

MARGARET L. BYRON

Assistant Professor · Department of Mechanical Engineering · Pennsylvania State University
301A Reber Building · University Park, PA 16802 · 814-863-0736 · mbyron@psu.edu

Research interests: aquatic biomechanics; particle-laden turbulence and multiphase flows; environmental fluid mechanics; intermediate Reynolds number locomotion and transport

APPOINTMENTS

Assistant Professor, Mechanical Engineering 2017 -
The Pennsylvania State University, University Park, PA

Postdoctoral researcher, Ecology and Evolutionary Biology 2015 - 2017
The University of California Irvine, Irvine, CA
Research topic: Biomechanics of cydippid ctenophore locomotion (Advisor: Dr. Matthew McHenry)

EDUCATION

Ph.D Department of Civil and Environmental Engineering 2015
University of California, Berkeley
Dissertation: The rotation and translation of non-spherical particles in homogeneous isotropic turbulence (Advisor: Dr. Evan Variano)

M.S. Department of Civil and Environmental Engineering 2012
University of California, Berkeley

B.S.E. Department of Mechanical and Aerospace Engineering 2010
Princeton University
Thesis: Design and fabrication of a robotic manta ray (Advisor: Dr. Alexander Smits)

AWARDS/HONORS

- Beckman Young Investigator Award, 2021
- American Chemical Society Doctoral New Investigator Award, 2019
- NSF Postdoctoral Fellowship in Biology, 2015 – 2017
- Best Postdoc Poster, Ctenopalooza, 2016
- Martin and Beate Block Winter Award for Promising Young Physicists, 2015
- NSF Graduate Research Fellowship, 2012 - 2015
- NSF IGERT Fellowship, CiBER, University of California Berkeley, 2010-2012
- Donald Janssen Dike Award for Excellence in Undergraduate Research, Princeton University, 2010

EXTERNAL FUNDING

2021 – 2025: Arnold and Mabel Beckman Foundation, “Fluid dynamics of flexibility: deformable bio-structures for locomotion and sensing in complex flows” (\$600,000)

2021 – 2024: National Science Foundation, “Collaborative Research: Scaling of ciliary flows at intermediate Reynolds number” (PIs: M.L. Byron, C. Li (Villanova), \$318,782.00)

2020 – 2022: American Chemical Society Petroleum Research Fund, “Formation and settling of multiphase oily aggregates under controlled isotropic turbulence” (\$110,000)

2017 – 2019: National Academies Keck Futures Initiative, “Swimming across scales: metachronal rowing in the deep blue sea” (PIs: M.L. Byron, D.W. Murphy (USF), \$50,000)

2015 – 2017: NSF Postdoctoral fellowship in Biology, “The navigational control and propulsive biomechanics of ctenophores” (Advisor: M.J. McHenry; \$138,000)

Small/internal awards

- 2021: Penn State Institute for Energy and the Environment (Seed Grant program), “Effects of biofilms on the transport of microplastics” (\$15,000)
- 2020: The Company of Biologists, “Symposium: Metachronal coordination of multiple appendages for swimming and pumping (Society for Integrative and Comparative Biology 2021 Annual Meeting).” (£1600)
- 2018: Association for the Sciences of Limnology and Oceanography Early Career Travel Grant (\$500)
- 2018: Bermuda Institute of Ocean Sciences Grant-in-aid (\$3,234)

