Mode Structure of the Plasma Response to Error Fields*

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Sustained operation at high-β_N [$= \beta /(I/aB)$] in DIII-D plasmas requires the correction of even small non-axisymmetric magnetic field asymmetries known as "error fields", which can lead to strong braking of the plasma rotation, performance degradation, and possibly disruptions. The sensitivity of high-β plasmas to error fields is caused by a paramagnetic plasma response to error fields whose topology is resonant with the structure of weakly damped resistive wall modes (RWM), a phenomenon referred to as resonant field amplification (RFA). [1] Recently, J.K. Park et al. have indicated that this effect also plays a role in low-β discharges where error fields can lead to locked modes. [2] A full understanding of the plasma response to non-axisymmetric fields is a prerequisite for understanding the effect of error fields on plasma rotation, and can be used to optimize error field correction and RWM feedback strategies.

Control coils are used to provide error field correction, and in active MHD spectroscopy experiments where slowly-rotating, low-n magnetic fields are applied in order to measure the macroscopic plasma stability via the RFA response. The RFA has been stimulated in a variety of DIII-D equilibria, using various coil geometries, current amplitudes, and field rotation frequencies. The external magnetic signature of RFA matches the expected helicity of the RWM. Here we report on measurements of the RFA mode structure using internal fluctuation diagnostics, including a charge-exchange recombination spectroscopy system, an electron cyclotron emission radiometer, and a soft x-ray imaging system. These are compared to calculations of the RFA eigenfunctions using the MARS-F code, which includes a model for the control coils, the effect of finite resistivity of the DIII-D vessel wall, and rotation in the plasma. Details concerning the effects of β, plasma rotation, and coil configuration will be presented.

[1] A.H. Boozer, Phys. Rev. Lett. **86**, 5059 (2001).

[2] J-K. Park et al., Phys. Rev. Lett. **99**, 195003 (2007).

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