4th URSI AT-RASC, Gran Canaria, 19-24 May 2024

Source of waves observed around interplanetary shocks

Zdenek Nemecek[(1)], Oleksandr Goncharov[(1)], Jana Safrankova[(1)], Andrey Koval[(2)]

(1) Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic; e-mail: zdenek.nemecek@mff.cuni.cz
(2) NASA Goddard Space Flight Center, Greenbelt, Maryland, USA

Observational and theoretical studies as well as simulations have shown that interplanetary (IP) shocks are associated with different types of waves that can be observed in their upstream and downstream regions. The nature of upstream and/or downstream wave packets depends upon the shock strength and geometry expressed by the Mach number, and the angle between the shock normal and the upstream magnetic field. Low-Mach number weak shocks are the result of a balance between the nonlinear steepening and either dissipation due to some anomalous processes or wave dispersion. High-frequency (several Hz) wave packets in the upstream region of quasi-perpendicular shocks are observed in fast magnetic field data and provide a strong evidence that these shocks have magnetosonic whistler precursors with frequencies up to 7 Hz. On the other hand, low-frequency waves (below 1 Hz) are more frequently registered in the downstream region behind the shock.

Our analysis of the low-Mach number and low-beta nearly perpendicular IP shocks reveals a large number of shocks with similar upstream and downstream wave frequencies in the spacecraft frame. The waves propagate along the magnetic field in the upstream region whereas perpendicular propagation is preferred downstream. A deeper analysis shows that upstream and downstream frequencies are identical in the shock frame of reference. Such observations are consistent with the oscillations generated at the shock and launching waves that propagate simultaneously into upstream and downstream regions as Alfven or magnetosonic waves, respectively. The frequency of the waves in the shock frame suggests the protons gyrating at the shock overshoot as a possible source of the observed waves.