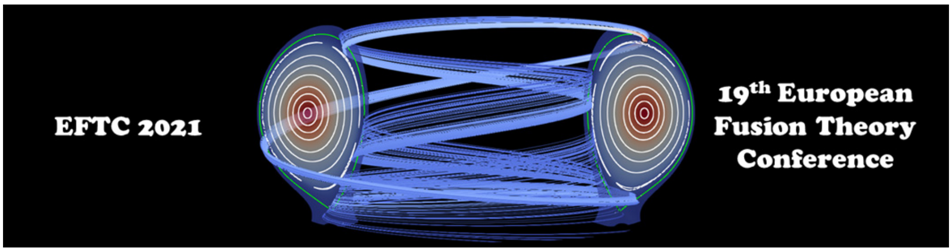

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On Ohm's law in reduced plasma fluid models

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Drift-reduced plasma fluid models are commonly used to model the edge-SOL region of L-mode discharges in tokamaks. It is often observed that electrostatic simulations of plasma turbulence are restricted to a very small explicit timestep, or the implicit timestep is very poorly conditioned. The origins of this restriction can be traced to the properties of the linear waves supported by the model. We present the results of our recently submitted paper, where we review the impact on the system dispersion relation of different approximations that can be made in the model Ohm's law. The analysis uses a simplified set of equations which nevertheless contain the key linear features of a wide class of drift-reduced models used in the plasma community to model SOL turbulence. The electrostatic limit features dispersion relations that diverge at small perpendicular wave number $k_\perp$, giving rise to fast dynamics that may limit timestep size in simulations, or result in a poorly conditioned implicit timestep, as has been noted in gyrokinetic simulations. An electromagnetic Ohm's law removes the difficulty at small $k_\perp$, but in the zero electron mass case introduces a divergence at large $k_\perp$ due to the kinetic Alfven wave. Including in addition finite electron mass results in a well behaved dispersion relation, with parallel wave speeds between the Alfven speed at low $k_\perp$ and the electron thermal speed at high $k_\perp$. The practical significance of our conclusions from the dispersion relation is demonstrated in non-linear seeded filament simulations using STORM. Even in the very low \beta conditions of the SOL, including both electromagnetic effects and finite electron mass results in the fewest iterations per unit simulation time being taken by the implicit time-solver.

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