Eva KANSO

Associate Professor & Zohrab A. Kaprielian Fellow in Engineering
Aerospace and Mechanical Engineering
University of Southern California, Los Angeles, CA 90089
email: kanso@usc.edu, *url:* kanso.usc.edu
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EDUCATION

2003: **Ph.D.** in Mechanical Engineering, University of California, Berkeley
co-advisors: Prof. Andrew J. Szeri and Prof. Panayiotis (Panos) Papadopoulos
2002: **M.A.** in Mathematics, University of California, Berkeley
1999: **M.Sc.** in Mechanical Engineering, University of California, Berkeley
1997: **B. Eng'g** in Mechanical Engineering *(with distinction)*, American University of Beirut

ACADEMIC POSITIONS

05/2015– 07/2015: **Chercheur Invité**, Laboratoire LadHyX, Ecole Polytechnique
hosts: Prof. Sebastien Michelin and Prof. Charles Baroud
12/2010– present: **Associate Professor**, Aerospace & Mechanical Engineering, USC
01/2012–12/2014: **Visiting Associate**, Computational & Applied Math, Caltech
hosts: Prof. Mathieu Desbrun and Prof. Houman Owhadi
08/2005–12/2010: **Assistant Professor**, Aerospace & Mechanical Engineering, USC
08/2005–06/2008: **Visiting Associate**, Control & Dynamical Systems, Caltech
host: late Prof. Jerrold E. Marsden
08/2003–08/2005: **Post-doctoral Scholar**, Control & Dynamical Systems, Caltech
co-advisors: late Prof. Jerrold E. Marsden and Prof. Mathieu Desbrun
03/2004–06/2004: **Visiting Researcher**, Mechanical & Aerospace Eng'g, Princeton University
hosts: Prof. Naomi E. Leonard and Prof. Clarence W. Rowley
06/2003–08/2003: **Post-doctoral Scholar**, Sensor & Actuator Center, UC Berkeley
co-advisors: Prof. Andrew J. Szeri and Prof. Albert P. Pisano

HONORS and AWARDS

04/2014: **Distinguished Young Alumnus Award**, American University of Beirut
06/2011 - present: **Zohrab A. Kaprielian Fellow in Engineering.** USC
03/2007 - 02/2012: **NSF Faculty Early Career Development Award**
05/2002: **Outstanding Graduate Student Instructor**, University of California, Berkeley
01/1999 - 05/1999: **Lebanese-American Association Scholarship**
08/1998 - 12/1998: **Poage Memorial Scholarship**
08/1997 - 05/2000: **UC Regents Fellowship**, University of California, Berkeley
05/1996: **Award for Academic Excellence**, Hariri Foundation, Lebanon
09/1994 - 07/1997: **Dean's Honor List**, American University of Beirut

CONTRACTS and GRANTS

1. **NSF Grant** Current: 08/2015-07/2018
CBET 15-12192: *Collaborative Research: Crossing the boundary: motion of solid objects across air-liquid interfaces.* co-PIs: Eva Kanso (lead), Fotis Sotiropoulos.

2. **WiSE Supplementary Support for Continuing Faculty** Current: 05-07/2015

3. **Bavaria California High-Tech Initiative** Current: 03/2015-12/2016
Seed funding for new collaborations: *What do a bacterial cell and a bird have in common? Commonalities in propulsion and transport mechanisms across multiple flow regimes.*
Co-PIs: Eva Kanso and Walter Zimmerman of Universität Bayreuth.

4. **ONR Grant** Current: 06/2014-05/2017
ONR 14-001: *Wake signatures and optimal design of underwater sensory systems for wake detection.* PI: Eva Kanso, subcontractors: Geoffrey Spedding of USC and Jeannette Yen of Georgia Tech.

5. **NSF Grant** Current: 07/2014-06/2017
CMMI 13-63404: *Aerodynamics of Passive Flight and Probability of Landing Sites.*
PI: Eva Kanso.

6. **NSF CAREER Award** Completed: 03/2007-02/2012
CMMI 06-44925: *Modeling and Control of Solid-Fluid Interactions in Aquatic Locomotion.*
PI: Eva Kanso.

7. **WiSE Major Support for Continuing Faculty** Completed: 05/2010-09/2011
From Fish Locomotion to Cell Motility. PI: Eva Kanso.

8. **NSF CCF Grant** Completed: 08/2008-07/2012
CCF 08-11480: *Aquatic Propulsion Laboratory.*
Co-PIs: Jarek Rossignac, Greg Turk & Karen Liu of Computer Science at Georgia Tech and Eva Kanso of USC.

9. **NSF Collaborative Grant** Completed: 08/2008-07/2011
CMMI 07-57092: *Geometric Time Integrators for Mechanical Dynamical Systems.*
Co-PIs: Mathieu Desbrun of Caltech, Eva Kanso of USC, and Yiying Tong of Michigan State University.

10. **Rose Hills Grant** Completed: 05/2008-07/2008
Rose Hills Grant for Undergraduate Mentoring: *Fish Schools: Kinematic and Kinetic Models.*
PI: Eva Kanso.

JOURNAL PAPERS IN PREPARATION

Students and post-docs advised and co-advised by Kanso are underlined. Corresponding authors are indicated by $*$.

