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Pathways to Elasto-inertial Turbulence in Polymer Jets[1] SAMI YAMANI, MIT, TAMER A. ZAKI, Johns Hopkins University, GARETH H. MCKINLEY, IRMGARD BISCHOFBERGER, MIT — We report experiments on the spatio-temporal evolution of flow structures in a jet of dilute polymer solution entering a quiescent bath of Newtonian fluid. High-speed digital Schlieren imaging is used to follow the evolution of local Lagrangian features revealing a rich sequence of transitional and turbulent states. A comprehensive state diagram constructed using the Reynolds number Re, elasticity number and polymer extensibility shows that increasing the fluid viscoelasticity at fixed Re initially destabilizes and then re-stabilizes the flow. At high elasticity numbers, we identify a distinct transitional pathway to elasto-inertial turbulence (EIT) which stabilizes the conventional turbulent bursts observed in Newtonian jets and instead a shear layer instability leads to elongated filaments of elastic fluid, termed elasto-inertial streaks. Within the family of jet flows studied here, we find that the temporal features of EIT far from the nozzle are universal and characterized by a power-law spectral decay f^{-3}, independent of fluid properties or flow parameters, whilst the spatial features of the turbulent structures in the jet strongly depend on polymer microstructure and concentration.

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