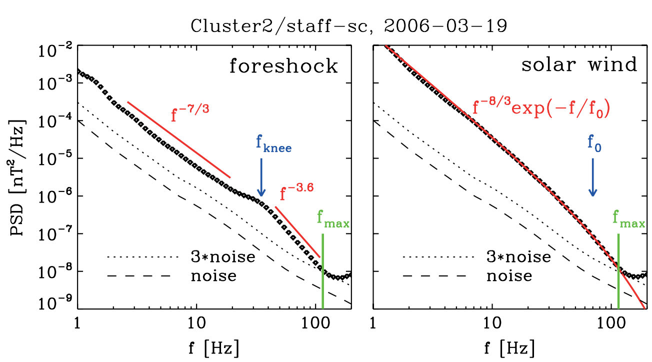

FIG. 2 (color online). Foreshock (left) and solar wind (right) spectra measured by STAFF-SC in burst mode (black diamonds). The spectra are physically significant at $f < f_{max} = 115$ Hz.

Sahraoui and Goldstein [5] recognize that electrons reflected from the bow shock were indeed observed during the interval of S09. But Ref. [5] is not widely distributed, so that the spectra of S09 are always quoted in the literature as free solar wind spectra.

Figure 2 shows wavelet spectra of magnetic fluctuations measured by STAFF-SC in burst mode in the foreshock (left) and in the solar wind (right), for 2.4 min subintervals, starting at $t_i = 21{:}00$ and 22:05 UT, respectively. These spectra are dissimilar in some important respects. While in the foreshock the spectrum follows $\sim f^{-7/3}$ at $f < 20$ Hz and has a knee around 35 Hz, the solar wind spectrum is steeper at $f < 20$ Hz and at higher frequencies has a curvature. The solar wind spectrum can be fitted with $\sim f^{-8/3}\exp(-f/f_0)$ as proposed by Alexandrova *et al.* [6] on the basis of the analysis of more than 100 intervals in the free solar wind.

We conclude that the spectrum from the subinterval in the foreshock is not representative of the spectrum from the subinterval in the free solar wind.

Note as well that the electric power spectrum (see Fig. 4 in S09) is subject to digitization noise above a few Hz, and so should be interpreted cautiously.

O. Alexandrova,[1,*] S. D. Bale,[2] and C. Lacombe[1]
[1]LESIA
Observatoire de Paris
92190 Meudon, France
[2]Space Sciences Laboratory and Physics Department
University of California
Berkeley, California 94720, USA

Received 17 October 2012; published 2 October 2013
DOI: 10.1103/PhysRevLett.111.149001
PACS numbers: 96.60.Vg, 52.35.Ra, 94.05.Lk, 95.30.Qd

*Corresponding author.
olga.alexandrova@obspm.fr

[1] F. Sahraoui, M. L. Goldstein, P. Robert, and Y. V. Khotyaintsev, Phys. Rev. Lett. **102**, 231102 (2009).
[2] C. Lacombe, A. Mangeney, C. C. Harvey, and J. Scudder, J. Geophys. Res. **90**, 73 (1985).
[3] Y. Zhang, H. Matsumoto, and H. Kojima, J. Geophys. Res. **103**, 20 529 (1998).
[4] P. C. Filbert and P. J. Kellogg, J. Geophys. Res. **84**, 1369 (1979).
[5] F. Sahraoui and M. L. Goldstein, AIP Conf. Proc. **1320**, 160 (2011).
[6] O. Alexandrova, C. Lacombe, A. Mangeney, R. Grappin, and M. Maksimovic, Astrophys. J. **760**, 121 (2012).

