Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Linearized propulsion theory of flapping airfoils revisited[1] RAMON FERNANDEZ-FERIA, Universidad de Malaga (Spain) — A vortical impulse theory is used to compute the thrust of a plunging and pitching airfoil in forward flight within the framework of linear potential flow theory. The result is significantly different from the classical one of Garrick that considered the leading-edge suction and the projection in the flight direction of the pressure force. By taking into account the complete vorticity distribution on the airfoil and the wake the mean thrust coefficient contains a new term that generalizes the leading-edge suction term and depends on Theodorsen function $C(k)$ and on a new complex function $C_1(k)$ of the reduced frequency k. The main qualitative difference with Garrick's theory is that the propulsive efficiency tends to zero as the reduced frequency increases to infinity (as $1/k$), in contrast to Garrick's efficiency that tends to a constant (1/2). Consequently, for pure pitching and combined pitching and plunging motions, the maximum of the propulsive efficiency is not reached as $k \to \infty$ like in Garrick's theory, but at a finite value of the reduced frequency that depends on the remaining non-dimensional parameters. The present analytical results are in good agreement with experimental data and numerical results for small amplitude oscillations.

[1]Supported by the Ministerio de Economia y Competitividad of Spain Grant No. DPI2013-40479-P

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Date submitted: 26 Jul 2016

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