PEER-REVIEWED JOURNAL PUBLICATIONS¹

1. **Byron, M.L.**, A. Santhanakrishnan, and D. Murphy (2021). Metachronal Coordination of Multiple Appendages for Swimming and Pumping. *Integrative and Comparative Biology*. In press.
2. **Byron, M.L.**, D.W. Murphy, A. Hoover, D. Takagi, K. Katija, J. Daniels, K. Garayev, M. Ruszczyk, E. Kanso, A. Santhanakrishnan (2021). Metachronal motion across scales: current challenges and future directions. *Integrative and Comparative Biology*. In press.
3. Herrera-Amaya, A., E.K. Seber, D.W. Murphy, W.L. Patry, T.S. Knowles, M.M. Bubel, A.E. Maas, **M.L. Byron** (2021). Spatiotemporal Asymmetry in Metachronal Rowing at Intermediate Reynolds Numbers. *Integrative and Comparative Biology*. In press.
4. Nayak, A.R., H. Jiang, **M. L. Byron**, J. M. Sullivan, M. McFarland, and D. Murphy (2021). Small Scale Spatial and Temporal Patterns in Particles, Plankton, and Other Organisms. *Frontiers in Marine Science: Marine Ecosystem Ecology*. 8(2021):245. doi:10.3389/fmars.2021.669530
5. **Byron, M.L.**, Y. Tao, I. Houghton, and E.A. Variano. Slip velocity of large low-aspect-ratio cylinders in homogeneous isotropic turbulence. (2019) *International Journal of Multiphase Flow*.
6. Carrillo, A., D. Van Le, **M. Byron**, H. Jiang, and M.J. McHenry (2019). Canal neuromasts enhance foraging in zebrafish (*Danio rerio*). *Bioinspiration and Biomimetics*, 14(2019) 035003.
7. van der Hoop, J.M., **M.L. Byron**, K. Ozolina, D.L. Miller, J. Johanson, P. Domenici, and J. F. Steffensen (2018). Lower oxygen consumption rates in high-turbulence flows in a labriform swimmer, *Cymatogaster aggregata*. *Journal of Experimental Biology*, jeb-168773.
8. **Byron, M.L.**, J. Einarsson, K. Gustavsson, G. Voth, B. Mehlig, and E.A. Variano (2015). Shape-independence of particle rotation in isotropic turbulence. *Physics of Fluids*, 27:035101. doi:10.1063/1.4913501
9. Meyer, C.R., **M.L. Byron**, E.A. Variano (2013). Rotational diffusion of particles in turbulence. *Limnology and Oceanography: Fluids and Environments*. 3:89-102. doi: 10.1215/21573689-2326592
10. **Byron, M.L.**, E.A. Variano (2013). Refractive-index-matched hydrogel materials for measuring flow-structure interactions. *Experiments in Fluids*. 54:1456. doi: 10.1007/s00348-013-1456-z.
11. Bellani, G.B., **M.L. Byron**, A.G. Collignon, C.R. Meyer, and E.A. Variano (2012). Shape effects on turbulence modulation by large nearly neutrally buoyant particles. *Journal of Fluid Mechanics*. 712:41-60. doi: 10.1017/jfm.2012.393

Manuscripts in preparation, submitted, and under review:

1. **Byron, M.L.** and E.A. Variano. Effects of small changes in buoyancy and aspect ratio on the rotation of large cylinders in turbulence. (in prep)
2. **Byron, M.L.**, C. Abarca, and M.J. McHenry. Passive and active locomotion in the ctenophore *Pleurobrachia bachei*. (in prep)
3. Herrera-Amaya, A. and **M.L. Byron**. Three-dimensional maneuverability and agility in metachronal swimming. (in prep)
4. Chantarawong, N. and **M.L. Byron**. Swimming kinematics of multimodal aquatic insects. (in prep)

¹ Supervised student authors underlined.

PEER-REVIEWED CONFERENCE PUBLICATIONS

1. Angle, B.R., M.J. Rau, and **M.L. Byron**. Effect of mass distribution on falling cylindrical particles at intermediate Reynolds numbers. *Proceedings of the ASME/FEDSM 2019*. San Francisco, July 29-31, 2019.
2. Menold, J., C. Berdanier, S. Ritter, M. Handley, C. Grady, M. Byron, E. Starkey, S. Miller, M. Parkinson. BUILDing a community of female makers through hands-on experiences in a university MakerSpace. *2019 IEEE Frontiers in Education Conference (FIE)*. October 16-19, 2019, Cincinnati, OH.

