Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Prediction of unsteady lift on a pitching foil[1] SHUJI OTOMO, University of Edinburgh, KAREN MULLENERS, EPFL, KIRAN RAMESH, University of Glasgow, IGNAZIO MARIA VIOLA, University of Edinburgh — The ability to accurately predict the forces on an aerofoil in real-time when large flow variations occur is important for improving the manoeuvrability and control of small aerial and underwater vehicles. Closed-form analytical formulations are only available for small flow fluctuations. This limits their applicability to gentle manoeuvres. Here we investigate large-amplitude, non-symmetric pitching motions of a NACA 0018 aerofoil at a Reynolds number of 3.2×10^4 using time-resolved force and velocity field measurements. We adapt the linear theory of Theodorsen, assuming it gives a normal force as a high angle of attack treatment. The accuracy of the models is remarkably good, including when large leading-edge vortices are present, but not when leading and trailing edge vortices have a strong interaction. In such scenarios, discrepancies between the theoretically predicted and the measured forces are shown to be due to vortex force that is calculated using the impulse method. These results aim to contribute to the development of low-order models to predict unsteady forces for high-amplitude manoeuvres characterised by massive separation.

[1]This work was supported by the Postgraduate and Early Career Researchers Exchanges Grant of the Energy Technology Partnership (PECRE059).

Shuji Otomo
University of Edinburgh

Date submitted: 03 Aug 2020 Electronic form version 1.4