Excitation of a whistler mode wave packet by interacting, higher-frequency, electrostatic-wave eigenmodes

M. Koepke[1,2], N. Brenning[2], I. Axnäs[2], M. Raadu[2], E. Tennfors[2]

[1] *West Virginia University, Morgantown WV, USA*

[2] *Royal Institute of Technology, Stockholm, Sweden*

Infrequent, bursty, electromagnetic, whistler-mode wave packets, excited spontaneously in the laboratory by an electron beam from a hot cathode, appear transiently, each with a time duration around ~1 μs. The ensemble of wave-packet frequency f_W is broadly distributed in the range 7 MHz < f_W < 40 MHz. Wave-packet excitation takes place in the plasma volume which is filled with an ensemble of separate electrostatic (es) plasma oscillations, having frequency f_hf, 200 MHz < f_hf < 500 MHz, that are hypothesized to match eigenmode frequencies of an axially localized hf es field in a restricted subvolume attached to the cathode. Features of these es-eigenmodes that are studied include: the mode competition at times of transitions from one dominating es-eigenmode to the next, the amplitude and spectral distribution of simultaneous, independent es-eigenmodes that do not lead to a transition, and the correlation of these features with the excitation of whistler mode waves. It is concluded that transient coupling of es-eigenmode pairs having f_1,hf and f_2,hf, such that | f_1,hf - f_2,hf | = f_W < electron gyrofrequency, can explain both the transient lifetime and the frequency spectra of the whistler-mode wave packets (f_W) as observed in lab. The generalization of the results to bursty whistler-mode excitation in space from electron beams, created on the high potential side of double layers, is discussed. This research on radiation from an electron beam in magnetized plasma [1] strives to identify ways for a double layer in space to produce electromagnetic radiation that propagates over a long distance.

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1. N Brenning et al 2006 J. Geophys. Res. 111, A11212; 2017 Plasma Phys. Control. Fusion 59 124006.