MAGNETIC RECONNECTION AS A POSSIBLE CAUSE OF IN-ECLIPTIC IMF ZERO VANISH ON THE WAY FROM THE SUN TO THE EARTH

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If we look at the distributions of Bx and By - horizontal components of interplanetary magnetic field (IMF) at the Earth orbit, we can see striking hole in the area near zero. There are two peaks of By and Bx distributions: one negative and one positive, while the Bz component is distributed around zero.

For many years this fact has been simply explained by geometrical considerations. It has been supposed that sector structure of IMF leads to observation of predominant negative or positive horizontal IMF component sign, first of all, because heliospheric current sheet (where zero magnetic line always exists) is enough thin and it passes the Earth very fast in comparison with the positive or negative sector stay time. The next explanation was the high inclination of the heliospheric current sheet, which is often considered to be perpendicular to the ecliptic plane.

These explanations seemed so obvious that the problem even had not been discussed in the literature so long as V.Obridko in 2006 pointed out at the fact of significant mismatching of horizontal IMF components distribution near the Earth and distribution of magnetic field at the Sun (for the projection of the Earth to the solar wind source surface).

Solar magnetometers allow measure radial component of magnetic field at the Sun with the accuracy and time resolution enough for comparison with near-Earth IMF spacecraft data. The radial solar magnetic field in the interplanetary space should decrease as $r^{-2}$ for a quiet flowing out stream. Modern successful calculations of in-ecliptic IMF at the Earth orbit are mainly based on this law, but calculated horizontal field values are permanently lower than measured ones. Moreover, distribution of radial solar magnetic field is fundamentally different from spacecraft measured in-ecliptic magnetic field distribution: there is no double-humped distribution of field at the Sun; it is usual Gauss-like one.
It was shown these variances can not be explained by "technical" causes, and it is necessary to seek for physical nature of these differences. There are evidences that near-Earth “zero” is lost even at the heliospheric current sheet. Shortfall of IMF zero values could be explained by unceasing magnetic reconnection at the heliospheric current sheet (sector boundary) as well as at current sheets often associating with the streamer belt.

As a result the main zero-line gets thinner and thinner on the way from Sun to the Earth, and the heliospheric current sheet becomes wider, looks like a sandwich, full of reconnection’s products. Simulation results and experimental proofs of reconnection at the heliospheric current sheets and at small-scale current sheets in space plasma are given.