Dynamic of helical states and their description through a predator-prey model in MST

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In the Reversed Field Pinch (RFP) configuration the Quasi Single Helicity (QSH) state is of great interest for its favorable confinement properties. This state is characterized by the presence of a dominant tearing mode, usually the innermost resonant one, and by a three-dimensional "bean-like" structure. The QSH state is in contrast to the Multiple Helicity (MH) state characterized by a broad mode spectrum and an axisymmetric structure. In several RFP experiments the formation of thermal transport barriers associated with the transition from MH to QSH has been observed, but its presence is intermittent.

In order to better understand what controls the formation and the persistence of the QSH and of the transport barriers, a technique that locks the 3D structure in optimal position for any desired diagnostic was recently developed at MST. This technique allowed the building of a large ensemble of measurements of the time evolution during the MH to QSH transition of many physical quantities including electron density and temperature, Soft X-Ray emission, ion temperature, and magnetic field magnitude. Non-axisymmetric equilibrium reconstruction using V3FIT has been augmented with polarimetry measurements from this data set. The dynamic of the QSH and the dependence of its persistence on the plasma current have been successfully reproduced by a predator-prey model [1] (see Fig 1). In this model the dominant mode is not part of an equilibrium but a long-lived coherent structure that suppresses nonlinear energy transfer to the secondary modes.

[1] PW Terry and GG Whelan, submitted to PPCF