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Suppression of Magnetic Islands and Avoidance of Disruptions via RF Current Condensation[1]

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Large islands produced by off-normal events routinely cause disruptions. We identify a nonlinear effect, "RF current condensation", that facilitates island stabilization, allowing the stabilization of larger islands than would otherwise be possible [1]. The effect arises from the sensitivity of the power deposition and driven current to the temperature perturbation in the island. There is a nonlinear enhancement of the temperature, with the increased power deposition leading to a further increase in the temperature perturbation. In combination with the sensitivity of the current drive to the temperature, this leads to the RF current condensation effect. There is a discontinuous jump in the steady-state solution to the thermal diffusion equation at a threshold in power and island width, with the temperature above the threshold saturated by depletion of the wave power [2] or by the ITG threshold [3]. This bifurcation is associated with a hysteresis effect that can cause the islands to shrink to smaller widths than would otherwise be the case. For lower hybrid waves, the effect narrows the generally broad deposition, and it can lead to automatic, passive stabilization of islands [4]. The stabilizing effect can be further enhanced by pulsing the RF power [5]. We have developed a code for simulating the effect, and we find that current condensation and bifurcation can occur in ITER plasmas with the available EC power [6]. [1] A. Reiman and N.Fisch, Phys. Rev. Lett. **121**, 225001 (2018). [2] E. Rodriguez, A. Reiman and N. Fisch, Phys. Plasmas **26**, 092511 (2019). [3] E. Rodriguez, A. Reiman and N. Fisch, Phys. Plasmas **27**, 042306 (2020). [4] S.J. Frank, A.H. Reiman, N.J. Fisch and P.T. Bonoli, Nucl. Fusion, to appear. [5] S. Jin, N. J. Fisch, and A. H. Reiman, Phys. Plasmas 27, 062508 (2020). [6] R. Nies, A. Reiman, E. Rodriguez, N. Bertelli, N. Fisch, http://arxiv.org/abs/2005.05997.

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