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Building up a turbulent jet from homogeneous turbulence

B. Viggiano[a], T. Basset[b], L. Chevillard[b], R. Volk[b],
C. Meneveau[c], M. Bourgoin[b] and R. B. Cal[a]

A Lagrangian model is proposed to construct a turbulent jet, with the ability to capture intermittency, using self-similarity principles inspired by Batchelor[1]. The original methods of Batchelor[1] provide techniques to extend Lagrangian theory of turbulent diffusion by Taylor[2] to inhomogeneous flow fields (instationary Lagrangian flows), but in transforming these relations, a turbulent jet can be modelled from an ensemble of homogeneous, isotropic, stationary, turbulent velocity signals. This is achieved through compensation of the Lagrangian velocity and the time step of the trajectory to account for the decay of background Eulerian turbulent fluctuations and to address the evolution of temporal Eulerian background properties, respectively. The transformation is performed on the initial stationary signals, shown in figure 1(a), to create a turbulent jet, a subset of the modelled trajectories is provided in figure 1(b). To validate the model, experimental jet data is provided, a subset of its trajectories are presented in figure 1(c) where qualitatively, there is good agreement between the modelled and experimental jet. Furthermore, the statistics of the experimental and modelled data are compared at four downstream locations along the centreline of the jet. Results of the two datasets show good agreement for Eulerian and Lagrangian statistics. Special attention is paid to the probability density functions of the velocity increments to validate the ability of the model to reproduce Lagrangian intermittency. Remarkable agreement is observed.

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[a] Dep. Mechanical Engineering, Portland State University, Portland, OR 97201, USA
[b] Laboratoire de Physique, ENS de Lyon, CNRS, 69007 Lyon, France
[c] Dep. Mechanical Engineering, The Johns Hopkins University, Baltimore, MD 21218, USA
[1] Batchelor, *J. Fluid Mech.* **3**, 67 (1957).
[2] Taylor, *Proc. Lond. Math. Soc.* **20** (1), 196 (1922).

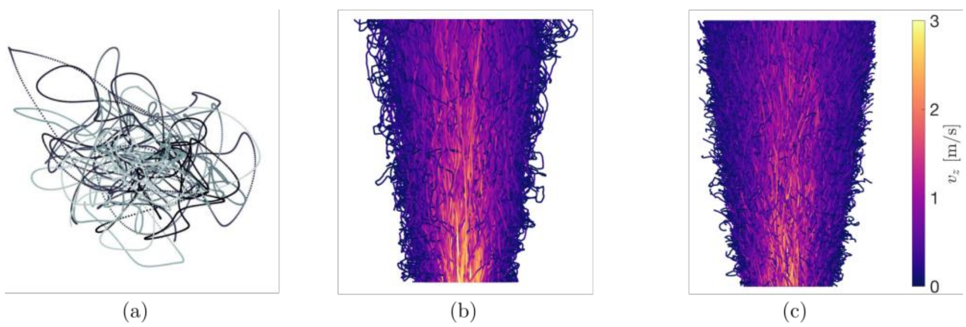

Figure 1: (a) Homogeneous isotropic and stationary signal. (b) Modelled velocity trajectories of the jet. (c) Experimental velocity trajectories.