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Phase transitions and flux-loop metastable states in rotating turbulence LUCA BIFERALE, Department of Physics and INFN, University of Rome Tor Vergata, PATRICIO CLARK DI LEONI, Department of Mechanical Engineering, Johns Hopkins University, ALEXANDROS ALEXAKIS, Laboratoire de Physique de l'Ecole Normale Superieure, CNRS, PSL Research University, MICHELE BUZZICOTTI, Department of Physics and INFN, University of Rome Tor Vergata — By using direct numerical simulations of up to a record resolution of 512x512x32768 grid points we discover the existence of a new metastable out-of-equilibrium state in rotating turbulence. We scan the phase space by varying both the rotation rate and the dimensionless aspect ratio, $\lambda = H/L$, where L and H are the sizes of the domain perpendicular and parallel to the direction of rotation, respectively. We show the existence of three turbulent phases. For small Ro but finite λ, we have a split cascade where the injected energy is transferred to both large and small scales. For large λ and finite Ro there is no inverse cascade and the energy is transferred downscale in Fourier space only. Surprisingly, between these two regimes, a third phase is observed as reported here for the first time. Consequently, for certain intervals of Ro and λ, energy is no longer accumulated at arbitrarily large scales, rather it stops at some characteristic intermediate length-scales from where it is then redistributed forward in Fourier space, leading to a flux-loop mechanism where the flow is out of equilibrium with vanishing net flux, and non-vanishing heterochiral and homochiral sub-fluxes. P. Clark Di Leoni, et al. arXiv preprint arXiv:2002.08784 (2020).

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