Experimental validation of the reconnection model (full or partial) in the sawtooth instability in KSTAR

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The long-standing issue whether the central safety factor (q_0) goes back to above ~1.0 or not after the crash of the sawtooth instability was revisited in this paper. In this study, it was found that the "full reconnection model" in which the q_0 goes back to above ~1.0 after the crash, originally proposed by Kadomtsev, is likely to be the correct model [1]. This model was discarded for a long time due to the first q_0 measurements (Faraday rotation and Motional Stark Effect (MSE)) where the measured q_0 was remained well below ~1.0 (~0.8) after the crash. Now we have learned that the unfolding techniques of these polarimetry measurements are much more complex and understanding has evolved since the first measurement. Some of the critical issues in unfolding techniques will be addressed in this paper. Recent MSE measurement of the q_0 for sawtoothing plasmas on KSTAR has been $\sim 1.0 \pm 0.03$ and this value is consistent with the previous MSE measurements in DIII-D. Since the change of the q_0 (or core current density) is relatively small, the required absolute accuracy of ~2% of the MSE system for a definitive proof of the model is too stringent. A controlled supplementary experiment employing the higher order tearing modes that are extremely sensitive to the background q_0 in conjunction with the measured q_0~1.0 successfully validated the full reconnection model [2]. Here, a resistive MHD code, M3D-C1 was employed to identify the growth rate of the excited modes and compared with the experiment. The dynamics of the high *m* tearing modes in non-sawtoothing plasmas (hybrid mode) are studied and the results are consistent with the conclusion from the sawtoothing discharges. This work is supported by the NRF of Korea under Contract No 2014M1A7A1A03029865

[1] B.B. Kadomtsev, Sov. J. Plasma Phys. **1**, 389 (1975).

[2] Y.B. Nam, et al., Validation of "full reconnection model" of the sawtooth oscillation, to be published in Nuclear Fusion, 2018.