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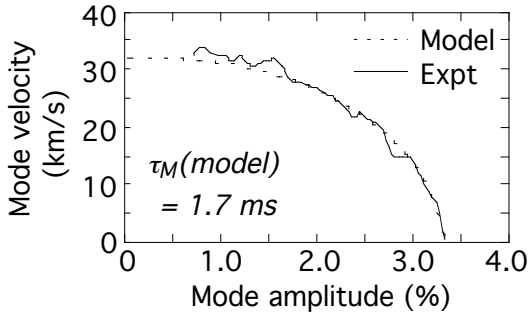
Demonstration of tearing mode braking and locking due to eddy currents in a toroidal magnetic fusion device

B. E. Chapman[1], R. Fitzpatrick[2], D. Craig[1], P. Martin[3], G. Spizzo[3]

[1]*Dept. of Physics, University of Wisconsin-Madison, Madison, Wisconsin, USA*
[2]*Inst. for Fusion Studies, Dept. of Physics, University of Texas at Austin, Austin, Texas, USA*
[3]*Consorzio RFX, Associazione EURATOM-ENEA sulla Fusione, Padova, Italy*

We demonstrate [1] clear examples of tearing mode braking and locking due to eddy currents induced in the conducting shell of the MST reversed-field pinch (RFP). The first theoretical work proposing an electromagnetic braking torque on tearing modes due to eddy currents in the tokamak and RFP was published about 15 years ago [2,3]. The theory was later augmented with the inclusion of the plasma viscous torque [4,5]. While the theories for the tokamak and RFP differ in detail, the underlying physics is generic. Despite the long existence of the theory and the potential importance of this effect in present and future fusion devices, there have been very few tests of the theory.

The braking and locking observed in MST occurs with the growth to large amplitude of a single m = 1 tearing mode. In the figure below is the mode velocity versus amplitude from a plasma with mode braking and locking. The braking is well described by a new time-dependent version [1] of the most recent theory-based model for the RFP [5]. The only adjustable parameter in the model is the global momentum confinement time, τ_M, which is adjusted such that the experimental and model curves coincide at zero velocity. The model-required value of τ_M = 1.7 ms (for the plasma in the figure) is quite consistent with experimental measurements. Given τ_M, the model is used to predict the full evolution of the mode velocity. That the two curves in the figure overlay is *not* a result of simple curve fitting (the curves could diverge substantially). It reflects the fact that the measured braking is well described by the model.



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