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Direct Numerical Simulation of Instabilities in MHD Duct Flows
MAXIME KINET, Université Libre de Bruxelles, SERGEI MOLOKOV, Coventry University, XAVIER ALBETS, University of Cyprus, BERNARD KNAEPEN, Université Libre de Bruxelles — Magnetohydrodynamics (MHD) — which governs the flow of an electrically conducting fluid in presence of a magnetic field — has applications in the steel industry (where magnetic fields are used to damp or to stir the turbulent motions) and in nuclear fusion devices (i.e. tokamaks). There, the liquid lithium, used as coolant, undergoes the effect of the plasma-confining magnetic field. When a magnetic field is applied perpendicularly to a rectangular duct whose walls are electrically conducting, the Lorentz force strongly modifies the the flow and gives rise to an M shaped velocity profile with two strong jets in the vicinity of the walls parallel to the magnetic field. Because of the important shear they generate, those jets are unstable at sufficiently high Reynolds number. Using Direct Numerical Simulations, we compute the critical Reynolds number as a function of the wall conductivity and the strength of the magnetic field. The frequency and form of the corresponding instabilities are also studied. Finally, turbulence statistics and mean velocity profiles in the fully developed regime are discussed.

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