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Quantitative visualization of fine-scale three-dimensional flow structures in turbulence using time-resolved stereoscopic scanning Particle Image Velocimetry YE CHENG, FRANCISCO JAVIER DIEZ — A time-resolved stereoscopic scanning particle image velocimetry (TR-SSPIV) system is developed to investigate the fine-scale 3D structures in free shear turbulent jets. The system provides a simultaneous measurement of the three-component velocity field in a three-dimensional volume (3D3C) with Kolmogorov-scale (η) resolution, offering a true representation of the complete nine-component velocity gradient tensor. Quantitative visualization of the coherent structures at fine-scale turbulence is obtained and four basic structural shapes (sheets, tube, square ribbons and spherical blobs) are identified as building blocks of complex turbulent structures. The local acceleration $\partial\mathbf{u}/\partial t$ is obtained and represented as 3D structures, which showed a strong anti-alignment with the convective acceleration terms. A novel vortex identification scheme is introduced based on the local pressure. This method gives more direct description of vortex cores, compared to previously published ones including enstrophy, Q, λ_2 and Δ criteria. Extensive statistical analyses are performed to study the probability density function (PDF), joint PDF, and spectra of the velocity gradients, enstrophy production rate and energy dissipation rate to compare with isotropy theory.

Ye Cheng

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