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Linear Stability Analysis of Free Surface Liquid Metal Flow[1] D. GIANNAKIS, R. ROSNER, U. Chicago, P. FISCHER, Argonne National Laboratory, H. JI, M. BURIN, K. MCMURTRY, Princeton U. — We study the linear stability of the flow of a liquid metal on a planar surface in the presence of an external magnetic field. The objective is to account for the behavior encountered in a free surface MHD experiment at Princeton, but the model has a range of astrophysical and industrial applications (see companion poster). This class of free surface flow exhibits two mechanisms of linear instability. In the so-called 'soft' instability, a downstream propagating surface wave of large wavelength becomes mildly unstable. The second, 'hard', instability is of the critical layer type and takes place at shorter wavelengths. Solving the eigenvalue problem posed by the coupled Orr-Sommerfeld and induction equations via a spectral method, we find that in the regime of relevance to the Princeton experiment (Reynolds number, magnetic Reynolds number and Hartmann number up to 10^5, 10^{-1}, and 10^3, respectively) MHD effects suppress both types of instability. The soft instability is efficiently suppressed via resistive dissipation if the background magnetic field is normal to the basic flow. In contrast, the hard instability is strongly suppressed irrespective of the details of the background magnetic field configuration, even at moderate Hartmann numbers.

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