1. Colvert B. and **E. Kanso*** [2015], Following the local pressure gradient: optimal sensors placement and emergent locomotion in laminar and vortical flows, *in preparation*

2. Guo H. and **E. Kanso*** [2015], Leanning into the flow: a design principle for motile cilia, *in preparation*

3. Huang Y. and **E. Kanso*** [2015], Roll stability of flapping wings, *in preparation*

4. Guo H. and **E. Kanso*** [2015], Cilia beating in viscoelastic fluid, *in preparation*

REFEREED JOURNAL PUBLICATIONS

Students and post-docs advised and co-advised by Kanso are underlined. Corresponding authors are indicated by $*$. Manuscripts under review are posted on the math arXiv and listed on kanso.usc.edu

5. Tsang A.C.H. and **E. Kanso*** [2015], Density shock waves in confined microswimmers, *under review*
6. Huang, Y. and **E. Kanso*** [2015], Regular and chaotic flapping of insectile wings , *under reivew*
7. Ding Y., and **E. Kanso*** [2015], Selective particle capture by randomly beating cilia, *under review*
8. Huang, Y. and **E. Kanso*** [2015], Aerodynamically optimal hovering is unstable, *under review*
9. Babikian, S., F. Valero-Cuevas and **E. Kanso*** [2015], Slow limb movements require precise control of muscle stiffness, *under review*
10. **Kanso E*** and Tsang A.C.H., [2015], Pursuit and synchronization in hydrodynamic dipoles, *accepted*
11. Tsang A.C.H., and **E. Kanso*** [2015], Circularly-confined microswimmers exhibit multiple global patterns, *PRE*, 91, 043008.
12. Tsang A.C.H., and **E. Kanso*** [2014], Flagella-induced transitions in the collective behavior of confined microswimmers, *PRE rapid communication*, 90, 021001(R).
13. Guo, H., J. Nawroth, Y. Ding and **E. Kanso*** [2014], Cilia beating patterns are not hydrodynamically optimal, *Phys. Fluids,* 26, 091901.
14. Ding Y., J. Nawroth, M. McFall-Ngai and **E. Kanso*** [2014], Mixing and transport by ciliary carpets, *J. Fluid Mech.*, 743, 124-140.
15. **Kanso E*** and A.C.H. Tsang [2014], Dipole models of self-propelled bodies, *Fluid Dynamics Research*, 46, 061407.
16. Heisinger L., P.K. Newton and **E. Kanso*** [2014], Coins falling in water, *J. Fluid Mech.*, 742, 243-253.
17. Tsang, A.C.H. and **E. Kanso*** [2013], Dipole interactions in doubly-periodic domains, *Journal of Nonlinear Science*, 23(6), 971-991.
18. Jing, F. and **E. Kanso*** [2013], Stability of underwater periodic locomotion, *Regular & Chaotic Dynamics*, **18**(4): 380-393.
19. Oskouei, B. G. and **E. Kanso*** [2013], Stability of Passive Locomotion in Periodically-generated Wakes, *Phys. Fluids*, **25**, 021901.
20. Lee A., G.W. Tormoen , **E. Kanso**, O. McCarty, P.K. Newton* [2012], Modeling and simulation of procoagulant circulating tumor cells in flow, *Frontiers in Cancer Molecular Targets and Therapeutics*. DOI 10.3389/fonc.2012.00108
21. Lee A., M. Berny-Lang, S. Liao, **E. Kanso**, P. Kuhn, O.J.T. McCarty, P. K. Newton* [2012], A stochastic mathematical model for tumor cell release and entry into the bloodstream, *Phys. Fluids*, **24**, 081903.

22. Tchieu A.*, **E. Kanso** and P.K. Newton [2012], The finite dipole dynamical systems, *Royal Proc. A.* **468**, 3006-3026.

23. Jing F.*, **E. Kanso** and P.K. Newton [2012], Insights into vortex merger using the core growth model, *Phys. Fluids.* **24**, 073101.

24. Jing, F. and **E. Kanso*** [2012], Effects of Body Elasticity on Passive Stability of Submerged Bodies, *J. Fluid Mech.* **690**, pp 461 - 473.

25. Ysasi A., **E. Kanso***, and P.K. Newton [2011], Wake Structure of a Deformable Joukowski Airfoil, *Physica D*, **240**(20), pp 1574-1582.

26. Tiron R., **E. Kanso***, and P.K. Newton [2011], Hydrodynamically Coupled Oscillators, *J. Fluid Mech.*, **677**, pp 589 - 606.

27. Pavlov D., P. Mullen, Y. Tong, **E. Kanso**, J. E. Marsden, and M. Desbrun* [2011], Structure-Preserving Discretization of Incompressible Fluids, *Physica D*, **240**(6), pp 443-458.

28. Oskouei B., **E. Kanso***, and P.K. Newton [2011], Streamline Bifurcations and Scaling Theory for a Multiple-Wake Model, *International Journal of Nonlinear Mechanics.* **46**(4), pp 592-60.

29. Mullen, P., A. McKenzie, D. Pavlov, L. Durant, Y. Tong, **E. Kanso**, J. E. Marsden, and M. Desbrun* [2011], Discrete Lie Advection of Differential Forms, *Foundations of Computational Mathematics*, **11**(2), pp 131-149. Erratum, **11**(2), p 151.

30. **Kanso, E.*** [2010], Swimming in an Inviscid Fluid, *Theoretical and Computational Fluid Dynamics*, **24**(1), 201–207.

31. Jing F.*, **E. Kanso**, and P.K. Newton [2010], Viscous evolution of point vortex equilibria: the collinear state, *Physics of Fluids.* **22**(12): 123102.

32. **Kanso E.*** and P. K. Newton [2010], Locomotory Advantages to Flapping Out of Phase, *Journal of Experimental Mechanics*, **50**, 1376-1372.

33. Vankerschaver J.*, **E. Kanso** and J.E. Marsden [2010], The Dynamics of a Rigid Body in Potential Flow with Circulation, *Regular & Chaotic Dynamics.* **15**:4-5, 606-629.

