Lagrangian structure-function using stationarised fluid trajectories in the wake of a smooth cylinder

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We present here a statistical study to determine the Lagrangian structure function in the anisotropic and inhomogeneous wake behind a smooth cylinder. Based on the extension of the stationary Lagrangian diffusion theory to self-similar flows, we stationarise velocity components in order to obtain Lagrangian statistics. Viggiano et al. (2011)[1] have shown how to obtain fundamental Lagrangian statistics from the anisotropic and inhomogeneous dynamics of a jet flow by normalizing the trajectories based on local Eulerian scales. In particular, computing the Lagrangian structure-function scaling constant C_0 is a crucial parameter in modelling turbulent transport. A similar role is played by the C_0 constant in the Lagrangian framework as a Kolmogorov constant in the Eulerian framework. We performed direct numerical simulations (DNS) and time-resolved particle tracking velocimetry (4D-PTV) experimental analyses in the wake behind a smooth cylinder for Reynolds numbers between 300 to 3900. Details of the tracking algorithm used in the present study are addressed in Khojasteh et al. (2021)[2]. Preliminary results of the experiments indicated reasonable agreement between the stationarised Lagrangian trajectories of the wake flow and the hypothesis of Lagrangian self-similarity at inertial scales (see Fig. 1).

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1 Viggiano et al., J. Fluid Mech. **918**, 25 (2021).

2 Khojasteh et al., *Phys. Fluids* **33**, 095113 (2021).

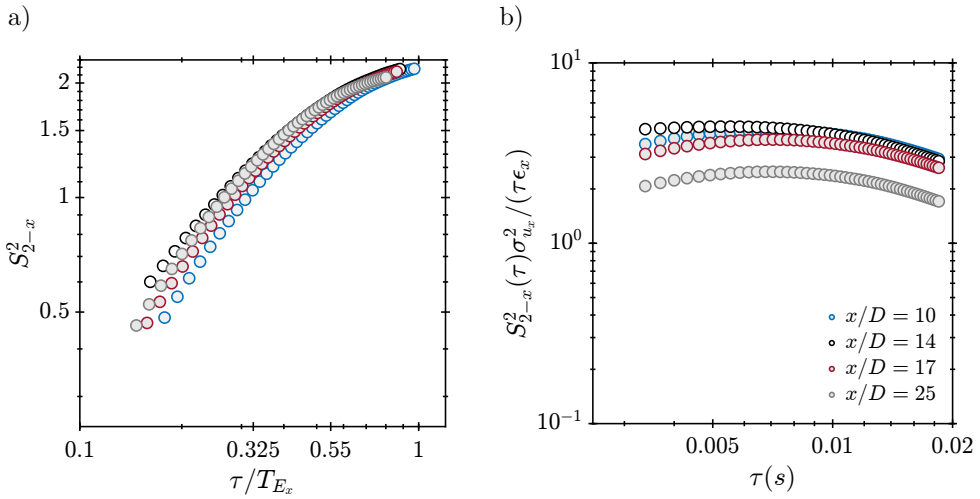

Figure 1: Lagrangian second order structure function of the streamwise direction at four downstream locations. (a) As a function of non-dimensional timescale. (b) Re-dimensionalised structure function representing the C_0 constant.