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The effect of confinement on the stability of the Rankine vortex with axial flow MATTHEW JUNIPER, University of Cambridge — It has been shown recently that two-dimensional inviscid jets and wakes become significantly more unstable when they are confined between two flat plates, due to the interaction of Kelvin-Helmholtz modes in the inner and outer flows. It has also been shown that swirl significantly destabilizes unconfined inviscid jets and wakes, due to the interaction between Kelvin-Helmholtz modes and inertial modes. In this paper, the Rankine vortex with axial flow is confined within a duct in order to test the combined effect of confinement and swirl. The flow's stability is calculated as a function of shear, density ratio, swirl and confinement using a classic spatio-temporal instability analysis. It is found that confinement particularly destabilizes the helical $m = 1$ and $m = 2$ modes. These are at their most unstable when the radius of the outer flow is 1.4 times the radius of the inner flow. Experiments on coaxial fuel injectors with this geometry have shown that confined shear flows exhibit a strong helical $m = 1$ mode, which can be exploited to increase mixing in a combustion chamber. This paper explains this effect and shows how the presence of strong helical modes can be predicted with a low order model.

Matthew Juniper
University of Cambridge

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