Studies of Langmuir Turbulence in HAARP Experiments

J. P. Sheerin*[(1)], B. J. Watkins [(2)], W. A. Bristow[(2)] S. I. Oyama[(3)]
C. J. Heinselman[(4)], and K. M. Groves[(5)]
(1) Eastern Michigan Univ, Ypsilanti, MI USA
(2) Geophysical Institute, U. Alaska-Fairbanks, Fairbanks, AK USA
(3) STE Lab, Nagoya U., Nagoya, Japan
(4) SRI, 333 Ravenswood Ave., Menlo Park, CA USA
(5) AFRL, Hanscom AFB, MA USA

High power HF transmitters induce a number of plasma instabilities in the interaction region of overdense ionospheric plasma. HF radars such as SuperDARN Kodiak station have been used to study artificial field-aligned irregularities (AFAI) created by the high power HF radiowave at the HAARP Ionospheric Observatory, Gakona, AK. The SuperDARN radar can also be used to record upper hybrid wave spectra. HF receivers can monitor the development of spectra of stimulated electromagnetic emissions (SEE). A new Modular UHF Ionospheric Radar (MUIR) sited at HAARP, may now be used to monitor changes in the Langmuir plasma waves detected in the UHF backscatter. We report the results from recent campaigns using these new facilities in coordinated and comprehensive studies of strong Langmuir turbulence (SLT) and AFAI. Among the effects observed and studied are: SLT spectra including cascade, collapse, the outshifted plasma line or free-mode, appearance of a short timescale ponderomotive overshoot effect, temporal evolution of SLT, dependence of SLT on growth or suppression of AFAI, dependence of AFAI and MUIR backscatter on HAARP pulselength, duty-cycle, and aspect angle. In particular, we explore the aspect angle effect of increased turbulence with the HF wave directed at small angles to the field line. Langmuir modes parallel to the geomagnetic field are proposed to explain other features in stimulated electromagnetic emissions (SEE). Evidence of suprathermal electrons is evaluated. These plasma waves are theorized to play a key role in certain features of radio-induced aurora. Experimental results are compared to previous high latitude experiments and predictions from recent modeling efforts.