Notes on EGU Poster EGU-2007-A-03106, XY0821, Propagation of Electrostatic Solitary Waves in the Magnetosheath: Multispacecraft Observations and Simulations, by Pickett, Christopher, Ghosh, Lakhina, Winningham, Lavraud, Lucek, and Gurnett

Figure 2A, panel a: Please point out the difference between the usual (smooth with no kinks or breaks in pulse) bipolar pulses (the last two) and the offset bipolar pulse at the start, which has an interruption between the oppositely-directed, half-sinusoidal pulses. Tsurutani et al. (GRL, Vol. 25, p. 4117, 1998) interpreted the offset bipolar pulse as a broadened electron hole, perhaps due to dispersion effects. Also note that the initial polarity (negative) of all pulses is the same, whereas we often see pulses with both polarities in any one snapshot of data taken in the magnetosheath, implying that the ESWs are traveling in different directions, or that there is a mixture of positive and negative potentials. IMPORTANT: Our instrument is not capable of determining the polarity of the structures, so a negatively directed initial pulse is not indicative of a negative potential structure.

Figure 2A, panel b: Yes, the main thing I want to get across here using a wavelet transform is that the ESWs are localized in time and frequency and are nonstationary and nonlinear. Therefore, traditional methods of converting such data to the frequency domain via a Fast Fourier Transform will lead to a false impression that the ESW structures are broadband electrostatic noise composed of many intermixed frequencies, as opposed to coherent, nonlinear structures.

Figure 2B, panel A: Shows the amplitude of both the bipolar and the tripolar ESW to be no greater than about 1 mV/m, with the low end down around 0.04 mV/m, which is close to the noise threshold of the instrument. Note that the magnetic field (red line) is very turbulent, typical of the magnetosheath.

Figure 2B, panel B: Shows the time duration of the pulses. The apparent cutoff at 1 ms is artificial and forced by us because the filters in our instrument distort pulses that are longer than 1 ms. We have found, through bench testing, that input bipolar pulses longer than 1 ms get distorted to look like tripolar pulses. Conversely, input tripolar pulses longer than 1 ms get distorted to look like bipolar pulses. Rather than explain all this, we simply discard any pulses that are found which are greater than 1 ms in time, but everyone needs to be aware that longer pulses are observed, although less abundantly in the magnetosheath than in some other regions. The apparent lower cutoff around 25 ms for most of the plot is also a filter effect; in this case the bandwidth of the 9.5 kHz that is employed here does not have enough resolution to resolve pulses shorter than about 0.25 ms. Please note that at the very start in this panel (first 2 or 3 minutes) you see pulses with time durations down to 0.04 ms, but not higher than 0.2 ms. That is because we started out with a broader filter, 77 kHz, which allows us to see pulses of time durations down to about 0.01 ms, but on the high end, we get filter distortions above 0.25 ms, so those pulses are removed from the plot. It is clear in this case that, since we switched from the 77 kHz to the 9.5 kHz filter, if we were able to operate both filters simultaneously (which we cannot), we would see pulses ranging from about 0.01 to 1 ms throughout the magnetosheath. I think I may have sent you a plot showing statistics of time duration vs. amplitude for several magnetosheath intervals where the 77 kHz filter was used for some and the 9 .5 kHz filter for others. Here we clearly see that the time durations run fairly smoothly across the entire interval of about 0.02 to 1 ms.

Figure 3A: This one I have explained quite well in the text of the 3B panel. The main result is that we see propagation of two bipolar solitary waves from Cluster spacecraft 4 to spacecraft 3 along the magnetic field. The resulting delay between detection at one spacecraft from detection at the next gives us a delay time. Knowing the separation distance along the field line on which the ESWs are believed to be propagating, we obtain the velocity of the ESWs as 1,334 km/s and they are traveling away from Earth (i.e., in the direction opposite to the magnetopause). Knowing the velocity and duration of the pulse, we can calculate the size of the structure along the field (0.8km) and the perpendicular size is at least as large as the cross separation distance of 40 km. Thus the structures are pancake shaped or flat.

Figures 4A, 4B and 4C: I don't want to say much about these data since they are not mine. I would only say that these data are used for the model inputs. The data come from the Cluster CIS ion instrument in the case of Figure 4A, and from the Cluster PEACE electron instrument in the case of Figures 4B and 4C. Also, particularly point out the last note in the side panel for Figure 4A with regard to not knowing the density and temperature of the He++ in the magnetosheath. We need to poll the community to see if anyone can come up with a reasonable value for this since measurements in the magnetosheath are usually dominated by the intense H+, leading to saturation of most ion detectors that resolve mass. As for the electron data in Figure 4B, point out the counterstreaming electrons, which could possibly lead to generation of BGK mode ESWs through a two-stream instability, but can be equally invoked in an electron acoustic mode instability. It is usual to see these counterstreaming electrons, which dominate over the perpendicular ones, in the magnetosheath.