On the structure of acceleration in turbulence

Acceleration and spatial velocity gradients are obtained simultaneously in an isotropic turbulent flow via three dimensional particle tracking velocimetry. We observe two distinct populations of intense acceleration events: one in flow regions of strong strain and another in regions of strong vorticity. Geometrical alignments with respect to vorticity vector and to the strain eigenvectors, curvature of Lagrangian trajectories and of streamlines for total acceleration, and for its convective part, are studied in detail. We discriminate the alignment features of total and convective acceleration statistics, which are genuine features of turbulent nature from those of kinematic nature. We find pronounced alignment of acceleration with vorticity. Similarly, and especially are predominantly aligned at 45° with the most stretching and compressing eigenvectors of the rate of the strain tensor, , and , respectively. Via autocorrelation functions of acceleration, conditioned on preferential directions, the vorticity vector field is found to play an important role as an ordering reference axis for acceleration orientation. Associating a velocity–acceleration structure function with an energy flux gives a clear indication that a strong energy flux occurs via compression in strain dominated events and via stretching in vorticity dominated events.

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