

SIDDHARTHA VERMA

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EDUCATION

California Institute of Technology, Pasadena, California
PhD, Aeronautical Engineering, June 2014.
Master of Science in Aerospace Engineering, June 2010.

Georgia Institute of Technology, Atlanta, Georgia
Bachelor of Science in Aerospace Engineering, May 2009.

CURRENT POSITION

SEP '14 - PRESENT

Post-Doctoral Scholar - ETH, Zurich

- Fluid mechanics of collective behavior - examine the role of hydrodynamics in facilitating efficient fish-schooling.
 - Utilize deep reinforcement learning to create autonomous swimmers capable of extracting energy from their environment.
 - Use numerical optimization to discover body adaptations and swimming gaits that provide a competitive edge to certain fish species.
 - Turbulent flow and Artificial Intelligence - exploit deep artificial neural networks to formulate reduced order turbulence models.
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PHD THESIS

Velocity resolved - scalar modeled simulations of high Schmidt number turbulent transport

- Established a fundamental understanding of the turbulent cascade physics for high Schmidt number passive scalar transport.
 - Developed high-fidelity numerical schemes for the transport of passive scalars in turbulent flows.
 - Analyzed the dependence of the subgrid scalar-flux on filter-kernel shape, and on the strain-rate tensor.
 - Examined the effectiveness of subgrid models for scalars in the viscous-convective subrange.
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JOURNAL PUBLICATIONS

Verma, S., Novati, G., Koumoutsakos, P., “Efficient collective swimming by harnessing vortices through deep reinforcement learning”, *Under Review*, (<https://arxiv.org/abs/1802.02674>)

Verma, S., Abbati, G., Novati, G., Koumoutsakos, P., “Computing the force distribution on the surface of complex, deforming geometries using vortex methods and Brinkman penalization”, *International Journal of Numerical Methods in Fluids* (2017), **85**, 484-501

Novati, G., Verma, S., Alexeev, D., Rossinelli, D., van Rees, W. M., Koumoutsakos, P., “Synchronisation through learning for two self-propelled swimmers”, *Bioinspiration & Biomimetics* (2017), **12**, 036001

Verma, S., Blanquart, G., “Subfilter scalar flux vector orientation in homogeneous isotropic turbulence”, *Physical Review E* (2014), **89**, 063015

Verma, S., Xuan, Y., Blanquart, G., “A bounded semi-Lagrangian scheme for the turbulent transport of passive scalars”, *Journal of Computational Physics* (2014), **271**, 1-22

Carroll, P.L., Verma, S., Blanquart, G., “A novel forcing technique to model turbulent mixing in a decaying scalar field”, *Physics of Fluids* (2013), **25**, 095102

Verma, S., Blanquart, G., “On filtering in the viscous-convective sub-range for turbulent mixing of high Schmidt number passive scalars”, *Physics of Fluids* (2013), **25**, 055104

Verma, S., Koumoutsakos, P., Triantafyllou, M. S., “Independent caudal fin kinematics for optimal fish propulsion”, *In preparation*

Luethen, N., Verma, S., Hadjidoukas, P., Arampatzis, G., Papadimitriou, C., Koumoutsakos, P., “Optimal distribution of sensory cells in fish larvae”, *In preparation*

CONFERENCE PROCEEDINGS

Verma, S., Hadjidoukas, P., Wirth, P., Koumoutsakos, P., “Multi-objective optimization of artificial swimmers”, *IEEE Congress on Evolutionary Computation*, Donostia - San Sebastián, Spain, June 2017

Verma, S., Novati, G., Noca, F., Koumoutsakos, P., “Fast motion of heaving airfoils”, *Procedia Computer Science* (2017), 108, 235–244

Verma, S., Hadjidoukas, P., Wirth, P., Rossinelli, D., Koumoutsakos, P., “Pareto optimal swimmers”, *The Platform for Advanced Scientific Computing*, Lugano, Switzerland, June 2017

