Introduction

Numerous resonant and overlapping tearing modes of multiple helicity (MH) generate the stochastic magnetic field in reversed field pinch (RFP) plasmas. However, RFPs with one resistive tearing mode impart a single helicity (SH) to the magnetic field and are predicted to preserve good geometric surfaces and reduce transport. Between the extremes of MH and SH is Quasi-Single-Helicity (QSH), a plasma with a dominant tearing mode and multiple smaller modes. Typically, when going from MH to QSH, a dominant mode increases while other modes are suppressed or maintain constant amplitude. To date, the QSH state is identified by measurements of the magnetic fluctuation amplitude and mode number spectrum at the boundary using external coils. Herein, the equilibrium and fluctuating magnetic field and density are measured for the plasma core. The goal is to determine how the equilibrium profiles are modified during QSH and whether changes in the core fluctuations (magnetic and density) are consistent with those determined at the edge.

Initial comparison of the MH and QSH states indicates the latter has a hollow density profile. Modification to stochastic magnetic field driven particle transport during QSH provides a potential explanation for the equilibrium profile changes. Examination of \( \hat{b} \) and \( \hat{n} \) in the plasma core finds a higher amplitude in QSH plasmas for all modes, not just the dominant mode. Moreover, the mode amplitude of \( \hat{b} \) in the core of QSH plasmas is not consistent with measurements of \( \hat{b}_0 \) at the wall. This work is supported by the DoE.

Equilibrium density and magnetic field

Fast polarimeter measures core mean and fluctuating \( B \) & \( J \)

Faraday rotation angle

\[ \psi = \int \frac{J \times B \cdot dl}{c} \]

- \( \psi = 0 \) as \( m = 1 \) nature of perturbation sets to \( \psi = 0 \)

With measurement of core \( \hat{j} \) and edge \( \hat{b}_0 \) the current fluctuation can be measured

\[ \psi_{Faraday} = \int \frac{\hat{b}_0 \cdot d\ell}{c} \]

MSTFit utilizes Faraday rotation and raw density to calculate \( \hat{j} \)

Main difference in QSH and MH plasmas in equilibrium studies is hollow feature seen in inverted density profile

Conclusions

- equilibrium density decreases in core in QSH plasmas
- \( j_t \) and \( j_\theta \) are similar in QSH and MH plasmas
- fluctuating amplitude of \( \hat{n} \) increases for many modes on each chord in QSH plasmas
- \( b_r \) and \( \hat{b}_r \) are larger in the core in QSH plasmas
- core \( \hat{b}_r \) fluctuations are not linearly related to \( \hat{b}_0(a) \) fluctuations

Future

- Results presented are for a plasma with the \( m=0 \) mode resonant surface (\( f=0 \)) in the plasma. This can lead to nonlinear coupling and transport.
- Directly measure magnetic fluctuation-driven particle transport for MH and QSH plasmas
- Investigate QSH and MH plasmas where the reversal surface is moved to the boundary (\( f=0 \)), thereby suppressing \( m=0 \) modes and reducing nonlinear coupling.
- Investigate QSH state during high confinement MST plasmas where the current profile is modified to suppress tearing modes.
- Understand how QSH and MH plasma states differ.