Observation of Harmonic Oscillations and ELMs in NSTX *

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Recent experiments in the National Spherical Torus Experiment (NSTX) demonstrated the progressive suppression of edge localized modes (ELMs) with increasing lithium deposition until ELMs were completely eliminated [1]. Sufficient lithium suppressed ELMs and but increased the amplitude of oscillatory modes with low-frequency, low-n harmonics. Signatures of these harmonic oscillations with a significant edge component were observed in both the high-n Mirnov magnetic and soft X-ray diagnostics of NSTX. Two distinct sets of harmonic oscillations can be observed during some ELM-free periods. The harmonic oscillations are consistent with modes localized in the edge with the frequency of the n = 1 harmonic near the rotation frequency of the edge plasma. If there is mixed harmonic oscillation and ELM activity, the harmonic oscillations are quenched by the ELMs and then return as the edge rebuilds. These characteristics are similar to the edge harmonic oscillation (EHO) observed in DIII-D [2, first refer. in 5], but await confirmation of edge localization.

NSTX magnetic diagnostics also observe distinctive signatures of ELMs. Transient n = 1, and 2 mode bursts [3] and occasional higher n modes with frequency in the 30 to 90 kHz range occurred simultaneous with the increase in fast D_α signal. These bursts of n = 1 and 2 modes are reminiscent of a model simulation of ELMs in which a bifurcation of magnetic topology is driven by nonlinear feedback amplication of thermoelectric currents [4] from linear peeling-ballooning modes. Alternative conjectures are that the scrape-off layer (SOL) currents trigger ELMs through sheath breakdown, with lithium coating affecting the breakdown threshold [5] and the beating of high-n nearest neighbor peeling-ballooning modes to create an n = 1 mode [6]. These mechanisms await confirmation by measurement of the frequencies of the n = 1 and 2 mode bursts in the SOL currents, analysis of reflectometer data and the development of an effective Langmuir probe analysis method in NSTX.

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