Analysis of Whistler Mode Sidebands of Magnetospheric Triggered Emissions

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Very low frequency (VLF) magnetospheric wave injection experiments performed at Siple Station, Antarctica and the High Frequency Active Auroral Research Program (HAARP) in Gakona, Alaska show that magnetospherically amplified waves are often accompanied by bandwidth spreading and also discrete sidebands resulting from the nonlinear interactions with energetic electrons. Analysis of the sidebands provides access to several key parameters of the nonlinear interaction. While the amplitude of sidebands from the Siple Station experiment have been previously analyzed, the relative phase of the sidebands has received very little attention due in part to the high cost of digital spectral analysis in the 1970s and 1980s. Using recently digitized data from the Siple Station experiment, we analyze the sidebands of signals injected in Antarctica and received at the magnetic conjugate point in Lake Mistissini, Canada after ducted propagation and amplification. The data were originally recorded on magnetic tape in 1986. The sidebands are analyzed to determine the type of modulation with which they are generated. Some past work has suggested that the sidebands result from amplitude modulation that occurs during the saturation and associated amplitude oscillation of the main emission. At the same time, certain theories have suggested that sidebands should be generated by phase modulation of the nonlinear cyclotron current. It is shown that certain sideband events exhibit phase modulation of the main carrier. The results are interpreted in terms of theoretical formulations of a phase-space hole resulting from electron phase trapping in an inhomogeneous magnetized plasma. Under these formulations, the modulation results from oscillation of phase trapped electrons about the stable phase point.