Researchers reveal multi-scale characteristics of helicity in wall-bounded turbulent flows
19 May 2022, by Li Yuan

A research team from the Institute of Mechanics of the Chinese Academy of Sciences has revealed the multi-scale characteristics of helicity in wall-bounded turbulent flows.

Helicity is a second-order inviscid invariant in three-dimensional turbulence, which plays a key role in the evolution of turbulent systems. The research on the basic theory of helicity is important to improve the performance of the aero-engine, gas turbine and other key equipment.

In the past few decades, the helicity effect was mainly used to explore the internal mechanism of turbulence, but the statistical properties of helicity in turbulence, especially anisotropic turbulence, were rarely studied.

In this study, the researchers investigated the helicity statistics in turbulent channel flows with streamwise rotation at moderate rotation numbers and Reynolds numbers, including their spatial and scale distributions, anisotropy and cross-scale transfer.

They extended the helical turbulence theory from homogeneous and isotropic turbulent flows to wall-bounded turbulent flows. They found a new peak of helicity within the near-wall regions, which corresponded to an apparent scale separation of helicity distribution.

The results also showed that nonlinear interactions of different scales were strong sufficiently to sustain the broadband helicity spectra. Numerical consequences indicated that helicity cascade in wall-bounded turbulent flows was dominated by the vortex stretching process.

These findings will provide a necessary theoretical basis for more complex research on rotating wall turbulence theory and application technology.

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