Helical structures and improved confinement in the MST RFP

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A range of tearing spectra emerges spontaneously in MST

- Helical structure observed over entire range
Outline

- RFP equilibrium
- MST device
- Helical structure with flat spectra
- Helical structure with peaked spectra
- Helical equilibrium with very peaked spectra
  - internal detection of change in magnetic topology
Equilibrium provides many resonant surfaces

Helical structure associated with innermost mode

(m,n) = (1,5)  
(1,6)  
(1,7)...

Helical structure associated with innermost mode
MST = Madison Symmetric Torus

• R = 1.5 m
• a = 0.52 m

• Magnetic field diagnosis by:
  (1) Faraday rotation
  (2) sensing coils at plasma boundary
Helical structure with flat mode spectrum
Spectrum fairly flat after sawtooth crashes
SXR structure observed post crash

$m = 1$

$n = 5$

Te structure observed post crash

\[ \chi_e \approx 30 \text{ m}^2/\text{s inside structure} \]

(1000 m\(^2\)/s before structure appears)

H.D. Stephens et al.,
Helical structure with peaked mode spectrum
Some spectra are very peaked

\[ n = 5 \]
\[ b/B(a) \sim 7\% \]

\( m = 1 \) modes (G)

\( n = 6-10 \)
SXR structure observed with peaked spectra

$m = 1$
$n = 5$
Runaway electrons occur with peaked spectra

- Runaways not common in RFP
- Imply region of reduced stochasticity

ORBIT: largest electron energy in island region

- Particles initially placed in island region
- Particle trajectories evolved for about 2 ms
Core $T_e$ increases with peaked spectra

- Global energy confinement likely increased several fold
Emergence and detection of helical equilibrium on MST
In most-peaked spectra, equilibrium is helical.
Faraday rotation diagnostic sensitive to change in equilibrium

\[ \Psi \propto \int n_e B \cdot dl \]
Magnetic reconstructions track evolution of Faraday rotation zero crossing

- Faraday rotation not a constraint in the reconstructions
Summary

- Helical structures common in MST
- Associated with confinement improvement
- Most-peaked spectra produce helical equilibrium
- Alteration of equilibrium detected by Faraday rotation
- Increases confidence in edge-based magnetic reconstructions