Control of resistive wall modes – comparison of normal and tangential B sensing

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Abstract

We study control of linear and nonlinear resistive wall modes (RWM) with a slab (or cylindrical) model with complex gain $G_r + iG_i$, i.e. proportional gain with a possible phase shift. G_i is equivalent to a closer-fitting wall and G_i is equivalent to rotation. When the measured field is the *normal* component of magnetic field at the wall, the real gain required to give benign saturation of the RWMs can be *much* less than that required for linear stabilization, particularly near the threshold for instability with a perfectly conducting wall (the ideal wall β). Moderate real gain can reduce the amplitude of the nonlinear (wall locked) state to a benign level. We formulate the resistive wall - feedback coil boundary conditions in cylindrical geometry in terms of components of the inverse of the inductance matrix, and show the formalism for sensing based on (i) normal (radial) component of the magnetic field $\mathbf{B}$ inside (or outside) the resistive wall, (ii) tangential component of $\mathbf{B}$ inside the wall, and (iii) tangential component of $\mathbf{B}$ outside the wall. We compare the relation between these schemes and the efficacy of feedback based on the three. We will also show results on fitting equilibrium parameters with experimental measurements of the field by means of a Grad-Shafranov solver, taking into account a realistic estimate of the covariance matrix of the field measurements, related to the noise due to fluctuations such as ELMs.

1. J. M. Finn and L. Chacon, “Control of Linear and Nonlinear Resistive Wall Modes”, to appear in *Phys. Plasmas* (2004).