Effect of whistler precursor waves on energy dissipation in supercritical quasi-perpendicular collisionless shocks.

Ahmad Lalti$^{1,2}$, Yuri Khotyaintsev$^1$, Daniel Graham$^1$, Andris Vaivads$^3$, Andreas Johlander$^4$, Roy Torbert$^5$, Barbara Giles$^6$, Chris Russell$^7$, and Jim Burch$^8$

$^1$Swedish Institute of Space Physics, Uppsala, Sweden  
$^2$Department of Physics and Astronomy, Uppsala University, Uppsala, Sweden  
$^3$Space and Plasma Physics, School of Electrical Engineering and Computer Science, KTH Royal Institute of Technology, Stockholm, Sweden  
$^4$Department of Physics, University of Helsinki, Helsinki, Finland  
$^5$University of New Hampshire, Durham, USA  
$^6$NASA Goddard Space Flight Center, Greenbelt, USA  
$^7$University of California, Los Angeles, USA  
$^8$Southwest Research Institute, San Antonio, USA

The process of transforming the bulk kinetic energy of solar wind into the random motion of the plasma particles is still an open question. One of the proposed mechanisms for energy dissipation in such shocks is wave-particle interactions. Specifically reflected ions at the foot of the shock could interact with the solar wind plasma in an unstable way causing an increase in the temperature of the upstream plasma. Phase standing Whistler precursor waves upstream of the shock front could play a major role in enhancing energy dissipation. We analyze multiple shock crossing events encountered by the Magnetospheric Multiscale (MMS) multi-spacecraft Mission, with Alfvénic Mach numbers around 4 and a $\theta_B$ around 80 degrees. We use these events to study the effect of such waves on energy dissipation at quasi perpendicular shocks. Using spectral analysis and by calculating the poynting flux of the waves, we investigate the upstream shock energy transport by whistler waves, then we discuss the consequences of these results on the wave particle interaction as a mechanism for stabilizing such high Mach number shocks.