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Three-Dimensional Turbulent Structures of Different Scales

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An orthogonal vector wavelet multi-resolution technique has been developed and applied to decomposing the three-dimensional velocity data, which were simultaneously obtained by sixteen X-wires in two orthogonal planes in the turbulent near-wake of a circular cylinder, into a number of wavelet components based on their central frequencies or scales. The three-dimensional turbulent structure of each wavelet component is examined in terms of sectional streamlines and vorticity contours. The spanwise vorticity contours of the wavelet component at f0 (the vortex shedding frequency) display a secondary spanwise structure near the saddle point, whose vorticity is opposite-signed to that of the Kármán vortices. The wavelet components of f0 or 2f0 make a predominant contribution to the Reynolds normal stresses and account for most of the shear stress. On the other hand, the components of frequencies higher than f0 and 2f0 or the relatively small-scale turbulent structures contribute most to vorticity variance.

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