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An investigation of wake mode transitions and amplitude jumps in vortex-induced vibration using controlled vibration T.L. MORSE, C.H.K. WILLIAMSON, Cornell University — In this study, we have made extensive measurements of the fluid forces on a cylinder that is controlled to oscillate transverse to a free stream at Re = 4000. These measurements were used to create extremely high-resolution contour plots (based on nearly 6000 experimental runs) of the magnitude of the fluid force, and the phase angle between the forces and body motion, in the plane of normalized amplitude and frequency. We find transitions in certain regions of this plane where the character of the fluid forces changes between distinct modes. Interestingly, the mode regime boundaries we find based solely on force measurements correspond well with boundaries separating different vortex shedding modes in the Williamson-Roshko (1988) map. Using particle image velocimetry (PIV) to examine the wake of the cylinder, we have confirmed the existence of the vortex shedding patterns suggested by the fluid forces. A further fascinating characteristic, which is only observable with very high-resolution data, is the existence of regimes in this amplitude-frequency plane where two modes overlap. The peak amplitude of motion for a cylinder undergoing vortex-induced vibration occurs inside an overlap region, so understanding the vortex dynamics that occur in this region is essential to understanding the worst-case, peak amplitude of vortex-induced vibrations. As part of our ongoing research, we plan to extend our high-resolution data to higher Re.

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