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Sheet's getting real: dynamics and fragmentation in polymeric fluid sheets

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We encounter fragmentation in fluid sheets whenever we visit a waterfall or hold our thumb over the end of a hose. Because of their 2D geometry, these sheets present a unique opportunity to explore material instabilities. Newtonian fluid sheets have been well characterized; we are working toward an analogous understanding of complex fluid sheets, where the viscosity of the material depends on the applied stress. Fragmentation patterns in polymeric fluid sheets in particular demonstrate the distinct effects of flow properties and mesoscale fluid structure on material stability. In our experiments, we generate the sheets via the collision of two liquid jets and film their dynamics using high-speed photography. Our findings indicate that quickly-expanding sheets are less stable than slowly flowing sheets, and that higher viscosities generate thicker and more stable sheets. Jet velocity, jet diameter, and the investigated fluid's flow properties are all important in setting the observed instabilities, but polymeric fluids such as Carbopol 940 which self-assemble into microgels have unique fragmentation patterns. Adding sugar alcohols to these solutions changes the microstructure of the fluid without changing its rheology, which allows us to separately examine the roles of these two parameters.

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