Generalized Parallel Ion Viscous Stress Tensor in Slab Geometry

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Abstract

An analytical prelude to the NIMROD[1] implementation of the generalized (unified) parallel ion viscous stress[2] is presented in this work. The unified stress closure is cast into geometrically correct form suitable for the study of fluid flow, heat flow and general fluid dynamics, in magnetized plasmas of arbitrary collisionality. In this work, analytical models of plasma flow and temperature evolution, in slab geometry[3], were closed with the unified closure, instead of the Braginskii-type closure. The plasma is modeled as that immersed in slab magnetic islands[4] which may or may not include field line stochasticity. This model of flow and temperature evolution is further reinforced by using the integral parallel heat flow closure[5] in the energy conservation equation. Thus, the complete NIMROD-ready analytical model comprises all the relevant forms of equations, closures and weak forms that would facilitate NIMROD matrix computations, semi-implicit time advance, grid recomputation etc, in slab geometry. The divergence and gradient of the parallell ion sress tensor is derived, and its effects evaluated , within the context of fusion physics. The next logical step, in the future, would focus on implementing this model in NIMROD and performing relevant investigations. In particular, future work would involve NIMROD studies of several paradigms of plasma collisionality (low to high), as well all as various regimes of magnetic field stochasticity, to find out whether unified closures lead to more accurate physical results.

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