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# Instabilities in extensional flows and the dynamics of rifts in ice-shelves

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Ice shelves that spread into the ocean can develop rifts, which can trigger ice-berg calving and enhance ocean-induced melting. Fluid mechanically, this system is analogues to the propagation of a non-Newtonian, strain-rate-softening fluid representing ice that displaces a relatively inviscid and denser fluid that represents an ocean. Recent scaled laboratory experiments have shown that when the flow geometry is circular the front of the displacing non-Newtonian fluid, which represents the leading edge of a shelf, can become unstable and evolve finger-like patterns comprised of rifts and tongues (Sayag & Worster, 2019a). As the rifts and tongues evolved, their number declined with time through the closure of some rifts.

In this study we focus on the weakly nonlinear stability of the propagating front. We consider an annular ice shelf having a fixed grounding line and an edge that evolves due to constant mass flux across the grounding line. We investigate the time evolution of the perturbed front to quantify the instability mechanism and the reduction of the number of rifts and tongues over time. The model predictions have better agreement with experimental measurements than previous studies. Our analysis elucidates the formation and evolution of rifts in ice shelves and provides testable predictions.