Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Open-loop control of a weakly non-linear swirling jet instability by harmonic forcing CALUM SKENE, Imperial College London, UBAID QADRI, University of Cambridge, PETER SCHMID, Imperial College London — Highly swirled flows are often prone to a global instability with an azimuthal wavenumber of $|m| = 1$, where the sign is chosen so that the instability precesses against the mean-flow swirl. This instability is linked to the recirculation region typical of a vortex breakdown induced by high swirl, and can affect many types of flow. In particular, in lean premixed combustors swirling flows are often utilised to stabilise a flame onto a burner, as the recirculation region caused by vortex breakdown acts as a natural 'flame holder'. We investigate the manipulation of the global instability by harmonic forcing through a weakly non-linear analysis of an incompressible swirling jet. The flow is expanded about the critical Reynolds number where instability first occurs. Linear effects are obtained at first order, including both the unstable mode and the response to harmonic forcing. At second order, harmonics and base-flow modifications caused by non-linear interactions of the mode and forced response are obtained. An equation for the mode amplitude is obtained at third order, allowing for the effect of harmonic forcing to be quantified. In this manner, the effectiveness of control across a variety of forcing frequencies and azimuthal wavenumbers is assessed.

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Date submitted: 29 Jul 2019 Electronic form version 1.4