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Nonlinear instabilities and Koopman Modes in axisymmetric multiphase shear flows DANIEL DUKE, JULIO SORIA, DAMON HONNERY, Monash University, LABORATORY FOR TURBULENCE RESEARCH IN AEROSPACE & COMBUSTION TEAM[1] — The shear-driven atomisation of multiphase flows is a process about which relatively little is understood, as it is driven by complex, detailed and short-lived transient instabilites. Novel high-resolution surface velocimetry of axisymmetric annular sheets reveals new detail which has not been previously observed through spatially and temporally resolved velocity profiles. We hypothesise that three simultaneous and separate physical sources of instability may explain the complexity of this flow. A novel application of the Hilbert Transform permits the isolation of these distinct instabilities. The first two are the more well-known nozzle boundary layer and free shear layer driven instabilities. The third is due to nonlinear sheet distortion leading to rupture and may be directly driving the primary atomisation process. This instability has not been previously observed in isolation and is inherently non-linear and non-sinusoidal which has made its eduction challenging. A novel application of Koopman modes through use of the Dynamic Mode Decomposition suggests that traditional theoretical approaches to understanding these flows may need to be re-examined.

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