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Validation of $q(0) \geq 1.0$ in the MHD Quiescent Time after Crash of the Sawtooth Instability in KSTAR

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Long standing issue of full vs. partial reconnection model of the sawtooth instability is revisited in Korean Superconducting Tokamak Advanced Research (KSTAR). The measured central safety factor ($q(0)$) by Motional Stark Effect (MSE) is ~ 1.0 and this measurement alone cannot validate the sawtooth instability model definitively due to non-trivial off-set error. Study of controlled experiment of the tearing modes ($m > 1$) sensitive to magnetic shear with the resistive magnetohydrodynamic (MHD) theory supports the full reconnection model. Here, the radial position of the excited tearing modes ($m/n > 1/1$) and their time evolution into the $1/1$ kink mode before the crash in sawtooth plasma suggests that $q(0) \geq 1.0$ in the MHD quiescent period after the crash and $q(0) < 1.0$ before the crash. Experimental observation of long lived tearing modes with constant mode number in non-sawtooth discharge (presumably $q(0) \geq 1.0$) further supports the fact that $q(0) \geq 1.0$ in the MHD quiescent period after crash in sawtooth discharge and hence the complete reconnection model.

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