Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Synchronization in periodically forced oscillator flows[1] BENJAMIN HERRMANN, STEVEN BRUNTON, University of Washington, RICHARD SEMAAN, Technische Universitt Braunschweig — We investigate the synchronization properties of the turbulent wake past a D-shaped bluff body with periodic Coanda blowing. Time series from experimental measurements of the base pressure are used to study the response of the global vortex shedding mode for different actuation frequencies and amplitudes. Multiple regions of synchronization are found, resulting in the so-called Arnold tongues, where the oscillation frequency of the global mode locks-on to a rational multiple of the forcing frequency. We construct a model using a sparse regression and its structure explains these nonlinear couplings as an anharmonic parametric excitation of the global mode. The model is further analyzed using phase reduction theory, predicting the presence of $2:n$ synchronization and revealing the boundaries of the respective Arnold tongues. We postulate that this phenomena is universal to periodically forced oscillator flows, and arises from resonant wave-triads that transfer of energy from the n^{th} harmonic of the forcing, i.e., the parent wave, to the conjugate pair of vortex shedding modes, i.e., the daughter waves with half-frequency and higher wavenumber.

[1]The work has been supported by the PRIME programme of the German Academic Exchange Service (DAAD) with funds from the German Federal Ministry of Education and Research (BMBF).

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Date submitted: 30 Jul 2019 Electronic form version 1.4