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The nature of triad interactions in active turbulence JONASZ SLOMKA, PIOTR SUWARA, JORN DUNKEL, Massachusetts Institute of Technology — Generalized Navier-Stokes (GNS) equations describing three-dimensional active fluids with flow-dependent spectral forcing possess numerical solutions corresponding to parity-violating Beltrami-type chaotic flows that can sustain an upward energy transfer. To rationalize these findings, we study the triad truncation of two GNS models. Utilizing a previously unknown cubic invariant, we show that the asymptotic triad dynamics reduces to that of a forced rigid body coupled to a particle moving in a magnetic field. This analogy allows us to classify the triadic interactions by their asymptotic stability: unstable triads correspond to rigid-body forcing along the largest and smallest principal axes, whereas stable triads arise from forcing along the middle axis. This suggests that the unstable triads dominate the initial relaxation stage of the full GNS equations, which is characterised by helicity growth, whereas the stable triads determine the statistically stationary state. To support this hypothesis, we introduce and simulate a new active turbulence model, which develops an energy spectrum with Kolmogorov-type -5/3 scaling. Our results suggests that Beltrami-type flows and an inverse energy cascade are generic features of 3D active turbulence models with flow-dependent forcing.

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