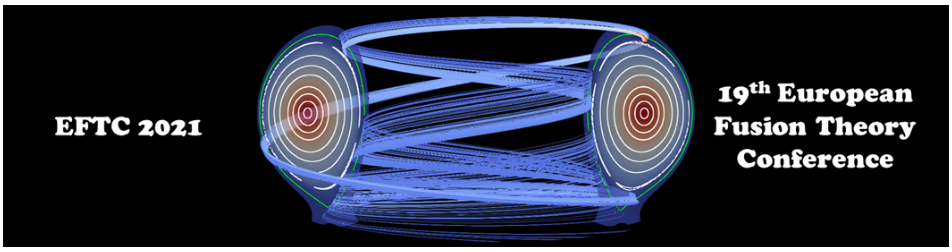

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Current drive induced crash cycles in W7-X

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In the Wendelstein 7-X stellarator, the vacuum rotational transform, iota, has a flat radial profile and does not cross any major rational resonance. Nevertheless, during plasma operation the iota profile can be strongly modified by electron cyclotron current drive (ECCD) in such a way that the resulting iota profile passes through low-order rational values, and this can trigger magnetohydrodynamic (MHD) events. Indeed, W7-X plasmas are sometimes subject to repetitive collapses of core confinement, which can be observed regardless of the direction in which the ECCD current is driven. These phenomena are periodic, rapid (on the order of Alfvénic times) and large "crashes"of electron temperature, which are reminiscent of tokamak "sawtooth" instabilities. There are also examples of discharges where related events lead to complete termination of the entire plasma. Even though the origin of these MHD instabilities is not yet clear, the fast crashes are likely to be connected to the formation of magnetic islands and magnetic reconnection. In the present work, we discuss the MHD events happening during the course of sawtooth cycles in W7-X using the combination of slow current diffusion with fast relaxation that conserves the corresponding helical flux. Utilising Taylor relaxation theory, we predict the nonlinear redistribution of plasma current caused by the largest of the observed events and obtain a 3D post-crash state. To study different types of crashes —not only fast and large ones, where we demonstrate a good agreement with Taylor relaxed state, but also smaller ones —we combine the Taylor theory approach and resistive evolution aspects of the current profile development.

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