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Scale-dependent entrainment velocity and scale-independent net entrainment in a turbulent axisymmetric jet[1] JIMMY PHILIP, University of Melbourne, DHIREN MISTRY, JAMES DAWSON, Norwegian University of Science and Technology, IVAN MARUSIC, University of Melbourne — The net entrainment in a jet is the product of the mean surface area ($\overline{S}$) and the mean entrainment velocity, $\overline{V}\ \overline{S}$, where, $\overline{V} = \alpha U_c$ with α the entrainment coefficient and U_c the mean centreline velocity. Instantaneously, however, entrainment velocity (v) at a point on the interface is the difference between the interface and the fluid velocities, and the total entrainment $\int v \ \mathrm{d}s = V\ S$, where S is the corrugated interface surface area and V the area averaged entrainment velocity. Using time-resolved multi-scale PIV/PLIF measurements of velocity and scalar in an axisymmetric jet at $Re = 25000$, we evaluate V and S directly at the smallest resolved scales, and by filtering the data at different scales (Δ) we find their multi-scales counterparts, V_Δ and S_Δ. We show that $\overline{V}\ \overline{S} = V_\Delta\ S_\Delta = V\ S$, independent of the scale. Furthermore, S is found to have a fractal dimension $D_3 \approx 2.32 \pm 0.1$. Independently, we find that $V_\Delta \sim \Delta^{0.31}$, indicating increasing entrainment velocity with increasing length scale. This is consistent with a constant net entrainment across scales, and suggests α as a scale-dependent quantity.

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