# On the small-scale coherent structures of wall-bounded turbulence

Sergio Pirozzoli

*Dipartimento di Meccanica e Aeronautica, Università di Roma "La Sapienza"*

*Via Eudossiana 18, 00184 Roma (Italy)*

Coherent eddy structures are regarded as playing a major role in the dynamics of turbulent flows, both in the case of free-shear flows and of wall-bounded flows. It is well known that zones of intense vorticity in isotropic turbulence have either tube- or sheet-like shape [1–3]. Vortex tubes (the so-called worms) drew most of the attention in early numerical simulations and experiments [4, 5], being the most prominent observed feature. Deeper analysis showed that vortex sheets, consisting of zones of locally nearly two-dimensional shearing motion, provide a dominant contribution to the enstrophy production through vortex stretching, and to energy dissipation [6], and therefore are at least as important as vortex tubes. Despite this evidence, vortex sheets are often disregarded, since they exhibit strong tendency to roll-up according to Kelvin-Helmholtz instability mechanisms forming vortex tubes, and their lifetimes are relatively short [7]. In the present work the statistical and geometrical properties of the small scale structures in wall-bounded turbulence will be investigated. Particular emphasis will be placed on assessing the validity of eduction methods for vortex tubes and sheets. Preliminary analysis has shown that in the inner part of the boundary layer vortex sheets are comparatively much more frequent than tubes, and they provide a dominant contribution to both turbulence kinetic energy and enstrophy. The statistical relationship between vortex tubes and vortex sheets will also be analyzed by means of conditional average fields extracted from a DNS database. The results (of which a sample is shown in Fig. 1) support strong association between the two types of coherent structures, and indicate that vortex tubes are produced upon roll-up of vortex sheets (as in the hairpin vortex paradigm), or interact causing the ejection of near-wall vorticity, or generate sheets of streamwise vorticity through a rubbing effect caused by the no-slip condition.

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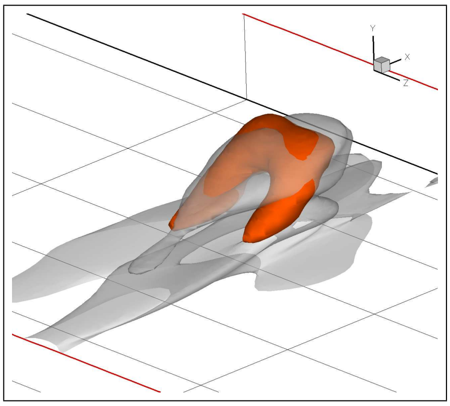

FIG. 1: Conditional expected fields associated with cross-stream, clock-wise vortex tubes. Light gray: iso-surfaces of sheet strength $\omega_s$; Orange: iso-surfaces of vortex tubes strength $\omega_t$.

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