Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

On the estimation of swimming and flying forces from wake measurements JOHN O. DABIRI, Graduate Aeronautical Laboratories and Bioengineering, California Institute of Technology, USA — This paper addresses the question of the minimum number of wake properties whose combination is sufficient to determine locomotive forces from wake measurements. In particular, it is shown that the vorticity field is by itself insufficient to determine locomotive forces, and must be combined with a parameter analogous to the fluid pressure. The measurement of this parameter in the wake is shown to be identical to a calculation of the added-mass contribution from fluid surrounding vortices in the wake, and proceeds identically to a measurement of the added-mass traditionally associated with fluid surrounding solid bodies. A model is developed to approximate the contribution of wake vortex added-mass to locomotive forces, given a combination of velocity and vorticity field measurements in the wake. Previous wake analyses are re-examined in light of these results to infer the existence and importance of wake vortex added-mass in those cases. It is shown that the commonly used time-averaged wake-based force estimates are not sufficient to prove that an animal is generating the locomotive forces necessary to sustain flight or maintain neutral buoyancy.

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Date submitted: 28 Jul 2005 Electronic form version 1.4