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# Experiments of Sawtooth control by ECRH on J-TEXT tokamak

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Sawtooth instability was first discovered by soft X-ray (SXR) diagnosis on the ST Tokamak in 1974 [1] and had been found on almost all large tokamaks since then. The sawtooth instabilty is thought to be important in future fusion reactor. On one hand, the big sawtooth could trigger the neoclassical tearing modes (NTMs), resulting in poor confinement and plasma disruption [2, 3]. On another hand, sawtooth instability can help eliminating the helium ash [4]. Looking for the way to control the sawtooth to avoid seeding NTMs while maintaining a suitable amplitude and frequent sawtooth to remove the accumulation of core impurities is valuable.

Electron cyclotron resonance heating and current drive (ECRH/CD) is an effective method for the control of sawtooth [5]. In this report, the experimental results of sawtooth control via ECRH on the J-TEXT tokamak will be presented. It is found that when the ECH deposition is inside the q=1 surface, the sawtooth is destabilized (characterized by reduced sawtooth period) under the experimental conditions of $n_e$=2-2.6×$10^{19}$$m^{-3}$ and $P_{ECH}$=400kW, while the sawtooth period is stabilized (characterized by prolonged sawtooth period) under $n_e$=1-1.5×$10^{19}$$m^{-3}$ and $P_{ECH}$=200kW. When the ECH deposition is outside the q=1, the sawtooth is both stabilized, and the sawtooth period reaches the maximum when the deposition is just outside the q=1. In the scanning process of the entire deposition from inside to outside of the q=1 surface, the sawtooth amplitude gradually decreases compared to W/O ECH. Modified sawtooth patterns with dual flux tubes (DFTs) and multiple partial collapses have been observed in J-TEXT tokamak plasmas as ECH deposition moves outward from within q=1 to just outside q=1. The time evolution these visualized by a 2D electron cyclotron emission imaging (ECEI) diagnostic typically consist of growth and merging of the second flux tube and multiple outward transfers of core heat. The appearance of DFTs is not stable, and the relationship between its occurrence probability and deposition will be introduced in the text. The modified sawtooth patterns have characteristics that are significantly different from the instability of the internal torsion mode, and play a key role in the ECH/CD control of the sawtooth instability.

References

[1] S. von Goeler. et al 1974 Physical Review Letters. 33(20): 1201
[2] G. P. Canal. et al 2013 Nucl. Fusion 53, 113026
[3] O. Sauter, E. et al 2002 Phys. Rev. Lett. 88, 105001
[4] M.F.F. Nave et al 2003 Nucl. Fusion 43 1204
[5] Furno I. et al 2001 Nucl. Fusion 41 403