CONFERENCE PRESENTATIONS

1. Herrera-Amaya, A. and **M.L. Byron**. Spatiotemporal asymmetry in ctenophores: metachronal locomotion at intermediate Reynolds number (MLB presenting). *Society for Integrative and Comparative Biology Annual Meeting*. January 3-February 28, 2021. Virtual.
2. Herrera-Amaya, A. and **M.L. Byron**. Measuring metachronal maneuvering at the milliscale: an analysis of ctenophore swimming kinematics. *Society for Integrative and Comparative Biology Annual Meeting*. January 3-February 28, 2021. Virtual.
3. Chantarawong, N. and **M.L. Byron**. Boatmen and backswimmers and beetles, oh my: intermediate Reynolds number locomotion in aquatic insects. *Society for Integrative and Comparative Biology Annual Meeting*. January 3-February 28, 2021. Virtual.
4. Herrera-Amaya, A. and **M.L. Byron**. Focused tracer detection algorithm for particle shadow velocimetry. *American Physical Society: Division of Fluid Dynamics Fall Meeting*. November 22-24, 2020. Virtual.
5. Herrera-Amaya, A., F. Karakas, D.W. Murphy, and **M.L. Byron**. The role of flexibility in sub-inertial swimming: An analysis of millimeter-scale ciliated structures. *American Physical Society: Division of Fluid Dynamics Fall Meeting*. November 23-26, 2019, Seattle, WA.
6. Kovar, C., **M.L. Byron**, and A. Eslam-Panah. Effects of foil shape on fish-like swimming. *American Physical Society: Division of Fluid Dynamics Fall Meeting*. November 23-26, 2019, Seattle, WA.
7. Sandall, E.L., J.M. Ulmer, I. Miko, and **M.L. Byron**. Digging into the mechanics of burrowing in dragonfly larvae. *Entomology*. November 17-20, 2019, St. Louis, MO.
8. **Byron, M.**, J. Bail, M. McHenry. Space utilization and orientation of cydippid ctenophores in simple shear and turbulence. *Society for Integrative and Comparative Biology Annual Meeting*. January 3-7, 2019, Tampa FL.
9. Seber, E.K., F. Karakas, D.W. Murphy, and **M.L. Byron**. Fluid dynamics of ciliary propulsion at intermediate Reynolds number: locomotion across ontogeny in the Atlantic ctenophore *Mnemiopsis leidyi*. *Society for Integrative and Comparative Biology Annual Meeting*. January 3-7, 2019, Tampa FL.
10. **Byron, M.**, E. Variano. Non-isotropy of slip velocity in large negatively buoyant non-spherical particles in turbulence. *American Physical Society: Division of Fluid Dynamics Fall Meeting*. November 18-20, 2018. Atlanta, GA.
11. **Byron, M.**, M. McHenry. Effect of flow rate and shear on swimming kinematics of cydippid ctenophores. *Ocean Sciences Meeting*. February 11-16, 2018. Portland, Oregon.
12. **Byron, M.** How does stuff move in the ocean? *National Academies Keck Futures Initiative*. November 9-12, 2016. Arnold and Mabel Beckman Center, Irvine, CA.
13. **Byron, M.**, M. McHenry. Effects of turbulence on the swimming of cydippid ctenophores. *Microscale Ocean Biophysics*. October 31 – November 4, 2016. InterUniversity Institute, Eilat, Israel.
14. **Byron, M.**, M. McHenry. Biomechanics of cydippid ctenophores in turbulent flows. *Ctenopalooza*. March 14-15, 2016. Whitney Marine Lab, Marineland, FL.
15. **Byron, M.**, Y. Tao, I. Houghton, E. Variano. Turbulent interactions at the meso-scale: effects of shape and density on rotation, translation, and settling. *Microscale Ocean Biophysics Symposium*. January 11 – 15, 2015. Aspen, CO.
16. **Byron, M.**, Y. Tao, I. Houghton, E. Variano. Spin, slip, and settle: effects of shape on motion for Taylor-scale particles in homogeneous isotropic turbulence. *American Physical Society: Division of Fluid Dynamics Fall Meeting*. November 24, 2014. San Francisco, CA.

17. **Byron, M.**, Y. Tao, E. Variano. Buoyancy effects on the rotation and translation of large anisotropic particles in turbulent flow. *American Physical Society: Division of Fluid Dynamics Fall Meeting*. Nov. 24, 2013. Pittsburgh, PA.
18. **Byron, M.**, E. Variano. Effect of body shape on rotation in turbulence. *Microscale Interactions in Aquatic Environments*. March 13, 2013. Les Houches, France.
19. **Byron, M.**, E. Variano. Development of Refractively Matched Hydrogels for PIV Applications. *American Physical Society: Division of Fluid Dynamics Fall Meeting*. November 19, 2012. San Diego, CA.
20. **Byron, M.**, C. Meyer, G. Bellani, E. Variano. Turbulent boundary layer on a large freely moving particle suspended in high-Reynolds number isotropic turbulence. *American Physical Society: Division of Fluid Dynamics Fall Meeting*. November 21, 2011. Baltimore, MD.
21. **Byron, M.**, E. Variano. Biological Applications of Refractive-Index-Matched Particles in Stereoscopic PIV. *Society for Integrative and Comparative Biology Annual Meeting*. January 5, 2012, Charleston, NC.
22. **Byron, M.**, C. Meyer, G. Bellani, E. Variano. Coupled Dynamics of Turbulent Water Flow and Non-Spherical Particles Through Novel Measurement Method. *American Geophysical Union Fall Meeting*. Dec. 5, 2011. San Francisco, CA.

