Effects on Ion Cyclotron Emission of the Wave-Particle Interactions in Toroidal Plasmas

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Emission of waves in the ion cyclotron range of frequencies has been observed in several tokamaks. In JET, cyclotron emission has been found to correlate with the fusion reactivity over six orders in magnitude [1], and explained by ion cyclotron instabilities driven by supra thermal particles. The spectra are characterised by narrow peaks corresponding to the fundamental or harmonic cyclotron frequencies of high-energy ions at the low field side edge. Due to the weak drive, at least at the low emission levels, only weakly damped eigenmodes can be excited. Weakly damped edge localised fast magnetosonic modes were proposed to excited by the supra thermal ions [2]. A puzzling fact with the cyclotron emission is the very narrow frequency peaks, since the energy distribution is expected to be inverted in a larger region allowing wider peaks. Since only magnetosonic waves with high toroidal mode number, too large to be consistent with the emission, can be localised in the outer midplane [3], the narrow localisation becomes even more puzzling. To explain the emission the theory of ion cyclotron emission in tokamak plasmas has been revised taking into account the poloidal extension of the eigenmode and including the effects of finite orbit width and RF-induced spatial transport in the wave-particle interactions in toroidal plasmas. The emission can then be explained by the finite parallel wave numbers allowing selective interactions with the most unstable part of the distribution function and the strong interactions at tangential resonances in the outer midplane [4, 5].

[1] Cottrell *et al*., Nucl. Fusion **33** (1993) 1365.

[2] Coppi, B., Physics Letters **A172** (1993) 439

[3] Hellsten, T and Laxåback, M., Phys. of Plasmas **10** (2003) 4371.

[4] Johnson, T., *et al*., 16th Topical Conf. on Radio Frequency Powers in Plasmas, Park City, Utah 2005.

[4] Hellsten, T., *et al*., 16th Topical Conf. on Radio Frequency Powers in Plasmas, Park City, Utah 2005.