Further drift-magnetohydrodynamic modeling of linear tearing mode dynamics in tokamak plasmas

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I. INTRODUCTION

Tearing modes are slowly growing instabilities of ideally-stable tokamak plasmas that reconnect magnetic field-lines at various resonant surfaces within the plasma, in the process degrading the plasma confinement.[1] If tearing modes gorw to sufficiently large amplitude then they can trigger major disruptions.[2] Tokamak plasma are observed to be particularly disruption prone when tearing modes *lock* (i.e., become stationary in the laboratory frame) to externally generated, resonant magnetic perturbations.[3]

It is well known that single-fluid resistive magnetohydrodynamics (MHD) offers a very poor description of tearing mode dynamics in tokamak plasmas. For instance, the strong *diamagnetic* flows present in such plasmas decouple the electron and ion fluid dynamics, necessitating a two-fluid treatment.[4] Moreover, resistive-MHD does not take the important *ion sound radius lengthscale*, below which electron and ion dynamics are further decoupled, into account.[5,6] Previously, Cole & Fitzpatrick[7] used the four-field model of Fitzpatrick & Waelbroeck[8] (which is based on the original four-field model of Hazeltine, et al.[9]), to determine the two-fluid response of a linear tearing layer in a tokamak plasma to an externally generated, resonant magnetic perturbation. However, the treatment of Cole & Fitzpatrick failed to take into account the strong anomalous perpendicular transport of particles and energy present in tokamak plasmas. The aim of this paper is to correct this deficiency.

II. FOUR-FIELD MODEL

ACKNOWLEDGEMENTS

This research was directly funded by the U.S. Department of Energy, Office of Science, Office of Fusion Energy Sciences, under contracts DE-FG02-04ER54742 and DE-SC0021156.

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