INVITED TALKS AND SEMINARS

1. “Not a sphere, not a point: how real particles move in environmental turbulence.” Environmental Engineering Seminar Series, Stanford University. April 27, 2021. Virtual.
2. “Spatiotemporal asymmetry in ctenophores: metachronal locomotion at intermediate Reynolds number.” Society for Integrative and Comparative Biology Annual Meeting (Symposium: Metachronal coordination of multiple appendages for swimming and pumping). January 7, 2020. Virtual.
3. “Scale-dependent complexity in locomotion: swimming across scales.” Frontiers of Mechanical Engineering and Sciences Webinar Series, Georgia Institute of Technology. November 13, 2020. Virtual.
4. “Swimming, spinning, and settling: dynamics of intermediate-scale particles and animals in turbulence.” Water Resources Engineering and Science Seminar, Civil and Environmental Engineering, University of Illinois at Urbana-Champaign. September 11, 2020. Virtual.
5. “Turning through turbulence: how animals navigate through complex fluid environments”. Department of Biology, West Chester University. April 1, 2019. West Chester, PA.
6. “Suspended in turbulence: how shape, size, and density affect the motion of particles and animals.” Garfield Thomas Water Tunnel Seminar Series, January 23, 2019. Applied Research Laboratory, Penn State University. University Park, PA.
7. “Nonspherical particles in turbulent flow: influence of shape, size, and density distribution.” Center for Environmental and Applied Fluid Mechanics Seminar Series, Johns Hopkins University. November 30, 2018, Baltimore, MD.
8. “Exploring non-homogeneous, non-spherical particles in flow: how do we quantify inertia?” Association for the Sciences of Limnology and Oceanography Annual Meeting, June 13, 2018, Victoria, British Columbia, Canada.
9. “How Stuff Moves in Turbulence: From Particles to Animals.” Bermuda Institute of Ocean Sciences, May 18, 2018, St. Georges, Bermuda.

TEACHING EXPERIENCE

Aerodynamics for Mechanical Engineers (ME427) – Spring 22

Undergraduate upper-level technical elective on aerodynamics and related flows. Penn State University.

Fluid Flow (ME320) – Fall 2017, 18; Spring 2018, 19, 21

Introduction to the basic principles of fluid mechanics (for undergraduates). Penn State University.

Foundations of Fluid Mechanics I (ME521) – Fall 2018, 19, 20, 21

Graduate-level introduction to the principles of fluid mechanics. Penn State University.

Elementary fluid mechanics (CE100) (Teaching Assistant) – Fall 2014

Undergraduate introduction to fluid mechanics in civil engineering. University of California Berkeley.

COURSES, CERTIFICATIONS, & WORKSHOPS

National Academies Keck Futures Initiative 2017: The Deep Blue Sea. Arnold and Mabel Beckman Center, Irvine, CA. November 9-12, 2016.

Certificate in Course Design. University of California Irvine Center for Engaged Instruction (CEI). November – December 2015.

Summer Course: Fish Swimming. Friday Harbor Laboratories, University of Washington. Friday Harbor, WA, July – August 2013. Instructors: P. Domenici and J.F. Steffensen.

Workshop: Research and Training at the Interface of Theory and Experiment. Society for Integrative and Comparative Biology Fall Meeting, January 2012.

PROFESSIONAL SERVICE

Peer review

Grant proposals: National Science Foundation (Ocean Sciences, Integrative Organismal Systems, Hydrologic Sciences, Earth Sciences); Woods Hole Oceanographic Institution Sea Grant

Journal articles: Physica D, Acta Mechanica, Experiments in Fluids, Physics of Fluids, Journal of Fluid Mechanics, Journal of Fluids and Structures, Limnology and Oceanography, Integrative and Comparative Biology, Journal of Experimental Biology

Service to scientific societies

- Vice Chair, Education and Outreach Committee, American Physical Society Division of Fluid Dynamics (2021 – present)
- Symposium organizer, “Metachronal coordination of multiple appendages for swimming and pumping”. Society for Integrative and Comparative Biology 2021 Annual Meeting, January 3-7, 2021. Virtual.
- Minisymposium organizer, “Topics in Fluid Mechanics”. American Physical Society Division of Fluid Dynamics Annual Meeting, November 19, 2018. Atlanta, GA.
- Session chair, American Physical Society Division of Fluid Dynamics Annual Meeting (2017 - present)
- Session chair, Society for Integrative and Comparative Biology Annual Meeting (2017 - present)
- Session chair, Thousand Islands Fluid Dynamics Meeting (2018 - present)
- Multiphase Flow Technical Committee, American Society of Mechanical Engineers Fluids Engineering Division (2019 – present)

