Adam C. DeVoria

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Research Interests

My research interests are varied among several areas within fluid dynamics, such as aero/hydrodynamics, inviscid flow modeling, vortex dynamics, multi-phase interface physics, and bio-inspired propulsion. Each area of interest is unified, however, by the pursuit of making novel scientific contributions that provide new understanding at a fundamental level. My work is a combination of theoretical and experimental efforts. On-going and future research seeks to develop simplified models of fluid regions exhibiting rapid variations in physical quantities, whereby the regions are replaced with mathematical discontinuities.

Education

Ph.D. Aerospace Engineering **2013**
University at Buffalo
Dissertation: *On the flow generated by rotating flat plates of low aspect ratio*

M.S. Mechanical Engineering **2011**
University at Buffalo
Thesis: *Vortex formation in the starting flow of rotating, low-aspect-ratio plates*

B.S. Aerospace Engineering and Mechanical Engineering **2004–2008**
University at Buffalo
Notes: dual degrees, Cum Laude

Experience

Assistant Professor: The Citadel School of Engineering **2022 – Present**
MECH 101: Introduction to Mechanical Engineering
MECH 102: Engineering Computer Applications
MECH 330: Measurements and Instrumentation with Lab
MECH 350: Modeling and Analysis of Dynamical Systems I
MECH 351: Modeling and Analysis of Dynamical Systems II
MECH 415: Heat Transfer
MECH 470: Introduction to Applied Aerodynamics
MECH 476: Propulsion Systems (*developed course*)
MECH 481: Senior Design I
MECH 482: Senior Design II
MECH 631: Advanced Engineering Mathematics (*developed course*)

ASME Student Section Faculty Adviser at The Citadel **2024 – Present**

Instructor: The Citadel School of Engineering **2021 – 2022**

Instructor: University at Buffalo **Summer 2012**
Undergraduate Heat Transfer (MAE 336)

Substitute Lecturer: University of Florida **2014-2019**
Fluids I (Unit: Fluid dynamic force on moving bodies)
Fluids II (Unit: Stokes Flow, 2 semesters)
Sources of Vorticity (Unit: Vorticity in Animal Flight and Swimming)

Postdoctoral Researcher: University of Florida **2013-2021**
Graduate Researcher: University at Buffalo **2008-2013**

Publications

Journal Articles (refereed)