Verma, S., Blanquart, G., “Effects of numerical diffusion and mass conservation errors on turbulent transport of high Schmidt number scalars”, *Seventh International Conference on Computational Fluid Dynamics*, Big Island, Hawaii, July 2012

Carroll, P.L., Verma, S., Blanquart, G., “Characteristics of linearly-forced scalar mixing in homogeneous, isotropic turbulence”, *Seventh International Conference on Computational Fluid Dynamics*, Big Island, Hawaii, July 2012

Retaureau, G. J., Kovitch, S., Verma, S., Menon, S., “Experimental studies of cavity flame-holding in a Mach 2.5 cross flow”, *47th AIAA Aerospace Sciences Meeting*, Orlando, Florida, January 2009

CONFERENCE PRESENTATIONS

Verma, S., Novati, G., Koumoutsakos, P., “Harnessing wake vortices for efficient collective swimming via deep reinforcement learning”, *APS-DFD*, Denver, Colorado, November 2017

Verma, S., Novati, G., Koumoutsakos, P., “Machine learning for synchronized swimming”, *Fluids and Structures: Interaction and Modeling*, Naples, Italy, May 2017

Verma, S., Li, G., Koumoutsakos, P., “Fluid-structure interaction with Vortex methods and the Finite Element Method” *JARA HPC Symposium*, Aachen, Germany, October 2016

Verma, S., Abbati, G., Koumoutsakos, P., “Surface-forces on deforming geometries using Vortex Methods and Brinkman penalization” *ECCOMAS Congress*, Crete Island, Greece, June 2016

Koumoutsakos, P., Novati, G., Verma, S., “Swimmers learning to school” *Fluid Mechanics and Collective Behavior*, Ascona, Switzerland, April 2016

Verma, S., Blanquart, G., “Role of the strain-rate tensor in turbulent scalar-transport modeling,” *European Turbulence Conference*, Delft, The Netherlands, August 2015

Verma, S., Ivannikov, S., Koumoutsakos, P., “Experiment-based simulations of interacting swimmers,” *Platform for Advanced Scientific Computing Conference*, Zurich, Switzerland, June 2015

Verma, S., Blanquart, G., “Exploring the link between intermittency in scalar dissipation (χ) and energy dissipation (ϵ) rates,” *APS-DFD*, Pittsburgh, Pennsylvania, November 2013

Verma, S., Blanquart, G., “A-priori analysis of subgrid scalar flux models for turbulent high Schmidt number passive scalar mixing,” *APS-DFD*, San Diego, California, November 2012

Xuan, Y., Verma, S., Blanquart, G., “Impact of numerical errors on the turbulent mixing of high Schmidt number passive scalars,” *APS-DFD*, San Diego, California, November 2012

Verma, S., Blanquart, G., “Velocity-Resolved LES (VR-LES) technique for simulating turbulent transport of high Schmidt number passive scalars,” *APS-DFD*, Baltimore, Maryland, November 2011

Robertson, N., Verma, S., Blanquart, G., “Error quantification in simulations of variable density low Mach number turbulent flows,” *APS-DFD*, Baltimore, Maryland, November 2011

Verma, S., Blanquart, G., “Numerical diffusivity of scalar transport schemes in high Schmidt number flows,” *APS-DFD*, Long Beach, California, November 2010

SKILLS

- Fortran, C++, High performance parallel computing (MPI, OpenMP), TotalView, Allinea DDT, CUDA
- HPC cluster administration, Matlab, Mathematica, Maple, Abaqus, Fluent, Paraview

HONORS

- Keck Institute of Space Studies Fellowship 2009 - 2010
- President's Undergraduate Research Award Spring '09, Spring '08
- Harvey Hochman, AE'54 Scholarship Spring '08
- Faculty Honors Spring '08, Fall '07, Summer '07, Spring '07
- Dean's List Fall '08, Fall '06

ADDITIONAL EXPERIENCE

REVIEWER

- Journal of Fluid Mechanics
- Journal of Turbulence
- Proceedings of the Royal Society A

