Turbulence: Effects of Rotation

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Energy Transfer in Turbulence under Rotation HUSSEIN ALUIE, University of Rochester, MICHELE BUZZICOTTI, LUCA BIFERALE, MORITZ LINKMANN, University of Rome Tor Vergata — It is known that rapidly rotating turbulent flows are characterized by the emergence of simultaneous direct and inverse energy cascades. However, the organization of interactions which leads to this complex dynamics remains unclear. Two different mechanisms are known to be able to transfer energy upscale in a turbulent flow: (i) 2-dimensional interactions amongst triads lying on the 2D3C (or slow) manifold, and (ii) purely 3-dimensional interactions between a sub-set of triads with the same sign of helicity (homo-chiral). Here, we perform a numerical study of high Reynolds rotating flows by means of direct numerical simulations (DNS), in different parameter regimes to highlight both forward and inverse cascade regimes. We find that the inverse cascade at wavenumbers close to the forcing scale is generated by the dominance of homo-chiral interactions which couple the 3-dimensional bulk and the 2D3C plane. This coupling produces an accumulation of energy in the 2D3C plane, which then transfers energy to smaller wavenumbers thanks to a 2-dimensional mechanism. We further analyze the energy transfer that occurs in different regions in the real-space domain. In particular we distinguish high strain from high vorticity regions and quantify their contributions to the cascade.

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