Magnetohydrodynamics (MHD)

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In denser media, the material is treated as a fluid, satisfying the energy and momentum equations of hydrodynamics,

$$\begin{aligned}\frac{\partial\rho}{\partial t}+\boldsymbol{\nabla}\cdot(\rho\mathbf{v}) &= 0\\ \rho\frac{\partial\mathbf{v}}{\partial t}+\rho\left(\mathbf{v}\cdot\boldsymbol{\nabla}\right)\mathbf{v}+\boldsymbol{\nabla}p &= -\frac{1}{\mu}\mathbf{B}\times(\boldsymbol{\nabla}\times\mathbf{B})\end{aligned}$$

where the electromagnetic driving force $\mathbf{J}\times\mathbf{B}=-\mathbf{B}\times(\boldsymbol{\nabla}\times\mathbf{H})$ is included in the momentum equation. This is appropriate to a compressible, nonviscous, perfectly conducting fluid. To these we add Maxwell's equations and the equation of state of the system. This system is extremely complicated; Jackson provides some simplifications.