34. Chamoun G., **E. Kanso** & P. K. Newton* [2009], von Kárman Vortex Streets on the Sphere, *Physics of Fluids.* **21**, 116603. DOI: 10.1063/1.3258066.

35. **Kanso E.*** & P. K. Newton [2009], Passive Locomotion via Normal Mode Coupling in a Submerged Spring-Mass System, *Journal of Fluid Mechanics.* **641**, pp 205–215.

36. Cochran J., **E. Kanso**, S. Kelly, H. Xiong, M. Krstic* [2009], Source Seeking for Two Nonholonomic Models of Fish Locomotion, *IEEE Transactions on Robotics,* **25**(5):1166–1176.

37. **Kanso, E.*** [2009], Swimming due to Transverse Shape Deformations, *Journal of Fluid Mechanics.* **631**, pp 127–148.

38. Vankerschaver J.*, **E. Kanso** and J.E. Marsden [2009], The Geometry and Dynamics of Interacting Rigid Bodies and Point Vortices, *Journal of Geometric Mechanics,* **1**(2), pp 223–266.

39. **Kanso E.***, and B. Oskouei [2008], Stability of a Coupled Body-Vortex System, *Journal of Fluid Mechanics*, **800**:77–94.

40. Nair, S. and **E. Kanso*** [2007], Hydrodynamically-coupled Rigid Bodies, *Journal of Fluid Mechanics*, **592**:393–411.

41. Elcott S., Y. Tong, **E. Kanso** M. Desbrun, and P. Schröder* [2007], Discrete, Circulation-preserving and Stable Simplicial Fluid, *ACM Transactions on Graphics*, **26**(1), art.4.

42. **Kanso E.***, M. Arroyo, Y. Tong, A. Yavari, J.E. Marsden and M. Desbrun [2007], On the Geometric Character of Continuum Mechanics, *Zeitschrift für Angewandte Mathematik und Physik*, **58**, 1-14.

43. **Kanso E.***, J.E. Marsden, C.W. Rowley and J. Melli-Huber [2005], Locomotion of articulated bodies in a perfect fluid, *International Journal of Nonlinear Science*, **15**, 255–289.

44. **Kanso E.**, A.J. Szeri and A.P. Pisano* [2004], Cross-coupling Errors of Micro-machined Gyroscopes, *IEEE Journal of Microelectromechanical Systems*, **13**(2): 323-331.

45. **Kanso E.** and P. Papadopoulos* [2004], Pseudo-rigid ball impact on an oscillating rigid foundation, *International Journal of Non-linear Mechanics*, **39**:1129-1145.

46. **Kanso E.** and P. Papadopoulos* [2004], Dynamics of pseudo-rigid ball impacting on rigid foundation, *International Journal of Non-linear Mechanics*, **39**:299-309.

BOOK CHAPTERS

47. Desbrun M.*, **E. Kanso**, and Y. Tong [2008], Discrete Differential Forms for Computational Modeling. In A.I. Bobenko, P. Schröder, J.M. Sullivan and G.M. Ziegler, editors. *Discrete Differential Geometry*, Oberwolfach Seminars, **38**. Birkhauser, Berlin.

REFEREED CONFERENCE PROCEEDINGS

IEEE CDC is the most prestigious conference in Control & Dynamical Systems with acceptance rates $< 50\%$.
SIGGRAPH is the most prestigious conference in Computer Graphics with acceptance rates $< 25\%$.

1. J.X. Sheng, A. Ysasi, D. Kolomenskiy, **E. Kanso**, M. Nitsche*, and K. Schneider [2012], Simulating Vortex Wakes of Flapping Plates, In S. Childress, A. Hosoi, W.W. Schultz & J. Wang *Natural Locomotion in Fluids and on Surfaces: Swimming, Flying, and Sliding,* The IMA Volumes in Mathematics and its Applications. **155**. Springer.

2. Oskouei, B. and **E. Kanso*** [2012], Stability of Passive Locomotion in Periodically-generated Wakes, In S. Childress, A. Hosoi, W.W. Schultz, & J. Wang *Natural Locomotion in Fluids and on Surfaces: Swimming, Flying, and Sliding,* The IMA Volumes in Mathematics and its Applications. **155**. Springer.

3. Jing, F., P.K. Newton and **E. Kanso*** [2011], Viscosity Effects on Inviscid Point Vortex Equilibria, *ENOC 2011.* Rome, Italy. Jul 2011.

4. **Kanso E.** [2010], Swimming in an Inviscid Fluid. In H. Aref, editor. *Proceedings of the IUTAM Symposium on 150 Years of Vortex Dynamics.* Copenhagen, Denmark. Oct 2008.

5. Leyendecker S.* and **E. Kanso** [2009], Locomotion of a Submerged Cosserat Beam, *International Conference on Multibody Systems, Nonlinear Dynamics, and Control, ASME International Design Engineering Technical Conference*, San Diego, California, Sep 2009.

6. Jing F. and **E. Kanso*** [2009], Stability of a Submerged Deformable Body, *International Conference on Multibody Systems, Nonlinear Dynamics, and Control, ASME International Design Engineering Technical Conference*, San Diego, California, Sep 2009.

7. Cochran J., **E. Kanso**, and M. Krstic* [2009], Source Seeking for a Three-Link Model of Fish Locomotion, *Proceedings of the American Control Conference,* St. Louis, Missouri, 2009.

8. Vankerschaver J.*, **E. Kanso** and J.E. Marsden [2008], The Motion of Solid Bodies in Potential Flow with Circulation: a Geometric Outlook, *ASME Conference on Dynamical Systems and Control*, Ann Arbor, Michigan, Oct 2008.

