Edge stability and transport control with resonant magnetic perturbations in collisionless tokamak plasmas.

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Abstract

A critical issue for fusion plasma research is the erosion of the first wall of the experimental device due to impulsive heating from repetitive edge magneto-hydrodynamic (MHD) instabilities known as "edge-localized modes" (ELMs). Here, we show that the addition of small resonant magnetic field perturbations completely eliminates ELMs while maintaining a steady-state high-confinement (H-mode) plasma. These perturbations induce a chaotic behaviour in the magnetic field lines, which reduces the edge pressure gradient below the ELM instability threshold. The pressure gradient reduction results from a reduction in particle content of the plasma, rather than an increase in the electron thermal transport. This is inconsistent with the predictions of stochastic electron heat transport theory. These results provide a first experimental test of stochastic transport theory in a highly rotating, hot, collisionless plasma and demonstrate a promising solution to the critical issue of controlling edge instabilities in fusion plasma devices.