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EBW harmonic generation in heating and current drive[1]

JOHN CARY, University of Colorado

Experiments on MST and NSTX are using or proposing to use electron Bernstein waves (EBWs) for heating and current drive, as these modes can couple into the overdense, high-beta plasmas via X-B or O-X-B mode conversions. This work shows that for modest power - typical of those planned for experiments - significant energy can be transferred from the fundamental mode to its harmonic. This arises because of the existence of a resonant point, where both the frequency and wave number match for the fundamental and its harmonic. This resonant point can occur where the harmonic has zero group velocity, hence it is weakly stabilized by propagation, and large power transfer occurs. The required pump power is much lower than the electron thermal energy. It is found that the amplitude of the second harmonic EBW excited can exceed that of the fundamental wave with the plasma and wave parameters used in the experiments. The system is investigated both analytically and through use of the VORPAL computing framework, with the latter via both via both the delta-f and full particle-in-cell (PIC) simulations, which confirm the analytical predictions. This second harmonic EBW generation can cause the wave power absorbed near the resonance layer at the half-harmonic frequencies and thus affect EBW power deposition significantly.

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