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Partial lock-on in the wake of a streamwise-oscillating cylinder[1]

MAYSAM SHAMAI, Caltech, ALEXANDRA TECHET, Massachusetts Institute of Technology, BEVERLEY MCKEON, Caltech — It has been well established for a streamwise-oscillating cylinder that forcing frequencies, f_f, of the same order of magnitude as the stationary vortex shedding frequency, f_0, can lead to the development of a lock-on state consisting of the synchronization between the forcing and shedding frequency. Although relatively less studied, forcing frequencies multiple orders of magnitude less than the stationary shedding frequency have been shown to cause the development of quasi-steady shedding. Between these two extremes, however, studies have shown the development of sub-harmonic lock-on. In this study, we use Particle Image Velocimetry and fluorescent dye flow visualization to study forcing frequencies between the quasi-steady and lock-on regimes and show that a "partial lock-on" state can also develop in which one portion of the forcing trajectory corresponds to quasi-steady shedding while the other portion sees the generation of a starting vortex phase-locked to the forcing. Various combinations of forcing frequency and amplitude will be discussed, all with a mean Reynolds number of $Re_0 = 900$.

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