Influences of multiple low-*n* modes on *n*=1 resistive wall mode (RWM) identification and feedback control

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ABSTRACT

It is well known in theory that even after the $n=1$ resistive wall mode (RWM) is suppressed, the other low-n modes, such as $n=2$ or 3, can appear sequentially, as β increases. In recent DIII-D [J.L. Luxon, Nucl. Fusion **42**, 614 (2002)] experiments, we found such an example that supports the theoretical prediction; *while the $n=1$ mode was suppressed, an $n=3$ mode grew dominant, leading to a β collapse*. The $n=1$ RWM suppression was likely due to a combination of rotational stabilization and $n=1$ RWM feedback. The multiple RWM identification was performed using an expanded matched filter, where $n=1$ and $n=3$ RWM basis vectors are simultaneously considered. Taking advantage of the expanded matched filter, we found that an $n=3$ mode following an edge-localized-mode (ELM) burst grew almost linearly for several milliseconds without being hindered. This $n=3$ mode appeared responsible for the β collapse (down to the $n=3$ no-wall limit), as well as for a drop in toroidal rotation. A preliminary analysis suggests that the identity of the $n=3$ mode could be related to the $n=3$ RWM (possibly the first observation in tokamak experiments), while the impact of the $n=3$ mode was not as destructive as that of $n=1$ RWM. A numerical post-processing of Mirnov probes showed that the $n=2$ mode was also unstable, consistent with the theoretical prediction. In practice, since the presence of an $n=3$ mode can interfere with the existing $n=1$ RWM identification, multiple low-n mode identification is deemed essential not only to detect $n>1$ mode, but also to provide accurate $n=1$ RWM identification and feedback control.

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