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SHEAR-DRIVEN DYNAMO WAVES IN THE FULLY NON-LINEAR REGIME

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Large-scale dynamo action is well understood when the magnetic Reynolds num- ber (Rm) is small, but becomes problematic in the astrophysically relevant large Rm limit since the fluctuations may control the operation of the dynamo, obscuring the large-scale behavior. Recently, Tobias & Cattaneo (2013); Cattaneo & Tobias (2014) demonstrated numerically the existence of large-scale dynamo action in the form of dynamo waves driven by strongly helical turbulence and shear. Their calculations were carried out in the kinematic regime in which the back-reaction of the Lorentz force on the flow is neglected. Here, we have undertaken a systematic extension of their work to the fully nonlinear regime. Helical turbulence, and large scale shear are produced self-consistently by prescribing body forces that, in the kinematic regime replicate the original velocity used by Tobias & Cattaneo. We have found four different solution types in the nonlinear regime for various ratios of the fluctuating velocity to the shear and Reynolds numbers. Some of the solutions are in the form of propagating waves. Some solutions show large-scale helical magnetic structure. Both waves and structures are permanent only when the kinetic helicity is non-zero on average.

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