Stability of resistive wall modes with liquid metal blankets

L.-J. Zheng, M. Kotschenreuther

Institute for Fusion Studies, University of Texas at Austin, Austin, TX 78712

M. S. Chu, M. Chance, and A. Turnbull

General Atomics, P. O. Box 85608, San Diego, CA 92186

Abstract

Resistive wall mode (RWM) stability is investigated in tokamaks with liquid metal (LM) blankets. Fast flowing liquid metal films have been examined as the first wall of a reactor and have been found to significantly stabilize RWMs in cylinder geometry with zero plasma beta and no plasma rotation [1]. Here, equilibria are considered that are very desirable for a reactor, but urgently require stabilization of RWMs: equilibria with high bootstrap fraction, sharp pressure gradients from transport barriers, and strong shaping (Fig. 1). The numerical studies utilized the newly developed AEGIS (Adaptive EiGenfunction Independent Solution) MHD shooting code, which can describe both low- and high-n modes in toroidal geometry for the full MHD equations. The AEGIS code employs Fourier decomposition in the poloidal direction and adaptive mash shooting in the radial direction. A multiple region matching technique is used to handle the numerical difficulty associated with stiff nature of the independent solutions. The n=1 mode structure calculated with AEGIS and GATO codes are shown in Figs. 2 and 3, respectively. Their agreement is very good. Due to its adaptive nature, AEGIS can study MHD modes with smaller growth rate. This can be seen from the sharpness of the mode near the singular layers in Fig. 2. As another feature of the AEGIS code, the wall is taken to have multiple layers and to have finite thickness. The effects of the LM flow speed, injecting direction, the wall position, and the plasma shaping on the RWM stability will be presented.

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[2] L.-J. Zheng, M. Kotschenreuther, A. Turnbull, F. Waelbroeck, J. W. Van Dam, and H. L. Berk, "computation of the MHD modes with rotation and kinetic effects", Bull. Am. Phys. Soc. **48**, 282 (2003).
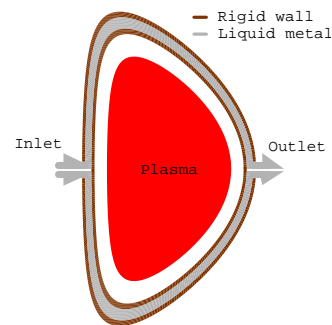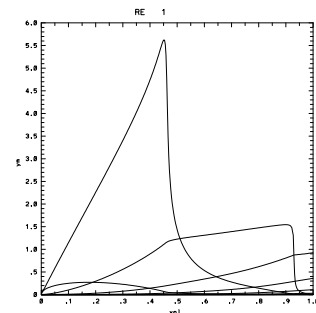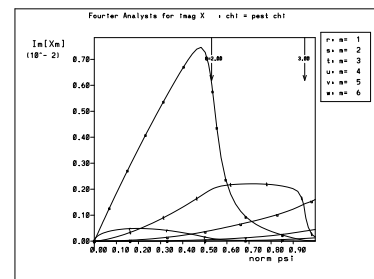
FIG. 1: Equilibrium

FIG. 2: AEGIS

FIG. 3: GATO