Kirigami sheets in fluid flow

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We show that kirigami patterned sheets placed in fluid flow exhibit a variety of structural responses (highly stable elongations, limit cycle oscillations, and snap-through buckling) and generate a myriad of wake patterns (complex jet arrays as well as multi-scale vortex shedding). These are all observed with simple changes in the patterns of cuts applied to a thin sheet of material. This work focuses on three main categories of kirigami patterns: ribbon cut, closed loop, and fractal cut, as they are deployed in flow. The ribbon cut patterns create an array of jets and induce significant turbulence in their wake and can take on different deployed profiles depending on how each strip of material is biased to rotate during elongation. Closed loop patterns are stable and exhibit smooth and sizable elongations, while redirecting the incoming flow in a radial direction. This characteristic stability is present across a range of geometrical parameters of the cuts and makes closed loop patterns attractive for the development of practical applications. Fractal cut patterns are characterized by buckling instabilities at critical flow velocities and produce an array of jets in their wake. Three-dimensional wake reconstruction reveals the complexity of these jet arrays and the influence of each specific reconfiguration on the observed jets.

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