Results from the Cluster Wideband Plasma Wave Investigation

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A review of results from the Cluster wideband plasma wave investigation is given after approximately two years of inflight operation. The primary objective of this investigation is to provide very high resolution comparisons of the waveform of magnetospheric radio and plasma emissions over baselines ranging from several hundred to a few thousand kilometers. Topics that have been studied include: whistlers, whistler-mode chorus emissions, auroral kilometric radiation, auroral hiss and electrostatic soliton-like structures. Numerous whistlers have been observed in the inner region of the magnetosphere. For baseline separations less than about one thousand km, usually the same whistler is observed by all four spacecraft with only small differences in the frequency-time spectrums. For larger separation distances the spectrums are often much different due to the different propagation paths to the spacecraft. In contrast, for whistler-mode chorus emissions it is usually quite difficult to identify the same chorus elements at two or more spacecraft. In cases where the same chorus elements can be identified the separation distances are usually small, less than 500 km and nearly along the same magnetic field line. In one case where the same chorus elements were detected by two spacecraft near the magnetic equator, a substantial frequency shift was observed, approximately 500 Hz. This frequency shift could possibly indicate that the frequency of the emission was evolving as the chorus wave packet propagated between the two spacecraft. Other possible explanations, such as Doppler shifts, are also being considered. By using the microsecond timing accuracy available from the NASA deep space receiving stations, for the first time we have been able to use multi-spacecraft long baseline interferometry techniques to determine the source location of auroral kilometric radiation (AKR). In one case where simultaneous ultraviolet auroral images were available from the Polar spacecraft (courtesy of G. Parks), we have been able to show that the AKR source lies on the same magnetic field line as a bright feature in the aurora. The upper cutoff frequency of auroral hiss has also been used to make very high time resolution measurements of the electron density in the auroral region and polar cap. These electron density measurements often show large differences over the typically several hundred kilometer separation distances between the spacecraft. Electrostatic soliton-like structures are also frequently observed in the magnetosheath, polar-cusp, plasma sheet, and other regions of the magnetosphere. Although the individual elements of these structures are usually not observed by more than one spacecraft, the very high time resolution of the Cluster wideband instruments show that these structures occur down to very small time scales, sometimes only a few tens of microseconds.