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Theoretical and JET experimental evidence of a new sawtooth control mechanism by off-axis toroidally propagating ICRF waves¹

JONATHAN GRAVES, Ecole Polytechnique Federale de Lausanne (EPFL), Centre de Recherches en Physique des Plasmas, Association EURATOM-Confederation Suisse, 1015 Lausanne

A new explanation has been given [J. P. Graves, et al, Phys. Rev. Lett. 102, 065005 (2009)] for the highly effective nature of sawtooth control using off-axis toroidally propagating ion cyclotron resonance waves in tokamaks. Energetic passing ions influence the internal kink mode when the distribution of ions is asymmetric in the parallel velocity, a natural feature of co or counter propagating ICRH waves. Dedicated JET experiments have been devised in order to eliminate an alternative explanation of modified sawteeth involving magnetic shear modification. Low concentration He-3 minority was employed because the large drag current of the background plasma yields very poor current drive efficiency. Nevertheless, these ITER relevant ICRH scenarios in JET demonstrate that sawteeth can be controlled effectively. Modelling of these experiments quantifies the role played by the fast ions. Importantly, the extreme sensitivity of the fast ion mechanism to RF deposition location is consistent with the variation of the observed sawtooth period over a change in the magnetic field strength of only a few percent. The success of these JET experiments in controlling sawteeth, and validating the theory, greatly improves the prospect of using the planned ICRH system in ITER to shorten or lengthen sawteeth.

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