Scilight

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Study takes a comprehensive look at energy distribution and transfers in rotating turbulence

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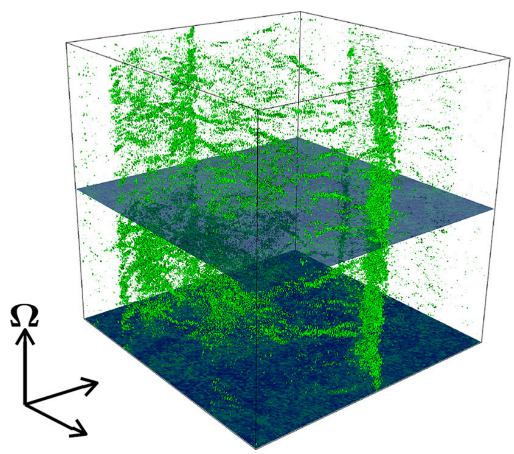
A numerical simulation of energy in rotational turbulence finds a significant difference between forced and decaying systems.



Turbulence in a rotating fluid is a common phenomenon, found in stars and reciprocating engines, amongst others. Yet despite numerous analytical, experimental and numerical experiments, its precise energy spectrum remains a topic of contention. Research from Sharma et al. has taken a fresh look at forced and decaying rotating turbulence using numerical simulations, and their results found significant differences between the two systems.

By simulating a forced, incompressible, rotating fluid, the study looked at the statistical features of the system and modeled the energy spectrum. Substantially different behavior presented in the results for wavenumbers larger and smaller than the wavenumber of forcing. At large scales, where the Coriolis effect is an important force perpendicular to the rotation, the system showed strong anisotropy and produced what's known as a Kuznetsov-Zakharov-Kolmogorov spectrum. Surprisingly, for smaller scales, the energy spectrum scaled exponentially, decaying faster than a power law that was reported in earlier work on rotating turbulence.

The authors found structures of the decaying turbulence to be much stronger than the forced one. The energy exhibited an inverse cascade, an extensively studied behavior. This inverse cascade created columnar structures in the flow on large horizontal scales.

The study did not simulate kinetic helicity — which accounts for the interconnectivity of vortices in the flow — though the authors expect it would likely impact forced and decaying turbulence differently. Simulating kinetic helicity will be important future work as it is found in planetary cores, including Earth's, as well as in stellar interiors.

Source: "On the energy spectrum of rapidly rotating forced turbulence," by Manohar K. Sharma, Mahendra K. Verma, and Sagar Chakraborty, *Physics of Fluids* (2018). The article can be accessed at https://doi.org/10.1063/1.5051444.