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Static shapes and instability of hanging flags conveying fluid

TONY S. YU, Department of Mechanical Engineering, MIT, SUNGHWAN JUNG, Department of Mathematics, MIT, CHRISTOPHE CLANET, LadHyX, Ecole Polytechnique — We investigate the interaction between a fluid jet and a long, thin sheet, *i.e.* "flag", clamped to the jet-nozzle. The jet wets and flows along one side of the flag from base (clamped end) to tip, which hangs freely. Experiments reveal a lateral force at the "free" end of the hanging flag; this force arises from the minimization of surface-energy as the jet detaches from the flag surface. At low Weber numbers (*i.e.* low flow rates), the tip force produces stable, static flag shapes with wavelengths inversely proportional to the flow rate. The static shapes are well described by a simple model coupling linear beam bending and inviscid flow. At higher Weber numbers, static shapes become unstable, leading to periodic oscillations analogous to previous work on hanging cantilever tubes conveying fluid (Paidoussis, 1970; Doaré and Langre, 2002). The observed critical flow rates for instability agree well with those predicted by linear stability analysis.

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