Non-stationary shock structure due to upstream waves observed by Cluster-II

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As widely known, there are varieties of interacting wave modes, energetic particles in the foreshock region. These waves and particles play an important role in dissipation processes. Several waves are generated by the backstreaming ions. As these upstream waves are convected toward the shock by solar wind and gradually steepened and eventually become the new shock front. The shock front exhibits cyclic behavior from the results of one dimensional (1-D) hybrid simulations with a quasi-parallel high Mach number shock. The shock transition was viewed as being composed of a patchwork of magnetic field enhancements at the quasi-parallel shock geometry. These shock reformation behaviors are indicated by many simulation studies, but there is no observational support for the cyclic behavior. One of reasons is the fact that it is difficult for single spacecraft to unambiguously identify the non-stationarity of shock front, since single spacecraft observations are not able to distinguish spatial change from temporal change. We found a non-stationary shock structure at oblique shock observed by Cluster. Alfven Mach number is 5.5 and shock angle between upstream magnetic field and shock normal is ˜50 degrees. Inter-spacecraft separation distance is several thousands km. FABs and ULF waves are seen in the upstream shock. The precursor pulsation structure has obviously grown with time. Cluster observation indicates that the shock reforms periodically. We will show the shock structure and electron dynamics of less oblique shocks using multipoint measurements Cluster.