Supplemental Material to the article
"Electric current structures with a shear magnetic field in space plasma"

Table 1. Structural features observed in the Current Sheets (CSs) under the presence of shear magnetic field

Structural features of the CSs under the presence of magnetic shear field	The Earth's magnetotail	The Solar Wind
The increase in CS thickness and the decrease of electric current density.	It is observed.	It is observed.
A shift of the maximum of electric current density (current density asymmetry) from the neutral plane of the CS.	It is observed.	It is observed.
A shift of the maximum of plasma density in the opposite direction from the neutral plane of the CS.	It is observed.	It is observed.

Table 2. The directions of quasi-adiabatic ion injections from the CS and the electric currents J_X, observed at the edges of the CS under the presence of magnetic shear (B_Y), for four possible magnetic configurations of the CS [20]

Magnetic configuration of the CS	The direction of quasi-adiabatic particle injection excess	The direction of a shift of the maximum of electric current density	The direction of electric current J_X	
			In the southern PS	In the northern PS
1. $B_Z > 0$, $B_Y > 0$	To the northern part of the PS	To the southern part of the PS	$J_X < 0$	$J_X > 0$
2. $B_Z > 0$, $B_Y < 0$	To the southern part of the PS	To the northern part of the PS	$J_X > 0$	$J_X < 0$
3. $B_Z < 0$, $B_Y > 0$	To the southern part of the PS	To the northern part of the PS	$J_X < 0$	$J_X > 0$
4. $B_Z < 0$, $B_Y < 0$	To the northern part of the PS	To the southern part of the PS	$J_X > 0$	$J_X < 0$

Model of the quasi-adiabatic ion interaction with the CS under the presence of magnetic shear

Numerical simulation of the CS under the presence of magnetic shear was carried out by tracing macroparticles in the prescribed magnetic and electric fields, with a subsequent step of making the currents $J_Y(Z)$, $J_X(Z)$ and magnetic fields $B_X(Z)$ and $B_Y(Z)$ self-consistent [37, 38]. A shear magnetic field component $B_Y(Z)$ was considered to be the sum of a self-consistent part $B_Y^S(Z)$ and the external constant magnetic field $B_Y^E(Z)$: $B_Y(Z) = B_Y^E(Z) + B_Y^S(Z)$. Above and below the CS region $\{|z|L\}$ (where L is the CS thickness) the magnetic field is constant (i.e., it does not depend on the spatial coordinates and time): $\mathbf{B}|_{Z\geq L} = B_X(L)\mathbf{e_X} + B_Y^E\mathbf{e_Y} + B_Z\mathbf{e_Z}$, $\mathbf{B}|_{Z\leq L} = B_X(-L)\mathbf{e_X} + B_Y^E\mathbf{e_Y} + B_Z\mathbf{e_Z}$, where $B_X(L) = 20\,\mathrm{nT}$ and $B_X(-L) = -20\,\mathrm{nT}$ are the values of the magnetic field at the edges of the CS.

The distribution function $f_0(z, \mathbf{v}, n_{(\pm)}, T_0, V_D)$ was taken as a shifted Maxwellian distribution on the CS boundary and was implemented by the generation of $N_g = 3 \cdot 2^{17}$ macroparticles with 16 energy levels. In the course of simulation, the concentration $n(Z)$, the components of the proton current $J(Z)$ and the self-consistent components of the magnetic field $B_X(Z)$, $B_Y(Z)$ were computed. The input parameters were selected as follows: the temperature $T_0 = 4\,\mathrm{keV}$, which gives the value of thermal proton velocity $V_T = \sqrt{eT_0/m_p} \approx 619\,\mathrm{km/s}$, the bulk velocity of protons $V_D = 2 \cdot V_T$, the value of variation of the tangential component of the magnetic field across the CS: $\Delta B_X = B_X(L) - B_X(-L) = 40\,\mathrm{nT}$, and the normal component to the CS plane $B_Z = \Delta B_X/20 = 2\,\mathrm{nT}$.

Modelling results can be subdivided into three main groups, in which the shear magnetic field component $B_Y(Z)$:

1) is absent; 2) is fully self-consistent and has the symmetrical spatial distribution with respect to the Z-coordinate;

3) has two parts: $B_Y(Z) = B_Y^E(Z) + B_Y^S(Z)$, one of which, $B_Y^S(Z)$, is self-consistently maintained by the electric current $J_X(Z)$ (which corresponds to the symmetric mode), and the other, $B_Y^E(Z) = \mathrm{const}$, is the external field caused by the global effect of interplanetary magnetic field penetration into the magnetotail. The case with a zero shear component $B_Y(Z) = 0$ is a basic CS configuration in which $J_X(Z) = 0$ and the tangent magnetic field is an odd function $B_X(Z) = -BX(-Z)$ [9, 37]