16. R. L. Chapman, T. M. Kelly, J. S. Gaglione, H. A. Cushman, S. Sungkeetanon, B. MacGavin, **A. C. DeVoria**, N. J. Washuta, and J. W. Sanders, "*Generalized Symplectic Integrators*", Journal of Computational and Nonlinear Dynamics, 21(7), CND-25-1300, 2026. (link)
15. J. W. Sanders, E. T. Becker, and **A. C. DeVoria**, "*Extension of Hamiltonian mechanics to non-conservative systems via higher-order dynamics*", Journal of Vibration and Acoustics, 146(6), 061107, 2024. (link)
14. J. Sanders, **A. C. DeVoria**, N. Washuta, G. Elamin, K. Skenes, and J. Berlinghieri, "*A canonical Hamiltonian formulation of the Navier-Stokes problem*", Journal of Fluid Mechanics, 984, A27, 2024. (link)
13. **A. C. DeVoria**, "*General solution for self-similar mixing layers*", ASME J. Fluids Engineering, 144(12), 121302, 2022. (link)
12. **A. C. DeVoria** and K. Mohseni, "*Theoretical model for the separated flow around an accelerating flat plate using time-dependent self similarity*", Physical Review Fluids, 6, 054701, 2021. (link)
11. **A. C. DeVoria** and K. Mohseni, "*New insights from inviscid modelling of starting flow separation with roll-up*", Journal of Fluid Mechanics, 903, A24, 2020. (link)
10. **A. C. DeVoria** and K. Mohseni, "*The vortex-entrainment sheet in an inviscid fluid: theory and separation at a sharp edge*", Journal of Fluid Mechanics, 866, 660-688, 2019. (link)
9. **A. C. DeVoria** and K. Mohseni, "*Vortex sheet roll-up revisited*", ***Journal of Fluid Mechanics***, 855, 299-321, 2018. (link)
8. **A. C. DeVoria** and K. Mohseni, "*On the mechanism of high-incidence lift generation for steadily translating low-aspect-ratio wings*", Journal of Fluid Mechanics, 813, 110-126, 2017. (link)
7. **A. C. DeVoria** and K. Mohseni, "*A vortex model for forces and moments on low-aspect-ratio wings in side-slip with experimental validation*", Proceedings of the Royal Society A, 473(2198), 110-126, 2017. (link)
6. **A. C. DeVoria** and K. Mohseni, "*Droplets in an axisymmetric microtube: effects of aspect ratio and fluid interfaces*", Physics of Fluids, 27(1), 012002, 2015. (link)
5. Carr Z. R., **A. C. DeVoria**, and M. J. Ringuette, "*Aspect-ratio effects on rotating wings: circulation and forces*", Journal of Fluid Mechanics, 767, 497-525, 2015. (link)
4. **A. C. DeVoria**, Carr Z. R., and M. J. Ringuette, "*On calculating forces from the flow field with application to experimental volume data*", Journal of Fluid Mechanics, 749, 297-319, 2014. (link)
3. **A. C. DeVoria** and M. J. Ringuette, "*The force and impulse of a flapping plate performing advancing and returning strokes in a quiescent fluid*", Experiments in Fluids, 54(5), 1515, 2013. (link)
2. **A. C. DeVoria** and M. J. Ringuette, "*On the flow generated on the leeward face of a rotating plate*", Experiments in Fluids, 54(4), 1495, 2013. (link)
1. **A. C. DeVoria** and M. J. Ringuette, "*Vortex formation and saturation for low-aspect-ratio rotating flat-plate fins*", Experiments in Fluids, 52(2), 441-462, 2012. (link)

Conference Papers (acceptance by review)

11. R. L. Chapman, T. M. Kelly, J. S. Gaglione, H. A. Cushman, S. Sungkeetanon, B. MacGavin, **A. C. DeVoria**, N. J. Washuta, and J. W. Sanders, "*Generalized symplectic integrators*", Paper 2025-167703, Proceedings of the ASME IDETC/CIE, Anaheim, CA, August 17-20, 2025.
10. J. W. Sanders, E. T. Becker, and **A. C. DeVoria**, "*Extension of Hamiltonian mechanics to non-conservative systems*", Paper 2024-142509, Proceedings of the ASME IDETC/CIE, Washington, DC, August 25-28, 2024.
9. J. T. Thalakkottor and **A. C. DeVoria**, "*Modeling a shock front as an extended dividing hypersurface*", AIAA Paper 2023-2481, AIAA SciTech, National Harbor, MD, January 23-27, 2023.
8. G. Elamin, M. Bubacz, **A. DeVoria**, R. Rabb, D. Ragan, and P. Niksiar, "*Student-Instructor Academic Relationships: Effects of Background and Culture*", ASEE Paper 103, ASEE Southeastern Section Conference, Charleston, SC, March 13-15, 2022.

