Geophysical Research Abstracts
Vol. 20, EGU2018-9213, 2018
EGU General Assembly 2018

Investigation of interplanetary shock front structure with plasma spectrometer BMSW onboard the SPEKTR-R

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During more than six years of BMSW plasma spectrometer operation onboard the SPEKTR-R satellite almost 60 interplanetary (IP) shocks were detected. Achieved high time resolution $\sim$ 0.031 s for the solar wind plasma parameters allowed to investigate close vicinity of ramp region where the energy is transform and redistributing. Analysis of IP shock fronts revealed that ion ramp scale is about 0.5-4 of ion inertial length. The ramp thickness decreases with the shock normal angles increases.

It was shown existence of a large amplitude waves both in the solar wind plasma and magnetic field near the ramp of low-Mach number (M$\leq$3), low-beta ($\beta\leq$1), quasi-perpendicular IP shocks. These waves are frequently observed both upstream and downstream the ramp. Observed upstream waves have clear evidence of magnetosonic-whistler precursor fluctuations with frequencies $\sim$0.6–10 Hz.

A sequence of six upstream whistler wave trains was recorded both in ion flux and magnetic field in the case of low-Mach, low-beta oblique IP shock observed on April 19, 2014. The probable mechanism of their formation is associated with the development of the instability caused by ions reflected from the ramp.