Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Local topology of energy transport in isotropic turbulence[1]

JONAS BOSCHUNG[2], CHARLES MENEVEAU, Johns Hopkins University — Similar to the velocity vector field, whose tangent (stream) lines represent how fluid volume (or mass in constant density flows) is transported in the flow, it is of interest to consider the vector field corresponding to the transport of mechanical energy (Meyers & Meneveau, 2012). The transport includes advection and viscous diffusion. In order to characterize the local topology of this vector field in turbulence, we examine statistical properties of its gradient field. This energy transport field is not divergence-free, due to dissipation and unsteady changes of kinetic energy. Therefore, the first invariant (the trace) of its gradient tensor is not zero, as in compressible flow. The three invariants P_E, Q_E and R_E of the energy transport gradient tensor are analyzed using concepts developed earlier for analysis of compressible flows. Data from DNS of isotropic turbulence is used, from the JHU database (Li et al. 2008, JoT), as well as other sources. Contracting node-like topology occurs very frequently, consistent with the dissipative nature of fluid turbulence. Further topological properties are established based on conditional PDFs of the invariants, and flow visualizations are used to develop insights into the local structure of the energy transport vector field

[1]This work is supported by project CMMI-0941530. The authors also thank Prof. J. Meyers, Prof. N. Peters and Mr. P. Schaefer for interesting discussions on this topic.

[2]Permanent address: Department of Mechanical Engineering, RWTH Aachen, Germany.

Charles Meneveau
Johns Hopkins University

Date submitted: 07 Aug 2012 Electronic form version 1.4