9. Chamoun G.*, **E. Kanso** and P.K. Newton [2008], Single Vortex Streets on the Sphere, *ASME Conference on Dynamical Systems and Control,* Ann Arbor, Michigan, Oct 2008.

10. Nair S. and **E. Kanso*** [2007], Configuration Control of Non-colliding Particles, *IEEE Conference on Decision and Control,* New Orleans, Louisiana. Dec 2007.

11. Jing F.*, **E. Kanso** and P. Newton [2007], Motion Control of a Spinning Particle on Rotating Earth, *IEEE Conference on Decision and Control,* New Orleans, Louisiana. Dec 2007.

12. Kharevych L., Weiwei, Y. Tong, **E. Kanso**, P. Schröder, J.E. Marsden and M. Desbrun* [2006], Geometric, Variational Integrators for Computer Animation, *ACM SIGGRAPH 2006/Eurographics symposium on Computer animation*, Vienna 2006.

13. Desbrun M.*, Kanso, E., and Tong, Y. [2006]. Discrete differential forms for computational modeling. In *ACM SIGGRAPH 2006 Course Notes on Discrete Differential Geometry.* ACM Press, 2006.

14. Kanso, E.* and J.E. Marsden [2005], Optimal motion of an articulated body in a perfect fluid, *IEEE Conference on Decision and Control,* 2511-2516. Seville, Spain, Dec 2005.

INVITED SEMINARS

1. "From flapping of insectile wings to density shocks in confined microswimmers" Laboratoire LadHyX. Ecole Polytechnique. Paris. May 2015.

2. "Stability versus maneuverability in hovering flight" Coordinated Science Laboratory. UIUC. Mar 2015.

3. "The fluid mechanics of bacteria-cilia associations" Center for Applied and Molecular Medicine. USC. Feb 2015.

4. "Stable hovering is not efficient" Applied Mathematics. UC Davis. Nov 2014.

5. "Wonderful fluids: from hovering hats to bacterial shock waves." AME. USC. Sep 2014.

6. "Hydrodynamically-triggered transition from swirling to clustering in confined suspensions." Active Matter Program. Kavli Institute of Theoretical Physics. UCSB. May 2014.

7. "Life from high to low Reynolds number." Applied Mathematics Colloquium. UCLA. May 2014.

8. "Motion in a Fluid: this, that and the other." Lunch Bunch. Computation and Mathematical Sciences. Caltech. May 2014.

9. "From Fish Swimming to Cell Motility" Workshop: Dynamics Days 2014. Georgia Tech. Atlanta. January 2014.

10. "Dipole Models of Self-Propelled Bodies" Workshop: Mathematical Aspects of Fluid-Structure Interactions. Institut Henri Poincare. Paris. November 2013.

11. "Hydrodynamic Interactions of Self-Propelled Bodies" IMA US-Japan Conference for Young Researchers on Interactions among Localized Patterns in Dissipative Systems. University of Minnesota. June 2013.

12. "Following Chemical and Hydrodynamic Signals in Animal Motion," USC/Scripps Research Institute: Research Retreat, May 2012.

13. "Fishes and Multi-dipole Interactions," USC, Applied Mathematics CAMS, Apr 2012.

14. "Fishes and Dipoles," **TF Ogilvie Lecture in Ocean Sciences and Engineering**, Mechanical Engineering Colloquium, MIT, Apr 2012.

15. "The Finite Dipole Dynamical Systems" Fluid Dynamics Seminar University of California, San Diego, May 2012.

16. "Fish and Dipoles" Department of Mathematics, UC Irvine, Jan 2012.

17. "Fish, Dipoles and Vortices" Galcit, Caltech, Jan 2012.

18. "Fluid-body Coupling in Aquatic Locomotion," Department of Mechanical & Aerospace Engineering, UC Irvine, May 2011.

19. "Research Progress: USC Nonlinear Dynamics Group," Department of Aerospace & Mechanical Engineering, USC, Apr 2011.

20. "Swimming against the flow," Laboratoire DHydrodynamique (LadHyX), École Polytéchnique, Paris, Apr 2011.

21. "How to Swim in a Perfect Fluid," Applied Mathematics Laboratory Courant Institute, New York University, Mar 2011.

22. "Locomotion of rigid and deformable bodies in Unsteady Flows," Department of Mechanical Engineering, McGill University, Montreal, Nov 2010.

23. "Dynamics and Stability of Submerged Spring-Mass Systems," Department of Mathematics, University of New Mexico, Albequerue, Oct 2010.

24. "Locomotion in Unsteady Flows," Department of Mathematics Seminar Series. Indiana University - Purdue University Indianapolis, Oct 2010.

25. "Active and Passive Locomotion of Submerged Bodies: Application to Fish Swimming," Institute of Mechanics. Swiss Federal Institute of Technology (ETH) Zürich. Sep 2010.

26. "Aquatic Locomotion: Active and Passive Mechanisms," Aerospace Engineering Seminar Series. University of Illinois, Urbana-Champain. May 2010.

27. "Hydro-dynamically Coupled Bodies," Mechanical & Aerospace Engineering, Thermo/Fluid Seminar Series. University of California, Los Angeles. Feb 2010.

28. "Dynamics of Aquatic Locomotion," Seminar Series of the Center for Control, Dynamical Systems and Computation. Electrical & Computer Engineering. University of California, Santa Barbara. Feb 2009.

29. "Swimming of a Deformable Body due to Transverse Shape Deformations," Control & Dynamical Systems Seminar. California Institute of Technology. Feb 2008.

30. "Swimming of Solid Bodies in a Perfect Fluid," Engineering Neuroscience & Health Seminar Series. University of Southern California. Oct 2007.

