Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Geometry-agnostic Methods for Determining Bound Circulation in Potential Flows[1] CODY GONZALEZ, HAITHEM TAHA, University of California, Irvine — A core detriment of potential flow theory, inherent in its kinematic nature, is that it is agnostic of the local work required to produce its divergence-free flowfield. The auxiliary Kutta-Joukowski condition has long served in prescribing circulation for airfoils at low angles of attack, but leads to unsatisfactory predictions for unsteady, separated flows, and its lack of a mathematical basis has made its extensions to these nonlinear regimes ad hoc and geometry dependent. This research posits existence of an upper bound on acceleration within the flowfield, and moreover, that such a limit is a function of streamtube diameter, Reynolds number, and Mach number, representing the constraints, ratio of inertial and viscous forces, and the ratio of local flow velocity to the speed of sound, respectively. Novel, geometry-agnostic methods, using the variational concepts of least constraint, and minimization of maximum accelerations, are presented for determination of bound circulation; both of which require no a priori assumptions for circulation or separation points. The result serves as a physical basis for obviating the Kutta-Joukowski condition, in a form which is amenable to aerodynamic analysis of arbitrary geometry in nonlinear and unsteady regimes.

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Date submitted: 10 Aug 2020 Electronic form version 1.4