

Furthering our understanding of Electrostatic Solitary Waves through Cluster multi-spacecraft observations and theory

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Nonlinear isolated Electrostatic Solitary Waves (ESWs) are observed routinely at many of Earth's major boundaries by the Wideband Data (WBD) plasma wave receivers that are mounted on the four Cluster satellites. We show that, for the most part, the amplitudes of these ESWs exhibit a general trend to increase with increasing background magnetic field strength which is consistent with potential structures known as BGK (Bernstein-Greene-Kruskal) mode phase space holes generated out of beam instabilities. However, we also show through simulation results that in the magnetosheath it is possible to generate ESWs, which represent density enhancements, out of the electron acoustic instability. Highlighting the Earth's Bow Shock, we discuss the differences in the characteristics of the ESWs that are detected in the shock transition region under differing upstream conditions. Finally, we present our findings with regard to two types of ESW propagation studies that take full advantage of the multi-spacecraft nature of Cluster. First, we present analysis of Cluster WBD data with respect to evidence of propagation of ESWs from one spacecraft to another through a series of isolated ESWs seen on one spacecraft that are observed almost identically on another in terms of the ESW pulse duration, amplitude and spacing intervals. Second, we use Cluster WBD observations of a type of emission called striated Auroral Kilometric Radiation (AKR) as a remote tracer of ESWs which propagate upward in the auroral acceleration region and perturb the velocity distribution associated with the cyclotron maser instability, out of which AKR is believed to be generated. Both types of studies provide information about ESWs, such as stability over large propagation distances, which would generally not be possible through single spacecraft measurements.