31. "Low-order models of fish swimming," Industrial & Systems Engineering Seminar Series. University of Southern California. Sept 2007.

32. "Motion of Solids Bodies in Inviscid Fluid," Chemical Engineering. Fluid Dynamics Seminar Series. University of California, Santa Barbara. Mar 2007.

33. "Hydrodynamic-coupling Effects on Multi-Body Motion," Mechanical Engineering, Fluid Dynamics Seminar Series. University of California, San Diego. Aug 2006.

34. "Hydrodynamically-coupled Rigid Solids," Department of Mathematics. University of Southern California. Aug 2006.

35. "An Articulated Fish Swimming with Point Vortices," Department of Mathematics, Interdisciplinary Seminar in Nonlinear Science. Northwestern University. Dec 2005.

36. "A Geometric Mechanics Approach for Studying Locomotion in a Perfect Fuid," Department of Applied Mathematics. Paderborn University, Germany. Aug 2005.

37. "Swimming in a Perfect Fluid," Mechanical Engineering. American University of Beirut. May 2005.

38. "The Fish, the Cat and the Wave^{TM}," GALCIT Fluid Mechanics Seminar Series. California Institute of Technology. May 2005.

39. "Dynamics of Micro-Machined Gyroscopes," Aerospace & Mechanical Engineering. University of Southern California. Apr 2005.

40. "Swimming in a Perfect Fluid: Dynamics and Optimal Control of a Submerged Articulated Body," Mechanical Engineering Seminar Series. Rice University. Mar 2005.

41. "Swimming in a Perfect Fluid: Mathematical Formulation and Optimal Control," Mechanical Engineering Seminar Series. University of Illinois at Urbana Champain. Mar 2005.

42. "Swimming in a Perfect Fluid: Reduced Models for Fishlike Locomotion," Mechanical & Aerospace Engineering Seminar Series. University of California, Los Angeles. Mar 2005.

43. "Swimming in a Perfect Fluid: a Geometric Approach," Mechanical Engineering Seminar Series. University of New Mexico, Las Cruces. Mar 2005.

44. "Swimming in a Perfect Fluid," Aerospace & Mechanical Engineering Seminar Series. University of Southern California. Feb 2005.

45. "Swimming in a Perfect Fluid," Mechanical Engineering Seminar Series. University of California, Berkeley. Jan 2005.

46. "Swimming in an Ideal Fluid: a three-link fish model," Program of Applied and Computational Mathematics, Dynamical Systems & Nonlinear Science Seminar Series. Princeton University. Apr 2004.

47. "Impact of a Pseudo-rigid Ball on a Rigid Foundation," Civil Engineering Informal Seminar. Johns Hopkins University. May 2003.

48. "Impact of a Pseudo-rigid Ball on a Rigid Foundation," Mechanical Engineering Informal Seminar. University of California, Santa Barbara. Jan 2002.

49. "Dynamics of Micro-gyroscopes," Mechanical Engineering Seminar. American University of Beirut. Nov 2000.

INVITED CONFERENCE PRESENTATIONS

47. "Bacteria-Cilia Associations." **Focus Talk**. Chaos, complexity and transport. Marseilles, France. Jun 2015.

48. "Bacteria association with ciliated surfaces." SIAM Computational Science and Engineering Conference. Salt Lake City. Mar 2015.

49. "Emergent behavior in confined microswimmers: from spiraling and clustering to traveling shock waves." Workshop on Living Fluids. Marrakech. Oct 2014.

50. "Density Shock Waves in Confined Swimmers and other stories" Workshop on Collective Behavior. Villa Garbald. Switzerland. Sep 2014.

51. "Wake Signatures and Optimal Design of Underwater Sensory Systems for Wake Detection" ONR Kick-off meeting. University of Virginia. Aug 2014.

52. "A Hydrodynamic Mechanism for Biofilm Initiation." AmeriMech Workshop. Virginia Tech. May 2014.

53. "Make a Wish: Probabilistic Models of Coins Falling in Water." **Keynote Lecture** (available on YouTube). FEA Students and Alumni Conference. American University of Beirut. April 2014.

54. "Dipole Interactions in Doubly-periodic Domains" **Featured Mini-symposium: Vortex Dynamics**. SIAM Dynamical Systems Meeting. May 2013.

55. "What would a body need to swim?" **Keynote Lecture**. International Workshop on Bio-Inspired Robots, Ecole des Mines, Nantes. Apr 2011.

56. "Stability and Control of a Vortex-Body System." Minisymposium: Dynamics and Control of Multibody Systems. Engineering Mechanics Institute. USC. Aug 2010.

57. "Viscous evolution of a point-vortex equilibrium." Minisymposium: Vortex Dynamics. American Mathematical Society (AMS) Sectional Meeting. New Jersey Institute of Technology. May 2010.

58. "Optimal Locomotion of a Submerged Cosserat Beam." Minisymposium: Structure-Preserving Integrators in Computational Dynamics and Control. IV European Conference on Computational Mechanics. Paris. May 2010.

59. "Submerged Spring-Mass Systems," 6th Structured Integrators Workshop, University of California, San Diego. May 2010.

60. "Inviscid Model for Vortex Shedding in Fish Schooling," SIAM Dynamical Systems, Snowbird. May 2009.

61. "Fish Locomotion and Multiple Wake Interactions," SIAM Computational Science & Engineering, Miami. Mar 2009.

62. "Stability of a Body-Vortex System" 4^{th} Structured Integrators Workshop, Stanford University, California. Apr 2008.

63. "Low-order Models of Swimming." Workshop on Geometric Mechanics: Continuous and Discrete, Finite and Infinite. Banff International Reseach Station, Canada. Aug 2007.

