Non-monochromatic RF power injection to control lower hybrid parametric instabilities in tokamak plasmas

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In present day LHCD experiments, parametric instabilities must be controlled for the accessibility of the driver pump to the inner layers of a tokamak plasma [1]. Previous works already studied, theoretically [2] and experimentally [3], the parametric interaction of a non-monochromatic pump driver with plasmas in the lower hybrid range of frequencies. The purpose of such studies was to find experimental conditions useful to mitigate, or better suppress, the parametric instabilities. However, if we consider the technical feasibility of the pump modulation, no practical conclusions could be drawn since stabilization effects on parametric instabilities can be achieved only if the frequency bandwidth of the modulated driver pump is larger than the resonance width of the parametric instability. Unfortunately, this condition is seriously limited by the frequency bandwidth of available power sources. This work presents a new nonlinear parametric dispersion relation for an amplitude modulated pump driver. This equation is based on an accurate nonlinear kinetic model of lower hybrid wave propagation, useful to analyse the instabilities emerging in the outer layers of a tokamak plasma [4,5]. We first validate numerical solutions of the new parametric dispersion relation reproducing the experimental observations of lower hybrid amplitude modulated pump experiments [3]. Furthermore, by changing the driver pump coherence, we study how undesirable parametric effects can be significantly reduced in the SOL plasma for EAST and FTU tokamaks. As a breakthrough of this study, we find a new amplitude modulation scheme exploitable within the frequency bandwidth of microwave power sources available for lower hybrid experiments.

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