7. **A. C. DeVoria** and K. Mohseni, "*Desingularized trailing-edge shedding from a flat plate with a point vortex method*", AIAA Paper 2018-0355, 56th AIAA Aerospace Sciences Meeting, Kissimmee, FL, January 8-12, 2018.
6. P. Zhang, **A. C. DeVoria**, and K. Mohseni, "*Methods for Controlling Vorticity Generation at the Triple Contact Line for Wake and Drag Mitigation*", 31st Symposium on Naval Hydrodynamics, Monterrey, California, September 11-16 2016.
5. **A. C. DeVoria** and K. Mohseni, "*The effect of aspect ratio on the near-wake flow of rectangular wings*", AIAA Paper 2016-0857, 54th AIAA Aerospace Sciences Meeting, San Diego, CA, January 4-8, 2016.
4. **A. C. DeVoria** and K. Mohseni, "*Vortex structure of low-aspect-ratio wings in sideslip*", AIAA Paper 2015-396, 53rd AIAA Aerospace Sciences Meeting, Kissimmee, FL, January 5-9, 2015.
3. **A. C. DeVoria**, P. Zhang, and K. Mohseni, "*Simple model for low-aspect-ratio droplets in an axisymmetric microchannel*", AIAA Paper 2014-1273, 52nd AIAA Aerospace Sciences Meeting, National Harbor, MD, January 13-17, 2014.
2. Carr. Z.R., **A. C. DeVoria**, and M. J. Ringuette, "*Aspect ratio effects on the leading-edge circulation and forces of rotating flat-plate wings*", AIAA Paper 2013-0675, 51st AIAA Aerospace Sciences Meeting, Grapevine, TX, January 7-10, 2013.
1. **A. C. DeVoria**, P. Mahajan, and M. J. Ringuette, "*Vortex formation and saturation for low-aspect-ratio rotating flat plates at low Reynolds number*", AIAA Paper 2011-396, 49th AIAA Aerospace Sciences Meeting, Orlando, FL, January 4-7, 2011.

Presentations

13. **A. C. DeVoria**. "*A vectorized evolution equation for interfaces represented as vortex-entrainment sheets*", ***78th Annual Meeting of the APS DFD***, Houston, TX, November 2025.
12. **A. C. DeVoria**. "*A complex variable boundary element method for principal value integrals*", ***75th Annual Meeting of the APS DFD***, Indiana, IN, November 2022.
11. **A. C. DeVoria**. "*A new quadrature for vortex sheet motion*", ***74th Annual Meeting of the APS DFD***, Phoenix, AZ, November 2021.
10. **A. C. DeVoria** and K. Mohseni. "A novel model to capture the flow asymmetry of an accelerating plate at incidence", ***73rd Annual Meeting of the APS DFD***, Chicago, IL, November 2020.
9. **A. C. DeVoria**, J. J. Thalakkottor, and K. Mohseni, "*Interfaces with mass: applications to vortex sheet dynamics and slip boundary conditions in viscous flows*", ***The second joint SIAM/CAIMS annual meeting***, Toronto, Canada, July 6-10, 2020.
8. **A. C. DeVoria** and K. Mohseni. "*Self-similar roll-up of vortex-entrainment sheets*", ***72nd Annual Meeting of the APS DFD***, Seattle, WA, November 2019.
7. **A. C. DeVoria** and K. Mohseni. "*The vortex-entrainment sheet*", 71st Annual Meeting of the APS DFD, Atlanta, GA, November 2018.
6. **A. C. DeVoria** and K. Mohseni. "*Vortex doublet as a mechanism of shedding for inviscid methods*", 70th Annual Meeting of the APS DFD, Denver, CO, November 2017.
5. P. Zhang, **A. C. DeVoria**, and K. Mohseni. "Vorticity dipoles and a theoretical model of a finite force at the moving contact line singularity", 70th Annual Meeting of the APS DFD, Denver, CO, November 2017.
4. **A. C. DeVoria** and K. Mohseni. "*High lift generation of low-aspect-ratio wings*", 69th Annual Meeting of the APS DFD, Portland, OR, November 2016.
3. **A. C. DeVoria** and K. Mohseni. "*The effects of aspect ratio on the flow invariants of droplets in an axisymmetric microtube*", 67th Annual Meeting of the APS DFD, San Francisco, CA, November 2014.
2. **A. C. DeVoria** and M. J. Ringuette. "*Vortex formation in the starting flow of rotating low-aspect-ratio plates*", 63rd Annual Meeting of the APS DFD, Long Beach, CA, November 2010.
1. **A. C. DeVoria**, J. Bapst, and M. J. Ringuette. "*Vortex formation time for a sweeping fin*", 62nd Annual Meeting of the APS DFD, Minneapolis, MN, November 2009.