64. "Hydrodynamically-coupled Solids." SIAM Dynamical Systems, Snowbird. May 2007.

65. "Configuration Control of Particles." Dynarum Meeting, University of California, Santa Barbara. Oct 2006.

66. "Low-order Models of Fish-Wake Interactions." World Congress on Computational Mechanics, Los Angeles. Jun 2006.

67. "Phases and Aquatic Locomotion: Body-Wake Interactions." SIAM Annual Meeting, Boston. Jul 2006.

68. "Discrete Mechanics and Optimal Control: Applications and Future Directions." Workshop organized by Dr. Florence Lin of USC and hosted by Prof. Anderson and Prof. Stone. Harvard University. Jul 2006.

69. "Geometric Phases and Swimming in a Perfect Fluid." US Congress on Theoretical and Applied Mechanics, Boulder. Jun 2006.

70. "Discrete Mechanics and Optimal Control." 2^{nd} Structured Integrators Workshop, Stanford University. Jun 2006.

71. "Mathematical Modeling of Fishlike Swimming." Poster Presentation. Workshop on Dynamical Systems Methods in Fluid Dynamics Oberwolfach, Germany. Aug 2005.

72. "Reduced Models for Fishlike Locomotion." SIAM Dynamical Systems, Snowbird. May 2005.

73. "Swimming in a Perfect Fluid," Workshop on Mechanics. Université de Pierre et Marie Curie, Paris, France. Mar 2005.

CONTRIBUTED CONFERENCE PRESENTATIONS

1. "Stability does not Compromise Maneuverability in Underwater Locomotion," APS DFD Meeting. San Francisco. Nov 2014.

2. "Mixing and Transport by Ciliary Flows: A Numerical Study," SIAM Annual Meeting. Chicago. Jul 2014.

3. "Orientational Order in Two-Dimensional Confined Active Suspensions," SIAM Annual Meeting. Jul 2014.

4. "Mixing and Transport by Ciliary Carpets," Aspen Physics Institute: Active Fluids: Bridging Complex Fluids and Biofluids. Jan 2014.

5. "Dipole Lattice," IUTAM Symposium on Vortex Dynamics: Formation, Structure and Function, Fukuoka, Japan. March 2013.

6. "Passive Locomotion in a Perfect Fluid." Minisymposium: Macroorganisms Swimming. US National Congress on Theoretical and Applied Mechanics 2010. State College, Pa. Jun-Jul 2010.

7. "Passive Locomotion in Unsteady Flows." Workshop on Natural Locomotion in Fluids and on Surfaces: Swimming, Flying and Sliding. Institute for Mathematics and its Applications. Minneapolis. May 2010.

8. "Low-order Models for Swimming in an Inviscid Fluid," IUTAM Symposium on 150 Year of Vortex Dynamics, Copenhagen. Oct 2008.

9. "Discrete Variational Fluids," World Congress on Computational Mechanics, San Francisco. Jun 2007.

10. "Overview of Discrete Fluid: a geometric variational approach to fluid simulations," 3^{th} Structured Integrators Workshop, University of Southern California. May 2007.

11. "Optimal Motion of an Articulated Body in a Perfect Fluid," IEEE Conference on Decision and Control CDC 2005, Seville, Spain. Dec 2005.

12. "Locomotion of Articulated Bodies in a Perfect Fluid," American Physics Society APS, Fluid Dynamics Meeting, Seattle. Nov 2004.

13. "Swimming in a Perfect Fluid." 9^{th} Southern California Nonlinear Control Workshop, UCLA. Apr 2004.

TEACHING and COURSE DEVELOPMENT

I developed two courses: AME 453 and AME 523

- ◇ **AME 523: Random Vibrations** Spring 2013
  Introductory topics in Probability Models, Markov Chains and Random Walks.

- ◇ **AME 525: Engineering Analytical Methods** Fall 2012, Fall 2013, Fall 2014
  Service course to all incoming Masters and PhD students covering topics in Complex Analysis, Vector Calculus and Linear Algebra.

- ◇ **AME 453: Engineering Dynamics** Spring 2011, Fall 2011, Spring 2014, Spring 2015
  Newtonian and Lagrangian Mechanics and Rigid body mechanics. Introduction to Dynamical Systems. Linear and Nonlinear Stability.

- ◇ **ENGR 102: Freshman Academy** Fall 2013
  Guest lectures covering elementary topics in mechanics and highlighting "cool" research in biofluid dynamics.

- ◇ **AME 301: Dynamics** Fall 2007 (two sessions), Spring 2009
  Introduction to Newtonian dynamics of particles and planar rigid bodies.

- ◇ **AME 599: Advanced Dynamics** Spring 2007
  Newtonian, Lagrangian and Hamiltonian dynamics, and introduced the students to notions from differential geometry and exterior differential forms. Linear and nonlinear Lyapunov stability.

- ◇ **AME 526: Engineering Analytical Methods** Spring 2006, Summer 2006
  Service course to all incoming Masters and PhD students covering topics in Ordinary and Partial Differential Equations.

RESEARCH TRAINING

Post-doctoral Scholars:

1. **Lionel Vincent** 01/2014 –01/2016
   Research project: (i) Emergent bacterial behavior, (ii) Aerodynamics of passive flight. Dr. Vincent received his Ph.D. from IRPHE, Marseille, France, under the supervision of Stéphane Le Dizès and Laurent Duchemin.

2. **Yang Ding** 12/2011 –05/2014
   Research project: Fluid transport, mixing and particle capture by ciliated carpets.

3. **Andrew Tchieu** 10/2010 – 12/2011
   Research project: Role of Hydrodynamic Coupling in Collective Behavior of Fish.

