Stabilization of vortices in the wake of a circular cylinder using harmonic forcing

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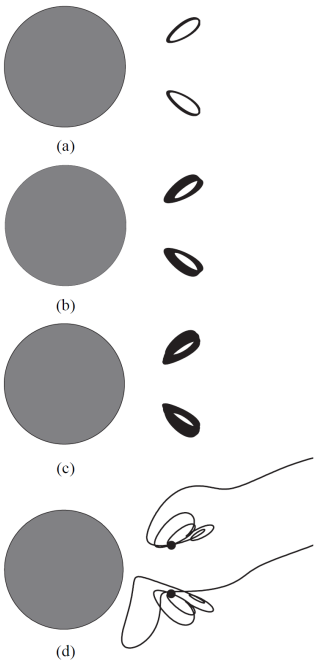
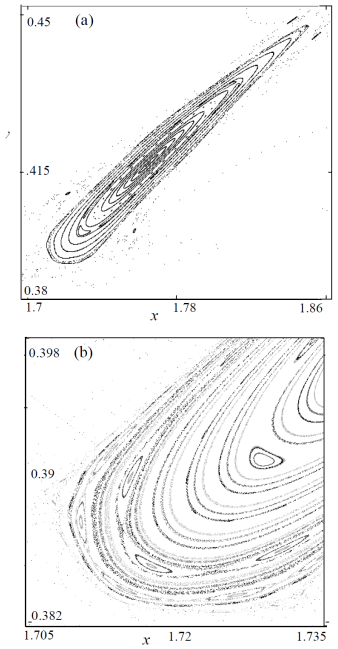
ABSTRACT

We explore whether vortex flows in the wake of a Fixed circular cylinder can be stabilized using harmonic forcing. We use Föppl's point vortex model [1] augmented with a harmonic point source-sink mechanism which preserves conservation of mass and leaves the system Hamiltonian. We discover a region of Lyapunov-stable vortex motion for an appropriate selection of parameters. We identify four unique parameters that affect the stability of the vortices: the uniform flow velocity, vortex equilibrium positions, forcing amplitude and forcing frequency. We assess the robustness of the controller using a Poincaré section.



Various responses of the vortices to the control. The cylinder is shown gray. The flow is from left to right. (a) Stable periodic motion. (b) and (c) show the response to small perturbations of the vortices, leading to non-periodic but bounded motion. (d) Large perturbation destabilizing the vortices



Poincaré section for a stabilized flow showing the island of stable motion. Panel (b) is close-up revealing the intricate KAM structure of chaotic motion interspersed with quasi-periodic islands.

REFERENCES

[1] L. Föppl *Wirbelbewegung hinter einem kreiszylinder* Sitzb. d. k. bäyr. Akad. d. Wiss., **1**, 2550, 1913.