Interactions between coherent motion and small scales. What can we learn from phase-averaged structure functions?

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Since the pioneering work of Townsend or Roshko and many other researchers since, it is now well known that most of shear flows give rise to some so-called coherent structures. These are energy containing eddies at rather large scales, but in contrast with classical large-scale turbulence, coherent structures strongly persist in time and/or in space. Their topology depends on initial conditions and their related statistics are not universal. The information enclosed within coherent structures persists until the far field and may thus influence small-scale statistics through non-local interactions and finite Reynolds numbers effects. Coherent structures have also the best prospect of being externally damped or excited for the whole range of scales of a given flow to be controlled.

Investigating the nature of the interactions between the coherent motion and the small scale motion is the principal motivation of the present work. We address three specific issues: *(i)* Is there a connection between activity of small scales at a given scale and the dynamics of the coherent motion? *(ii)* Is there an effect of the coherent shear and local anisotropy? *(iii)* What are the energy budget equations at a given scale in flows where a coherent motion may be discernible?

To unravel these issues, we extend the approach of *e.g.* Reynolds & Hussain 1972, by conditioning structure functions by a particular value of the phase ϕ arising from the phase-averaging operation. This study focuses mostly on a circular cylinder wake flow, which is investigated by means of hot wire experiments.

Close to the obstacle, it is shown that the influence of the coherent motion is perceptible even at the smallest scales, whose energy is enhanced when the coherent strain is maximum. Further downstream from the cylinder, the coherent motion clearly affects the largest scales, but the smallest scales are not likely to depend explicitly on the CM.

The second outcome of the present study concerns the dynamical effect of the coherent shear on local isotropy, which is investigated through kinematic and phenomenological test of isotropy.

We further derive energy budget equations on the basis of phase-conditioned structure functions. They reveal some additional forcing terms, the most important of which highlights an additional cascade mechanism associated with the presence of the CM. The isotropic formulation of the random motion energy budget compares favorably with experimental results.