4. **Roxana Tiron** 09/2009 – 08/2010
   Research project: dynamics and locomotion of a submerged spring-mass system in a ring formation, co-advised with Prof. P.K. Newton.

5. **Sujit Nair** 05/2006-12/2006
   Research projects: (i) dynamics of multiple hydro-dynamically coupled rigid bodies and (ii) control of multiple particles.

Ph.D. Students:

1. **Anthony Medrano** Expected Graduation: 05/2019
   Anthony is the recipient of a GEM fellowship, which provides five-year support for Anthony's graduate studies.

2. **Try Lam** Expected Graduation: 05/2018
   Research topic: Descent modes of heavy objects in Stratefied Flows

3. **Brendan Colvert** Expected Graduation: 05/2018
   Research topic: Optimal Design of Underwater Sensory Systems For Wake Detection Brendan is the recipient of a NDSEG fellowship, which provide three-year support for Brendan's graduate studies.

4. **Hanliang Guo** Expected Graduation: 05/2016
   Research topic: Effects of surface morphology, cilia arrangement and beat pattern on the generated flows.

5. **Yangyang Huang** Expected Graduation: 05/2016
   Research topic: Stability versus maneuverability of hovering flight.

6. **Sarine Babikian** Expected Graduation: 05/2016
   Research topic: Neuromuscular control of slow limb movement.

7. **Alan Tsang** Expected Graduation: 12/2015
   Research topic: Collective dynamics of confined microswimmers. Alan is the recipient of the 2015 AME Excellence in Research Award.

8. **Angela Cho** Graduated: 05/2014
   Thesis: Modeling and Simulation of Circulating Tumour Cells in Flow, co-advised with P.K. Newton.

9. **Babak Oskouei** Graduated: 05/2011
   Thesis: Body-Vortex Dynamics: Application to Aquatic Locomotion.

10. **Fangxu Jing** Graduated: 05/2011
    Thesis: Part I Viscous evolution of point vortex equilibria; Part II Effects of body elasticity on stability of fish motion.

11. **George Chamoun** Graduated: 05/2008
    Research topic: Streamline topologies of vortex streets on the sphere (*Proc. ASME CDSC* 2008 and *Phys. Fluids* 2009), co-advised with P.K. Newton.

Masters Students:

1. **Anthony Ge** Graduated: 05/2015
   Research topic: The mechanics of slithering locomotion

2. **Johannes Rudolph** Graduated: 05/2015
   Johannes spent six months in my group at USC working on a research project in partial fulfillment of his Masters degree at the University of Erlangen-Nuremberg, Germany. Research topic: Passive shape undulations in underwater locomotion

3. **Lorenzo Kustermann** Graduated: 05/2015
   Research topic: Wake signatures of undulatory swimmers

4. **Adam Ysasi** Graduated: 05/2010
   Research topic: Vortex shedding and locomotion of a deformable Joukouski airfoil. Adam is the recipient of a 2008/2009 Provost Fellowship for incoming graduate students.

Undergraduate Students:

1. **Min Zheng:** USC 05/2015-05/2016
   Research topic: Passive flight of elastic bodies. Min received a 2015/2016 WiSE Undergraduate Research Experience Award

2. **Stephen Rolfe:** USC 05/2015-05/2016
   Research topic: Probability and mechanics in the coin toss.

3. **W. Scott Shambaugh:** USC 08/2014-08/2015
   Research topic: The hydrodynamics of falling coins

4. **Anthony Medrano:** USC 08/2014-05/2015
   Research topic: Cellular automata and the "game of life." Anthony received a GEM graduate student fellowship. He will begin his graduate studies in my lab in Fall 2015.

5. **Luke Heisinger:** USC 05/2012-08/2013
   Research topic: Interplay of Probability and Physics in Falling Coin. Heisinger's work is published in *J. Fluid Mech.*

6. **Ali Alawieh:** American University of Beirut, Lebanon Summer 2012
   Research topic: Dipole motion near solid boundaries.

7. **Mathieu Renard:** Institue Nationale de Sciences Appliquées de Toulouse Summer 2011
   Research topic: the dynamics of submerged rigid and deformable bodies near a wall.

8. **Julien Méric:** Ecole Nationale Supérieure de Mécanique et d'Aérotechnique, Poitiers, France. Research topic: dynamics of vortex dipoles near solid walls. Summer 2010

9. **Rustom Jehangir:** USC Spring 2010
Research topic: dynamics of passive tracers in the flow field of stochastically perturbed doublet, co-advised with Prof. P.K. Newton.

10. **Sehoon Ha:** Georgia Tech Summer 2009
Research topic: Swimming of multiple hydro-dynamically fish.

11. **Kurt Bitter:** USC Summer 2009
Research topic: dynamics of multiple particles subject to social forces. Supported by a Rose Hills Fellowship.

12. **Sarine Babikian:** American University of Beirut, Lebanon Summer 2008
Research topic: dynamics and stability of 2D Kirchhoff's equations. Now pursuing her PhD degree in my group.

13. **Vincent Lubrano:** Ecole Nationale Supérieure de Mécanique et d'Aérotechnique, Poitiers, France. Research topic: an inviscid model of dipole shedding. Summer 2008

14. **Christian Baker:** USC Summer 2007
Research topic: classification of the dynamic response of linear 2nd-order ordinary differential equations, application to spring-mass systems.

15. **Paul Kleinknecht:** American University of Beirut, Lebanon Summer 2007
Research topic: parametric study of the dynamics of a submerged three-link fish. Kleinknecht received a Masters' degree from USC in 2009.

