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MHD Instability Excited by Interplay between Resistive Wall Mode and Stable MHD Modes in Rotating Tokamak Plasmas

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A mechanism exciting magnetohydrodinamic (MHD) instabilities in rotating tokamak plasmas is found numerically for the first time. This mechanism is the interplay between a resistive wall mode (RWM) and a stable MHD mode. When a plasma has a discrete stable MHD eigenmode, the RWM can be destabilized when the plasma rotation frequency is close to the real frequency of the stable eigenmode. In a cylindrical plasma, such a destabilizing mechanism can be observed as the result of the interplay between RWM and a stable external kink mode. In a tokamak plasma, it is found that not only an external kink mode but also Alfven eigenmodes can be the counterpart of this interplay. It is numerically demonstrated that this mechanism can overcome the continuum damping leading to the destabilization of RWM in a realistic tokamak plasma. These results indicate that understanding of the stable MHD modes is important for robust stabilization of RWM. The destabilization can be avoided by optimization of the safety factor profile. This optimization is indispensable in the design of steady state high beta tokamaks such as JT-60SA, DEMO and future tokamak reactors.

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