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Analysis for inertial and elastic instabilities in extensional flow and comparisons with cross-slot flow HOWARD HU, RANJIANGSHANG RAN, PAULO ARRATIA, University of Pennsylvania, H. HU, R. RAN AND P. ARRATIA TEAM — We theoretically investigate the instabilities of a steady planar extensional flow of viscoelastic fluids with the flow vorticity equation. The results of this linear stability analysis indicate two distinct instabilities depending on the values of Reynolds number (Re) and Weissenberg number (Wi). One instability is an inertia-dominated one occurring at a critical Re, in which the vorticity component ω_x becomes unstable, suggesting an emerging axial vortex in the extensional direction x. The other instability is an elasticity-dominated one at high Wi, where the vorticity component ω_z in the direction normal to elongational plane becomes unstable, indicating a symmetry breaking on the elongational xy-plane. The predicted critical Re and Wi numbers of these two instabilities by the linear stability theory are critically compared with experimental and numerical results in the cross-slot channel flows.

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