PROFESSIONAL SERVICE and MEMBERSHIPS

At USC:

◇ **USC Beyond The Ph.D. Career Conference** Mar 2015
Panelist at: Academia – Science, Technology, Engineering and Mathematics.

◇ **AME Facutly Search Committee** Academic year 2013-2014
I served on the search committee of the "thermofluids faculty" opening, which resulted in two hires at the assistant professor level: Mitul Luhar (post-doc at Caltech) and Ivan Bermejo-Moreno (post-doc at Stanford University). Both will join AME in January 2015.

◇ **AME PhD Award Committee** since 2013

◇ **AME Merit Review Committee** spring 2013

◇ **Viterbi School of Engineering Merit Review Committee** spring 2013

◇ **Appointment, Promotion and Tenure Committee** 2012-2013
Alternate member of the Viterbi School of Engineering Appointment, Promotion and Tenure Committee. I served on both at-large meetings and on APT subcommittee assignments.

◇ **Provost Advisory Committee on Transformative Hiring** 2012-2013

◇ **Provost Advisory Committee on Work & Family Life** 2009-2011

◇ **AME Nomination Committee of Graduate Student Fellowships** 2006-2007

◇ **WiSE Orientation** Feb 2014
Speaker and Panelist at WiSE orientation for new tenure-track assistant professors

◇ **Mentoring Panel: "Navigating the Tenure Track Process"** Oct 2012
Speaker and Panelist at the Mentoring Panel: "Navigating the Tenure Track Process"

◇ **Active Learning Retreat** Aug 2012
Speaker at the Viterbi School of Engineering Active Learning Retreat

◇ **Viterbi School of Engineering Workshop on Academic Careers** Spring 2011
Speaker and Panelist at graduate students workshop on academic careers

◇ **USC Promotion and Tenure Workshop** Spring 2011
Panelist at the University Promotion and Tenure Workshop

Scientific community:

◇ **Editorial Board: Frontiers in Mathematical Physics** since 2013

◇ **Communicating Editor: Journal of Nonlinear Science** since 2008

◇ **Editor: Special Issue of Journal of Nonlinear Science** 2014
Topic: "Emergent Collective Behavior: from fish schools to bacterial colonies," special issue in preparation.

◇ **Scientific Committee** 2014
"IUTAM Symposium: Dynamics and topology of vorticity and vortices" to be held in Copenhagen, Denmark in 2017

◇ **Scientific Committee** since 2007
"Southern California Symposium on Flow Physics" (SoCal Flow Physics) annual meeting

◇ **Scientific Committee** 2005-2011
"Structured Integrators Annual Workshop:"

◇ **Organizing Committee** 2010
"APS Division of Fluid Dynamics Conference" held in Long Beach on Nov 21-23, 2010.

◇ **APS-DFD Media & Science Relations Committee** 2010-2011

◇ **Mini-symposium** Jul 2014
"From Cilia Hydrodynamics to Biological Functions" at the SIAM Annual Meeting held in Chicago on Jul 7-11, 2014.

◇ **Featured Mini-symposium** Nov 2010
"Biological Perspective on Locomotion" at the APS Division of Fluid Dynamics Conference held in Long Beach on Nov 21-23, 2010.

◇ **Mini-symposium** Dec 2008
"Dynamics of Fluid Systems" at the ASME Conference on Dynamical Systems and Control, Ann Arbor. Oct 2008.

◇ **Mini-symposium** Jul 2007
"Geometric Time Integrators" at the World Congress on Computational Mechanics, San Francisco. Jul 2007.

◇ **USC Workshop Organizer** Apr 2011
"Southern California Symposium on Flow Physics:"

◇ **Caltech Workshop Organizer** May 2011
"Structured Integrators Workshop:"

◇ **USC Workshop Organizer** May 2007
"Structured Integrators Workshop:"

◇ **USC Workshop Organizer** Dec 2006
"Applications in Mechanics and Control:"

◇ **USC Seminars** since 2005
Organized informal and formal seminars for distinguished invited and local speakers

◇ **NSF Review Panels**
National Science Foundation panelist in Feb 2006, May 2006, Oct 2007, Dec 2008, Dec 2009 March 2010, May 2012, May 2013 and Sep 2013.

◇ **Proposal Reviews** since 2006
Proposal reviews for the National Science Foundation and the Office of Army Research

◇ **Article Reviews** since 2003
Zeitschrift für Angewandte Mathematik und Physik (ZAMP), Physics of Fluids, Journal of Engineering Mathematics, Journal of Fluid Mechanics, Journal of Theoretical and Computational Fluid Dynamics, ASME Journal of Applied Mechanics, Journal of Integrative and Comparative Biology, IEEE Journal of Sensors, IEEE Conference on Decision and Control, IEEE Conference on Robotics and Automation, IEEE Conference on Networking, Sensing and Control, etc.

◇ **Member of the American Physics Society (APS)** since 2005

◇ **Member of the Society of Industrial and Applied Mathematics (SIAM)** since 2005

OUTREACH

◇ **STEM Spotlight on AME Open House** Oct 2014
Open House to over 370 elementary to high-school students, where my team prepared 6 exhibits on fluid-structure interactions.

◇ **Cabrillo Aquarium** since 2013
Workshop leader at the 6th Annual Young Scientist Symposium at Cabrillo Aquarium for high-school students on March 17, 2013. Continue to work with Dr. Kiersten Darrow of the Cabrillo Aquarium on advising research projects with middle- and high-school students.

◇ **USC MESA College Day** since 2007
Workshops for local high-school students on "Funny Fluids" and "Dynamics in Nature."

◇ **Explore USC** 2006-2007
Session facilitator at the Explore USC event for prospect AME undergraduate students.