Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Simulation of flapping bird flight, part 1: closed-loop control, forces, and wake topology[1] VICTOR COLOGNESI, GIANMARCO DUCCI, RENAUD RONSSE, PHILIPPE CHATELAIN, UCLouvain, REVEALFLIGHT TEAM — This work aims at reproducing bird flight in silico in order to shed light on its performance-enabling mechanisms. To that end, we establish an anatomical model of a bird with a pure flapping gait, the bald ibis. It combines a multibody model of the skeleton, with the corresponding joints and degrees of freedom, and a plumage model. The latter allows extracting the wing geometry and aerodynamic properties for any configuration of the skeleton. These properties are translated into a deforming immersed lifting line, which handles the sources of vorticity within a vortex particle-mesh method. The resulting multiphysics framework captures, at a high fidelity, the full flight dynamics, the required efforts and the resulting wake. A sensitivity analysis is carried out and leveraged for the design of a flight controller. Specifically, we quantity the influence of shoulder kinematic features on the aerodynamic forces and moments. The controller then uses these features as command parameters. This bird model can reach a trimmed state over various flight regimes and can handle transients between them. Finally, the accurate capture of the wake vortical structures allows their unambiguous identification and association with the time-varying aerodynamic forces produced by the bird.

[1]This project was supported by the ARC program of the Federation Wallonie-Bruxelles (grant number 17/22-080, REVEALFLIGHT)

Victor Colognesi
UCLouvain

Date submitted: 26 Jul 2019 Electronic form version 1.4