Modelling sawteeth in tokamak plasma as a sequence of Multi-region Relaxed MHD equilibria

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The Multiregion Relaxed MHD [1] was successful in the construction of equilibria in 3D configurations, bridging the gap between Taylor relaxation, which allows relaxation but only globally, and ideal MHD, which includes no relaxation at all but infinite constraints. In MRxMHD, the plasma is sliced into sub-volumes separated by ideal interfaces, each undergoes relaxation. Stepped Pressure Equilibrium Code (SPEC) [2] was developed to solve MRxMHD equilibria numerically.

A sawtooth [3] is a spontaneous energy relaxation process in tokamak plasma. In the early phase of a sawtooth crash with a relatively small resistivity, the reconnection velocities are not too fast compared with the Alfven speed. One can model the plasma globally as a sequence of equilibria, treating the reconnection layer as an infinitely thin current sheet [4]. Starting with an unstable axisymmetic MRxMHD equilibrium, we found that a lower energy state exists with a helical core. The two interfaces bounding the volume containing the q=1 surface clash together to form a "cusp-type" current sheet [5]. We then construct a sequence of equilibrium by removing the interfaces one by one. The result is compared to a M3D-C1 [6] simulation.

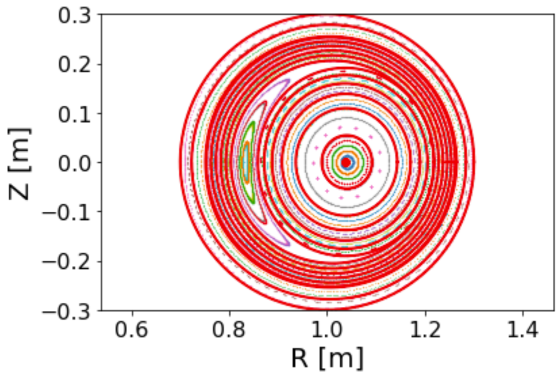

Figure 1. A SPEC equilibrium with a helical core and a current sheet.

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