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A weakly nonlinear approach to predict the dynamics of precession of vortex core in a strongly swirling flow KIRAN MANOHARAN, Indian Institute of Science, MARK FREDERICK, JACQUELINE O'CONNOR, Pennsylvania State University, SANTOSH HEMCHANDRA, Indian Institute of Science, INDIAN INSTITUTE OF SCIENCE COLLABORATION, PENNSYLVANIA STATE UNIVERSITY COLLABORATION — Swirling flows at large swirl numbers, ie the ratio of the axial flux of tangential momentum to the axial flux of axial momentum, the central recirculation zone (CRZ) precesses about the streamwise normal axis causing precession of the vortex core (PVC). In the present study swirling flow field at various inflow swirl numbers are obtained from a variable swirl experimental facility. At large inflow swirl numbers, a PVC was observed from the experiment. We perform a weakly non-parallel linear stability analysis on the time averaged flow field at the different swirl numbers to identify all the unstable global modes. The linear stability analysis predicts that the flow becomes globally unstable through m=1 helical instability and eventually with the increase in swirl m=2 double helical mode also becomes unstable. A Fast Fourier Transform of the velocity time series data where PVC is present shows a dominant m=1 oscillation at 1060Hz. But the linear stability analysis predicts a globally unstable m=1 mode at the first subharmonic of the PVC frequency and globally unstable m=2 mode at the PVC frequency. Hence, in the present study, a weakly nonlinear model is developed to predict the PVC frequency and the amplitude variation due to nonlinear interaction of m=1 and m=2 modes.

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