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Numerical modeling of flexible insect wings using volume penalization THOMAS ENGELS, M2P2-CNRS and CMI, Aix-Marseille University, Marseille, France & Institut fuer Stroemungmechanik und Technische Akustik (ISTA), TU Berlin, Germany, DMITRY KOLOMENSKIY, Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (CERFACS), Toulouse, France, KAI SCHNEIDER, M2P2-CNRS and CMI, Aix-Marseille University, Marseille, France, JOERN SESTERHENN, Institut fuer Stroemungmechanik und Technische Akustik (ISTA), TU Berlin, Germany — We consider the effects of chordwise flexibility on the aerodynamic performance of insect flapping wings. We developed a numerical method for modeling viscous fluid flows past moving deformable foils. It extends on the previously reported model for flows past moving rigid wings (J Comput Phys 228, 2009). The two-dimensional Navier-Stokes equations are solved using a Fourier pseudo-spectral method with the no-slip boundary conditions imposed by the volume penalization method. The deformable wing section is modeled using a non-linear beam equation. We performed numerical simulations of heaving flexible plates. The results showed that the optimal stroke frequency, which maximizes the mean thrust, is lower than the resonant frequency, in agreement with the experiments by Ramananarivo et el. (PNAS 108(15), 2011). The oscillatory part of the force only increases in amplitude when the frequency increases, and at the optimal frequency it is about 3 times larger than the mean force. We also study aerodynamic interactions between two heaving flexible foils. This flow configuration corresponds to the wings of dragonflies. We explore the effects of the phase difference and spacing between the fore- and hind-wing.

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