Magnetic Topology Change Induced By Discrete Relaxation Events In Reversed Field Pinch Plasmas

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The Reversed Field Pinch (RFP) is a toroidal pinch configuration characterized by a large plasma current, which leads to a strong paramagnetism. The toroidal field is reversed in the edge region, and this profile is maintained against resistive diffusion by a nonlinear process, involving several resistive MHD modes, called dynamo. In certain regimes, the dynamo takes place intermittently, giving rise to the so-called Discrete Relaxation Events (DREs). The DREs involve a sudden variation in the mode amplitudes, associated to a change in the magnetic topology dictated by the m=1 and m=0 islands.

Aim of this contribution is to illustrate the global changes in the RFP magnetic topology induced by the DREs, with special emphasis on Quasi-Single Helicity (QSH) states. This is achieved by performing field line tracing calculations and producing Poincaré plots. This approach is applied both to experimental data collected on the RFX-mod device operating in Padova, and to the results of 3D MHD simulations.

For the experimental case, the field line tracing calculation uses as input the mode eigenfunctions reconstructed over the plasma volume through the solution of a Newcomb-like equation, in force-free approximation. The equation is solved using edge magnetic measurements as boundary conditions. Different time slices during the relaxation event are simulated, thus obtaining a time evolution of the magnetic topology. Furthermore, an averaging is performed over multiple events, taking into account the phase shift of the dominant mode, so as to obtain a more statistically relevant outcome. The results are compared with Poincaré plots obtained from 3D MHD simulations of RFP plasmas performed with the Specyl code, whose output is fed into the NEMATO field line tracing code.

It is shown that the DRE induces magnetic reconnection at multiple locations, affecting both the m=1/n=7 plasmoids, which in RFX-mod QSH states dominate the core region, and the m=0 island chain present in the outer part of the plasma.