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Edge-localized modes on KSTAR: global structure and distinct evolution stages involving quasi-steady state and phase transitions

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Edge-localized modes (ELMs) in the KSTAR tokamak appear substantially different from the conventional picture of ELMs as an explosive transport event in the plasma edge triggered by exponentially growing ballooning and external kink modes on the low field side of the plasma. The 2-D images of ELMs visualized by an advanced imaging diagnosticsˆ1 with microsecond time resolution revealed that the modes evolve in three distinctive stages: (1) quasi-steady (saturated) filamentary modeˆ2 with long life time (up to ˜100 ms), (2) abrupt structural transformation near the onset of crash into irregular-shaped filamentsˆ2 or in the middle of the inter-crash periodˆ3, (3) and multiple filament bursts during the crash phaseˆ2. Perhaps the most astonishing finding is the clear existence of filamentary modes exist on the high field side as well as on the low field sideˆ4, suggesting that the ELM dynamics in the KSTAR involve other driving forces such as d'Angelo instability besides ballooning and external kink. In addition, we demonstrate that the ELM evolution stages are associated with distinct changes of RF emission spectraˆ5 (100—1000 MHz), suggesting the RF signal as a better alternative to the conventional D-alpha signal which represents only the aftermath of the collapse of the edge confinement. *Work supported by the NRF of Korea under grant No. NRF-2014M1A7A1A03029881, BK+ program, and A3 Foresight program.

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