Research Accomplishments

Postdoctoral Research (Univ. Florida, 2013–2021)

1. **Low-aspect-ratio wing aerodynamics**
   - *Developed a theory to explain high-incidence lift generation of low-aspect-ratio wings.*
     - Showed that downwash of the tip vortex flow reattaches leading-edge shear layer as well as aids in satisfying a (time-averaged) Kutta condition at the trailing edge.
     - This decreases strength/amount of vorticity shed and maintains an **effective bound circulation** resulting in Joukowski-type lift generation
   - *Conceived a simple vortex model for forces and moments exerted on rectangular wings of variable aspect ratio, angle of attack, and sideslip angle.*
     - Merging tip vortices in zero-aspect-ratio limit represented by a **vortex dipole**.
     - Theoretically derived a **parabolic** lift/circulation distribution instead of elliptical distribution of classical aerodynamic theory.
     - Results validated with volumetric stereo-PIV reconstructions of flow field and direct force measurements.
2. **Inviscid flow modeling**
   - *Developed a new inviscid model for viscous boundary and shear layers termed a* **vortex-entrainment sheet**.
     - Dynamic model superimposes a vortex sheet representing vorticity in the layer with an entrainment sheet representing **mass and momentum** in the layer.
     - The sheet is characterized by **discontinuities** in tangential velocity (harmonic potential) as well as **normal velocity** (stream function).
     - The 'intrinsic flow' confined to the sheet has mass per-unit-area and may support a pressure jump.
     - Proved that the **shedding angle** for flow around a sharp edge can be **non-tangential** to the edge face when entrainment occurs.
   - *Applied* **vortex-entrainment sheet** *model to study* **viscous effects** *of starting flow separation.*
     - Formulated generalized problem for flow around a sharp wedge to include entrainment boundary conditions.
     - Entrainment significantly augments the solution space that is more restricted by classical potential flow using no through-flow assumption.
     - Obtained the asymptotic solution in order to derive an analytical expression for the shedding angle.
     - Entrainment on freely shed sheet can represent diffusive as well as inertial effects.
     - Successful comparison with experiments indicates ability of model to capture viscous effects.
3. **Multi-phase microfluidics**
   - *Designed, built and conducted micro-PIV experiments to measure the recirculating flow inside translating droplets in a microchannel*
     - Objective: assess the effect of introducing fluid interfaces on global flow invariants (circulation, impulse, kinetic energy) for droplets of different length.
     - Decreasing droplet length increases magnitude of the invariants as compared to a continuous flow 'slug' of the same length.
     - Also increased are average rates at which invariants are advected along the channel.
   - *Assisted a graduate student in design and construction of a 'dynamic Wilhelmy plate' experiment for their dissertation work. The experimental set-up included:*
     - Optical measurement of the contact line angle.
     - PIV system for flow field measurement.
     - Laser displacement device for beam deflection measurement.

Graduate Research (Univ. Buffalo, 2008-2013)

Bio-inspired propulsion

- *Experimentally investigated the 3-D, unsteady development and vortex dynamics produced in the starting flow of rotating, low-aspect-ratio flat plates.*
  - Characterized the root-to-tip flow of rotating fins and the ensuing vortex break-down process.
  - Detailed the force and impulse generation for different bio-propulsive kinematics and orientations.
  - Revealed and quantified the increasing contribution to lift generation from the tip vortex for rotating wings as their aspect ratio is decreased.
  - Applications of results are to autonomous underwater vehicles using fin-like propulsors and micro aerial vehicles using wing-like propulsors.

- *Derived the 'objective origin' method to minimize errors in the calculation of forces on a moving body from velocity field measurements. The method:*
  - Determines a spatial origin based on the satisfaction of mathematical identities with experimental data.
  - Provides significant improvement in calculated forces with measured forces.
  - Offers a validity check based on statistics and probability in the absence of direct measurements.

Technical Skills

- Competency in technical writing
- Comfortable with public speaking
- Research grant writing
- Wind/water tunnel operation
- Planar PIV
- Stereo PIV
- micro PIV
- LabVIEW
- Matlab
- Maple
- LaTeX