BOOK

- *Matlab for Newbies: The bare essentials*, Amazon Kindle edition, 2015 (self-published)

RESEARCH INTERN - ROBERT BOSCH LLC, PALO ALTO, CALIFORNIA**JUL '13 - SEP '13****Multi-physics modeling of brake pad manufacturing process**

- Established a simulation framework to predict the impact of various manufacturing steps on the microstructural makeup of composite friction material.
- Evaluated various tools and models for simulating multiple physical processes including phase change, polymerization, fiber realignment, and the impact of stress waves on microstructure arrangement.
- Post-production Finite Element Analysis (FEA) of Representative Volume Element (RVE) to predict mechanical behavior of the finished product.

TEACHING ASSISTANT**Computational Methods for Engineering Applications I, ETH Zurich** **FEB '17 – JUN '17**

- Head TA - Taught a weekly exercise session on basic numerical methods. Responsible for grading and preparing homework and exam. Handled administrative matters related to the course.

Computational Methods for Engineering Applications I, ETH Zurich **FEB '16 – JUN '16**

- Taught a weekly exercise session on basic numerical methods. Responsible for grading and preparing homework and exam.

Computational Methods for Engineering Applications I, ETH Zurich **FEB '15 – JUN '15**

- Taught a weekly exercise session on basic numerical methods. Responsible for grading and preparing homework and exam.

Engineering Tool III: Object oriented programming with C++, ETH Zurich **FEB '15**

- Conducted interactive sessions with students new to programming in a low-level language.

Advanced Fluid Mechanics - Aerospace Engineering, California Institute of Technology **JAN '14 – MAR '14**

- Conducted interactive discussions with students. Responsible for grading and preparing homework solutions.

Undergrad Fluid Mechanics - Mechanical Engineering, California Institute of Technology **JAN '11 - MAR '11**

- Conducted weekly interactive discussions with students. Responsible for grading and preparing homework and exam solutions.

Introductory Calculus - School of Mathematics, Georgia Institute of Technology **AUG '08 - MAY '09**

- Taught two Calculus recitations per week and held weekly office hours. Responsible for proctoring tests and quizzes, and grading homework and exams.

RESEARCH MENTOR**Freshman Summer Research Institute (FSRI) – California Institute of Technology** **JUL '14 - AUG '14**

- Mentored two incoming freshmen on an intensive 6-week long project involving visualization of vortex structures in turbulent mixing layers.

Summer Undergraduate Research Fellowship (SURF) – California Institute of Technology **JUN '11 - AUG '11**

- Mentored an undergraduate student through a 10-week long project that assessed the numerical impact of introducing variable density in turbulent flows.

UNDERGRADUATE RESEARCH ASSISTANT**Computational Fluid Dynamics - Georgia Institute of Technology (*Advisor: Prof. S. Ruffin*)** **JUN '08 - MAY '09**

- Computational analysis and optimization of blunt nosed re-entry geometries in hypersonic flows for use in planetary re-entry vehicles.

Propulsion in Scramjets - Georgia Institute of Technology (*Advisor: Prof. S. Menon*) **AUG '07 - AUG '08**

- Experimental research focused on the study of cavity induced fuel mixing in scramjets.
- Responsible for programming and streamlining in-house software for data acquisition, and digital hardware control using Matlab. Responsible for creating a graphical user interface for the software.

RESIDENT ASSISTANT - GEORGIA INSTITUTE OF TECHNOLOGY

JAN '07 - MAY '09

- Responsible for ensuring the safety and well-being of over 60 students in the residence halls. Assisted residents in making their stay a personally and academically fulfilling experience.

CONFERENCE VOLUNTEER

- Platform for Advanced Scientific Computing Conference, Zurich, Switzerland, June 2015
- 2nd Frontiers in Computational Physics Conference: Energy Sciences, Zurich, Switzerland, June 2015
- American Physical Society Annual DFD meeting, San Diego, California, November 2012