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Gyroviscous effects in channel flow with Braginskii magnetohydrodynamics[1] PAUL DELLAR, University of Oxford — We study the pressure-driven flow across a magnetic field of a fluid obeying magnetohydrodynamics with the full Braginskii stress tensor. Momentum transport across magnetic field lines is strongly suppressed by the spiralling of charged particles around the field lines. This spiralling also creates gyroviscous stresses perpendicular to both the strain rate and the magnetic field. These stresses are negligible in the bulk of the flow, but they alleviate the singularities in current and shear that otherwise occur at the channel walls. They create boundary layers whose width scales as the three-quarters power of the ratio $\epsilon = \mu_\times/\mu_\parallel$ of the gyro to parallel viscosities. The maximum current and velocity scale as $\epsilon^{-1/4}$. The gyroviscous stresses generate a leading-order flow perpendicular to the plane defined by the pressure gradient and imposed magnetic field, so the maximum velocity is tilted close to 40° out of this plane. The related out of plane magnetic field scales as $\epsilon^{1/2}$ in the boundary layers, and as ϵ elsewhere. Regularisation by gyroviscous stresses alone is sufficient. Perpendicular viscosity makes only a further regular perturbation.

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