

Numerical Study of the Flow in a Finite Cylinder Driven by a Rotating Magnetic Field

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We present direct numerical simulations (DNS) of the flow in a finite cylinder driven by a rotating magnetic field. Employing the rigid-body and low-frequency approximations the mathematical model reduces to the Navier–Stokes equations with a priori known Lorentz force. A second-order finite-element method combined with Adams-Bashforth time integration is used for discretization. The objective of this study is to identify the dominating structures and mechanisms in the transitional and early turbulent flow regimes. The DNS cover a range up to $10T_{ac}$, where T_a denotes the magnetical Taylor number. The most striking result of the study is the insight in the formation, evolution and finally dissipation of Taylor-Gortler-like vortices that clearly dominate the turbulence physics and provide an efficient mixing mechanism in this flow. Moreover, large scale flow variations in azimuthal direction could be identified. However, these fluctuations do not contain any harmonic components even in near-critical flow.

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