

PHYSICS NUANCES CONTROLLING IONOSPHERIC GENERATION OF ELF/VLF WAVES

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Generation of ELF/VLF waves by modulating ionospheric currents, such as the auroral electrojet, has been accomplished using a number of ionospheric heating facilities. The observations have generated several physics puzzles¹ predominantly due to the non-linear physics involved in the interaction of modulated HF power with the ionospheric plasma. Critical among the various outstanding issues are:

Scaling of the HF to ELF/VLF conversion efficiency as a function of the HF frequency and ionospheric parameters The extent and cause of harmonic generation Near vs. far field propagation

This paper will present experimental results obtained recently by the HAARP ionospheric heater that focus on the non-linear physics. The experiments were conducted at the HAARP facility during the summer of 2005. The North-South and East-West components of the ionospheric magnetic field were recorded at a site 12 km away from the heater with EMI BF-6 magnetic sensors. The sensor output was digitized at 24 bit resolution with 96 kHz sampling frequency. GPS time code output simultaneously digitized was used for time reference. Temporally resolved waveforms of the magnetic signatures observed on the ground obtained with resolution of better than 10⁻⁶ sec will be presented and compared to theoretical models. The observations revealed several critical physics aspects of the ionospheric ELF/VLF generation, including the limits of HF to ELF/VLF conversion efficiency, bandwidth limitations and signal purity. The relevance of the results to the conduct of future experiments using the upgraded HAARP heater will be addressed.

1. K. Papadopoulos, et al., On the Efficiency of ELF/VLF Generation Using HF Heating of the Auroral Electrojet, Plasma Physics Reports, Vol. 29, No. 7, pp 561-565, 2003.

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: papadopoulos8167

Date Received: September 24, 2004

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2. G - Ionospheric Radio and Propagation

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4. P, Program chair: Mike Sulzer and Paul Bernhardt

5. To precede paper papadopoulos7761.