The dominant magnetic fluctuations in the reversed field pinch arise from large scale tearing instabilities, but a broadband spectrum is observed. Recent measurements in MST suggest that the magnetic fluctuations in MST are in equipartition. Bi-spectral analysis techniques are used to identify the frequency range over which the power in magnetic fluctuations becomes dominant at high frequencies. The cross-coherence between density and magnetic fluctuations simultaneously in the edge plasma region. While magnetic fluctuations dominate the power spectrum in the plasma edge a few frequencies, electric field fluctuations become dominant at high frequencies. The cross-spectra between electric and magnetic fluctuations peak near the frequency where the fluctuation spectrum is dominated by magnetic fluctuations. The cross-coherence spectra between density and magnetic fluctuations are strongly non-monotonic among electromagnetic fluctuations. Additionally, the non-linear relationship between the coherences and ratios of the fluctuation amplitudes may help illuminate the nature of these plasma fluctuations. MST and DIII-D support this work.

**Conclusions**

- Anisotropic magnetic and electrostatic turbulence has been observed in the edge of MST.
- Magnetic fluctuation spectra dominate at low frequencies (approximately 10 kHz). Electromagnetic fluctuation spectra dominate at high frequencies (megahertz).
- There is a secondary peak near 100 kHz in the coherence between the B- and the component of the electric field parallel to the equilibrium field.
- The frequency band secondary peak occurs near the frequency at which density fluctuations are observed in MST. The coherence near 100 kHz is also observed in DIII-D. This peak indicates a wave mode instability being excited in this frequency range.

**Fluctuation Coherences**

- There is a peak in the coherence between the electric field and magnetic field near tearing mode frequencies.
- A secondary peak appears near 100 kHz in the coherence between the electric field and the component of the electric field parallel to the equilibrium field.
- Sharp Alfven waves are likely ruled out since this peak is strong in coherences involving the fluctuating B component parallel to the equilibrium field.
- The frequency band secondary peak occurs near the frequency at which density fluctuations are observed in MST. The coherence near 100 kHz is also observed in DIII-D. This peak indicates a wave mode instability being excited in this frequency range.

### Statistical analysis of broadband electrostatic and magnetic turbulence in the MST reversed field pinch

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**Abstract**

Electromagnetic fluctuations in MST are in equipartition. Bi-spectral analysis techniques are used to identify coherences between density and magnetic fluctuations simultaneously in the edge plasma region. Magnetic fluctuations dominate the power spectrum in the plasma edge a few frequencies, electric field fluctuations become dominant at high frequencies. The cross-spectra between electric and magnetic fluctuations peak near the frequency where the fluctuation spectrum is dominated by magnetic fluctuations. The cross-coherence spectra between density and magnetic fluctuations are strongly non-monotonic among electromagnetic fluctuations. Additionally, the non-linear relationship between the coherences and ratios of the fluctuation amplitudes may help illuminate the nature of these plasma fluctuations. MST and DIII-D support this work.

**Motivations**

- Turbulence is present both in laboratory experiments and space physics environments.
- Turbulence is an important consideration in fusion research.
- Many theoretical models exist that describe turbulence for different environments, but more experimental data is needed to compare to these models.

**Turbulent Spectra**

- In MST, power is deposited in tearing modes at low frequencies and low wave numbers.
- The magnetic spectrum is characterized by an exponential low-slope region. This represents the loss of energy through an external process (e.g., energy from magnetic fluctuations being transferred to the heating of minority ion species).

**Previous work highlights**

- Measurements made at 8 cm
- Fluctuation power is anisotropic for B- and E-fluctuations, as expected when a strong guide field is present.
- The anisotropy alignment tracks the magnetic field direction, indicating locally resonant modes.
- Black line corresponds to linear Green horns indicating equilibrium magnetic field direction.

**Electrostatic Transport Probe**

- An inductive probe is used to monitor fluctuations in floating potential, and three dimensional vector external to the plasma.
- Measurements are restricted to the edge region (r/a<0.7) of low-current (0.01) MST plasma in order to ensure plasma stability.
- The measurements are shown as a function of frequency.

**Energy partition**

- A similar peak can be seen in the coherence between density and floating potential fluctuations. A phase difference that lies between 0 and π/2 could be an indicator of drift wave turbulence.

**Conclusions**

- Anisotropic magnetic and electrostatic turbulence has been observed in the edge of MST.
- Magnetic fluctuation spectra dominate close to zero frequencies and electromagnetic fluctuation spectra dominate at high frequencies (megahertz).
- There is a secondary peak near 100 kHz in the coherence between the B- component of the electric field parallel to the equilibrium field.
- High-frequency coherent peaks occur at small positive toroidal wave numbers (wavenumbers) but electrostatic fluctuation power dominates at high frequencies (wavenumbers).
- Anisotropic magnetic and electrostatic turbulence has been observed in the edge of MST.
- Magnetic fluctuation spectra dominate close to zero frequencies and electromagnetic fluctuation spectra dominate at high frequencies (megahertz).
- There is a secondary peak near 100 kHz in the coherence between the B- component of the electric field parallel to the equilibrium field.