Internal and external intermittency in turbulent scalar mixing at finite Reynolds numbers

Michael Gauding

In this seminar, internal and external intermittency in turbulent scalar mixing is analyzed by a combination of theoretical and numerical techniques.

Internal intermittency signifies coexistence of highly turbulent regions with regions where fluctuations are smoother. One way to examine this phenomenon, still an open question in modern turbulence, is to study statistical properties of the scalar increment, i.e. the difference of the scalar field at two points separated by a distance r. Scale-by-scale energy budget equations for high-order moments of the scalar increment are:

-formulated with an explicit account of the finite Reynolds number effect, and

-assessed using direct numerical simulations several flows at different Reynolds numbers. Special emphasis is laid on the scaling of the 'source' term that directly connects the instantaneous dissipation rate to the local variance of the scalar. Thus, the effect of intermittency is entangled by a complex mechanism involving both small and large scales. The aim is to close this term and therefore to propose analytical solutions for the transport equations. Proposing closures for this term requires a deep understanding of the way fluctuations are born in the flow. In free turbulent flows, the origin of the fluctuations stands in the entrainment of non-vortical flow into the fully developed turbulent region, which gives rise to the concept of external intermittency.

External intermittency is examined by direct numerical simulation of a plane turbulent jet flow. The edge of turbulent jet flows is characterized by having turbulent regions adjacent to non-turbulent ones. Both regions are separated by a thin interface. The impact of this interface on turbulent mixing is studied from conditional statistics.