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The Formation of Turbulent Vortex Rings by Synthetic Jets JOHN LAWSON, University of Cambridge, JAMES DAWSON, The Norwegian University of Science & Technology — Vortex rings formed by synthetic jets are found in many engineering and biological flows. For vortex rings formed both periodically and in isolation, a constraint on vortex formation ("pinch-off") has been observed which is relevant to unsteady propulsion. However, there is no clear consensus on the physical mechanism of this constraint. We present analysis of time resolved, 2D Particle Image Velocimetry measurements of the velocity and material acceleration field in an axisymmetric, turbulent synthetic jet in air at maximum stroke ratios $L_m/D = 2 - 15$. Using the acceleration field, pinch-off may be identified in a manner which is frame invariant and consistent with previous studies. An adverse pressure gradient behind the ring and induced by it plays a role in the pinch-off and separation of the ring from the jet. Recognising this, we revise an existing model for pinch-off: this revision fits our data well. Additionally, we show that as the ring forms, hydrodynamic impulse is delivered via two equally important mechanisms: a material flux and a vortex force. For large L_m/D, this vortex force may deliver a substantial impulse to the ring after pinch-off. This has implications for unsteady propulsion, models of vortex ring formation and existing explanations for pinch-off.

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