

DPP08-2008-000153

Abstract for an Invited Paper
for the DPP08 Meeting of
the American Physical Society

Using Space as a Nonlinear Plasma Laboratory¹

KONSTANTINOS PAPADOPOULOS, University of Maryland

Ionospheric heaters have been an important tool of plasma physics investigations. The extent that non-linear plasma phenomena can be triggered and observed depends critically on the heater power, its Effective Radiative Power (ERP) and its scanning capability. Increasing these parameters allows us to reach thresholds associated with effects that were not previously observed. The latest entry to ionospheric heating, the HF transmitter associated with the High Frequency Active Ionospheric Research Program (HAARP) was completed in June 2007. The transmitter consists of 180 antenna elements spanning 30.6 acres and can radiate 3.6 MW of HF power (a factor of almost 4 higher than any previous heater) in the 2.8-10.0 MHz range. With increasing frequency the beam-width varies from 15-5 degrees, corresponding to 20-30 dB gain and resulting in ERP between 1-5 GW. The antenna can point to any direction in a cone 30 degrees from the vertical, with reposition time of 15 microseconds resulting in superluminal scanning speeds. The transmitter can synthesize essentially any waveform and transmit any polarization. These capabilities far exceed those of any previous heater and allow for new frontier research in non-linear plasma physics. The presentation will focus first on the relationship of the new capabilities of the facility with thresholds of physical processes that had not been achieved previously. It will then present new spectacular results that have been achieved during the last year. They include whistler injection and amplification, injection of shear and magnetosonic waves in the magnetosphere, Langmuir turbulence, upper hybrid waves and thermal instabilities, electron acceleration, optical emissions and formation of artificial ducts for whistler propagation. The presentation will also discuss future experiments made possible for the first time by the new transmitter capabilities, large bandwidth and high ERP.

¹Work supported by ONR MURI Grant N000140710789 and by NAVY.N0017302C60.