Observation of high frequency emission from MST tokamak plasma in the presence of runaway electrons

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Abstract

First direct measurement of local magnetic fluctuations of high frequency emission in a runaway-dominated tokamak plasma with a magnetic probe inserted into the plasma $r/a \sim 0.8$ and digitized on a high-speed oscilloscope, 12.5 GHz. Emission is observed in several bands of frequencies that correspond to both low and high frequency Whistler bands of frequency, frequencies which would otherwise be hidden to probes outside the plasma. Whistler activities are excited by high energy runaway electrons at low plasma density. Magnetic emission occur in discrete frequency bands and in semi-periodic fashion. Emission bursts are correlated with burst of radial x-ray emission consistent with pitch-angle scattering of energetic electrons. Magnetic fluctuation power spectrum displays strong emission at multipole frequencies bands that scale with the mean magnetic field. Higher frequency modes ramp down with BT faster than the lower frequency modes, consistent with higher order harmonics. Runaway electrons are generated throughout the discharges at plasma density less than 0.02×10^{19} m^3, toroidal magnetic about 0.14 T, and plasma current in the range of 50-60 kA. Whistler mode have been observed when the toroidal magnetic field is as low as 900 gauss. High energy x-ray, few 100 keV, have been observed during the discharge break down stage. These high energy runaway electrons may be responsible for of the secondary runway electrons population that are present throughout low density discharge. Parallel and perpendiculars wave numbers have been measured as a function of frequency. Phase velocity of all Whistler modes range from 5.0 to 30.0 times the Alfven velocity, V_A. The polarization of different frequency modes have been measure with the polarization probe. Modes at frequency 37 MHz and the 3.2 GHz are elliptically polarized. A high frequency branch of the Whistler appears as well, it is a backward wave consistent with anomalous Doppler.