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Fast damping of Alfven waves: Observations and modeling

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Results of analysis of Cluster spacecraft data will be presented that show that intense ultra-low frequency (ULF) waves in the inner magnetosphere can be excited by the impact of interplanetary shocks and solar wind dynamic pressure variations. The observations reveal that such waves can be damped away rapidly in a few tens of minutes. We examine mechanisms of ULF wave damping for two interplanetary shocks observed by Cluster on 7 November 2004, and 30 August 2001. The mechanisms considered are ionospheric joule heating, Landau damping, and waveguide energy propagation. It is shown that Landau damping provides the dominant ULF wave damping for the shock events of interest. It is further demonstrated that damping is caused by drift-bounce resonance with ions in the energy range of a few keV. Landau damping is shown to be more effective in the plasmasphere boundary layer due to the relatively higher proportion of Landau resonant ions that exist in that region. Moreover, multiple energy dispersion signatures of ions were found in the parallel and anti-parallel direction to the magnetic field immediately after the interplanetary shock impact in the November 2004 event. These dispersion signatures can be explained by flux modulations of local ions (rather than the ions from the Earth's ionosphere) by ULF waves. Test particle simulations will be used to simulate the energy dispersions of particles caused by ULF waves. In our study, particles will be traced backward in time until they reach a region with known distribution function. Liouville's theorem is then used to reconstruct the distribution function at the location of Cluster in a model magnetosphere.

Primary author: WANG, Chengrui (University of Alberta)

Co-authors: SYDORENKO, Dmytro (University of Alberta); ZONG, Qiugang (Peking University); RANKIN, Robert (University of Alberta)

Presenter: WANG, Chengrui (University of Alberta)

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