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Numerical simulation of the fluttering instability using a pseudospectral method with volume penalization THOMAS ENGELS, M2P2-CNRS, Aix Marseille University, France & ISTA TU Berlin, Germany, DMITRY KOLOMENSKIY, McGill University / CRM, Montreal, Canada, KAI SCHNEIDER, M2P2-CNRS, Aix Marseille University, France, JOERN SESTERHENN, ISTA, TU Berlin, Germany — A new numerical scheme for the simulation of deformable objects immersed in a viscous incompressible fluid is presented. The 2d Navier-Stokes equations are discretized with a Fourier pseudo-spectral scheme. Using the volume penalization method arbitrary inflow conditions can be enforced, together with the no-slip conditions at the boundary of the immersed flexible object. The present work extends the penalization method to account for moving deformable objects while avoiding numerical oscillations in the hydrodynamic forces. For the solid part, a simple 1d model, the non-linear beam equation, is employed. The fluid and solid parts are coupled with a fast explicit staggered scheme. The fluttering instability of a slender structure immersed in a free stream is studied and three distinct states are obtained: stability of the initial condition or maintenance of an either periodic or chaotic fluttering motion. A detailed parameter study for different Reynolds numbers and reduced free-stream velocities is presented. The dynamics of the transition from a periodic to a chaotic state is investigated. The results are compared with those obtained by an inviscid vortex shedding method and by a viscous linear stability analysis, yielding for both satisfactory agreement.

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