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Finite element implementation of Braginskii's gyroviscous stress with application to the gravitational instability NATHANIEL FERRARO, STEPHEN JARDIN, Princeton Plasma Physics Laboratory — A general coordinate-independent expression for Braginskii's form of the ion gyroviscosity in the two-dimensional potential field representation is presented, and is implemented in a full two-dimensional, two-fluid extended magnetohydrodynamic (MHD) numerical model. The expression for the gyroviscous force requires no field to be differentiated more than twice, and thus is appropriate for finite elements with first derivatives continuous across element boundaries (C^1 finite elements). From the extended MHD model, which includes the full gyroviscous stress, are derived linear dispersion relations of a homogeneous equilibrium and of an inverted-density profile in the presence of gravity. The treatment of the gravitational instability presented here extends previous work on the subject. Linear and nonlinear simulations of the gravitational instability are presented. Simulations are shown to agree closely with the derived dispersion relations in the linear regime. The "gyroviscous cancellation" effect is demonstrated, and some limitations of the $\vec{v}_*$ approximation are discussed.

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