Comparison between the time development of HF-enhanced Langmuir and ion-acoustic turbulence under O- and X-mode heating at EISCAT

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We report experimental results related to the detection of specific features and distinctions in the behavior of HF-enhanced Langmuir and ion-acoustic turbulence excited by O- and X-mode powerful HF radio waves. By comparing the O- and X-mode enhanced plasma and ion line spectra derived from “raw” EISCAT UHF radar data with 5 s resolution, we aimed to distinguish the O- and X-mode effects according to their evolution in time after the onset of HF pumping. We analyzed in detail and summarize the distinctive features of the O-and X-mode radar spectra with 5 s resolution from a large body of the EISCAT Russian heating experiments at different HF heater frequencies in the range from 4.5 to 8 MHz. The behavior of the EISCAT UHF radar spectra are compared with the growth time of FAIs from CUTLASS (Co-operative UK Twin Located Auroral Sounding System) measurements. We proposed to distinguish the O- and X-mode effects according to the behavior in time after the onset of HF pumping and specific features of the HF-enhanced plasma and ion line spectra. The radical difference between the X- and O-mode plasma and ion line spectra derived with 5 s resolution was found. Namely, under O-mode HF pumping the abrupt enhancements in the ion and plasma line power in spectra appeared from the “cold” start just immediately after the onset of HF heating and were seen in the first 5 s radar data dump. Thereafter Langmuir and ion-acoustic waves are normally quenched by fully generated artificial small-scale field-aligned irregularities (FAIs) preventing further generation of the PDI. However, under high effective radiated power the reappearance of enhanced ion and plasma lines can occur after overshoots. The X-mode ion and plasma lines developed with a time delay relative to the onset of HF heating. After appearance, their intensity gradually increased and reached a maximum within about 1 min or even longer. The potential mechanisms of the partial conversion of the transverse electric field of the X-mode pump wave into the parallel electric field are discussed.