THE IONOSPHERE AS AN OPEN PLASMA LABORATORY, NEW CAPABILITIES

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Ionospheric heaters supplemented by ground and space based diagnostic instruments, such as radars, optical cameras and photometers, HF/ELF/ULF receivers and magnetometers, radio beacons, riometers and ionosondes have for a long time being used to conduct plasma physics, geophysical and radio science investigations. The latest entry to ionospheric heating, the HF transmitter associated with the High Frequency Active Ionospheric Research Program (HAARP), was completed in February 2007. The transmitter consists of 180 antenna elements spanning 30.6 acres and can radiate 3.6 MW of HF power in the 2.8-10.0 MHz frequency range. With increasing frequency the beam-width varies from 15-5 degrees, corresponding to 20-30 dB gain and resulting in Effective Radiating Power (ERP) between .36 – 4.0 GW. The antenna can point to any direction in a cone of 30 degrees from the vertical, with a reposition time of 15 degrees in 15 microseconds resulting in super-luminous scanning speeds. The transmitter can synthesize essentially any desired waveform within the regulatory allowed bandwidth in linear and circular polarization. These capabilities far exceed those of previous ionospheric heaters and allow for new frontier research in plasma physics, geophysics and radio science. Following a brief discussion of the relationship of the new capabilities of the facility with thresholds of physical processes that could not be achieved previously, the presentation will discuss recent results in the areas of ULF/ELF/VLF generation and propagation and wave-particle interactions in the magnetosphere acquired with the completed facility. The presentation will conclude with a detailed discussion of possible frontier science experiments in the areas of Langmuir turbulence, parametric instabilities, electron acceleration, optical emissions and field aligned striations and duct generation, made possible for the first time by the new transmitter capabilities, large bandwidth and especially the high ERP that allows for the first time operation at power density levels that exceed the theoretically predicted thresholds.