Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Modelling forces and flow features in flapping wings: a POD based approach.[1] MARCO RAIOLA, STEFANO DISCETTI, ANDREA IANIRO, Universidad Carlos III De Madrid — A novel POD-based approach to decompose the aerodynamic forces acting on a flapping wing along with the most relevant flow features is proposed. The method is applied to experimental data including PIV and force measurements at $Re = 3600$ and $St = 0.2$. An actuated 2D flapping wing with a NACA 0012 airfoil is designed to produce independent heaving and pitching motion. The wing is equipped with a 6 Degrees-Of-Freedom balance, providing aerodynamic force measurements. Planar PIV measurements are carried out to obtain a phase-locked flow features description in the wing near field. The PIV phase-averaged flow fields are transformed into flow fields in the reference frame fixed with respect to the moving wing. The POD performed on the vorticity field provides a time basis, constituted by the vorticity time coefficients, on which it is possible to project both the flow fields and the forces in order to assess the force contribution of each POD mode. The force generation is mostly ascribed to the first 4 modes. A satisfactory description of the measured forces is achieved through a truncation to the first 6 modes. A more detailed analysis of the flow field projections is useful to determine the force generation mechanism.

[1]This work has been supported by the Spanish MINECO under grant TRA2013-41103-P.

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Date submitted: 01 Aug 2016 Electronic form version 1.4