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On the kinematics of scalar iso-surfaces in turbulent flow[1]
WEIRONG WANG, JAMES J. RILEY, JOHN C. KRAMLICH, University of Washington — The behavior of scalar iso-surfaces in turbulent flows is of fundamental interest and also of importance in certain applications, e.g., the stoichiometric surface in nonpremixed, turbulent reacting flows. Of particular interest is the average area per unit volume of the surface, Σ. We report on the use of direct numerical simulations to directly compute Σ and to model its evolution in time for the case of isotropic turbulence. Using both a direct measurement technique, and also Corrsin's (1955) suggestion of surface-crossing, we find the iso-surface in space and also measure Σ as the surface evolves in time. This allows us to follow the growth of the surface due to local surface stretching and its ultimate decrease due to molecular destruction. We are also able to measure the principal terms in the evolution equation for Σ, including the surface stretching term $\mathcal{S}$ and the molecular destruction term $\mathcal{M}$. For example, for the scalar Z we find that its spatial derivative quantities are approximately statistically independent of Z itself, so that $\mathcal{S}$ and $\mathcal{M}$ are approximately statistically independent of Z as well. Finally, a model is proposed which fairly accurately predicts the evolution of Σ.

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