Departmental service

- Strategic Planning Committee (2019 – present)
- Fluids Caucus (2017 – present)
- Fluid Dynamics qualifying exam committee (2017 – present)
- Search Committee, “Emerging Areas of Mechanical Engineering” (2018 – 2019)

College and university-level service

- Search Committee, Mechanical Engineering Department Head (2020-2021)
- Water Festival Planning Committee (2020)

Service at Previous institutions

- Advisory Council on Campus Climate, Culture, and Inclusion (UC Irvine), 2016-2017
- Student Steering Committee, CiBER-IGERT (UC Berkeley), 2011 – 2012
Webmaster/Recruitment Chair, Graduate Women of Engineering (UC Berkeley), 2010 – 2011

PUBLIC OUTREACH

- Guest lecture, State College Area High School AP Physics class (2021)
- Guest speaker, State College Area High School Chemistry and Physics Club (2021)

- Guest speaker, Stanford Women in Fluid Dynamics “Virtual Coffee Chat” series (2020)
- Guest speaker/faculty mentor, BUILD (Building Undergraduate Innovation and Leadership in Design) (2018)
- EngineerGirl online portal (2017-present)
- Mentor, Bridges to Baccalaureate program (UC Irvine) (2016)
- Mentor, Girls’ Science Institute, San Francisco Exploratorium (2014)
- Judge, Think College Now/Int. Community School Elementary Science Fair (2014)
- Presentation Judge, Annual Biomedical Research Conference for Minority Students (2012)
- Project Leader, Summer Math and Science Honors Academy (Level Playing Field Initiative) (2011-2012)
- Bay Area Scientists in Schools elementary science enrichment (2010-2011)

PROFESSIONAL SOCIETY MEMBERSHIP

American Society of Mechanical Engineers (Fluids Engineering Division)
 American Physical Society (Division of Fluid Dynamics)
 Association for the Sciences of Limnology and Oceanography
 Society for Integrative and Comparative Biology

FURTHER RESEARCH EXPERIENCE

- Aug. 2010 – Aug. 2015* Graduate Student Researcher, University of California Berkeley Department of Civil and Environmental Engineering
Dissertation title: The rotation and translation of non-spherical particles in homogeneous isotropic turbulence (Advisor: Dr. Evan Viano)
- August 2009 – May 2010* Undergraduate Researcher, Princeton University Department of Mechanical and Aerospace Engineering
Designed and fabricated a robotic manta ray for use in hydrodynamics experiments (Advisor: Dr. Alexander Smits)
- June – August 2009* Research Assistant, Pennsylvania State University Department of Mechanical and Nuclear Engineering. State College, Pennsylvania
Developed assignments and supplementary curricula in fluid mechanics for upper-level undergraduate combustion class. (Supervisor: Dr. Dan Haworth)
- June – August 2008* Intern, Infosys Technologies Ltd. Bangalore, India.
Applied Finite Element Analysis to solve beam/plate buckling problems for aeronautics applications. (Supervisor: Dr. Sambasiva Rao)

STUDENT MENTORING

- Graduate:** Adrian Herrera-Amaya (Fall 2018 – present)
 Venkata Rajeshwar Majety (Fall 2018 – present)
 Nitis Chantarawong (Fall 2019 – present)
 Annalie Fazio (Fall 2020 – present)
 Anthony Sabatino, M.S. (Fall 2019 – Summer 2020)
 Brandon Angle, M.S. (Fall 2017 – Summer 2019)
- Undergraduate:** Brayden Bowie (Fall 2021 – present)
 Marwan Fayed (Summer 2021 – present)
 Luna Morales (Spring 2021 – present)
 Carlos Abarca, B.S. with honors (Fall 2019 – Spring 2021)
 Aaron Aguiles, B.S. (Fall 2019 – Spring 2020)
 Annalie Fazio, B.S. (Fall 2018 – Spring 2020; transition to MS)
 Nitis Chantarawong, B.S. (Summer 2018 – Spring 2019; transition to MS)

Rebecca Denby, B.S. with honors (Fall 2018 – Spring 2019)
Aiden Cronin, B.S. with honors (Fall 2018 – Spring 2019)
Joseph Bail, B.S. (Fall 2017 – Spring 2018)
Elizabeth Seber, B.S. (Spring 2018 – Summer 2018)

SKILLS

Software: MATLAB, DaVis/LaVision, PIVlab, ProAnalyst, Creo Parametric, Autodesk Fusion, Microsoft Office Suite.

Languages: French (professional proficiency)