

# Nicholas G. Gravish

Assistant Professor

Mechanical and Aerospace Engineering  
University of California, San Diego



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APPOINTMENTS	<b>Assistant Professor</b> , Mechanical and Aerospace Engineering	2016-Current
EDUCATION	<i>Ph.D. Physics</i> <b>Georgia Tech School of Physics</b> Thesis: Collective dynamics of active and passive granular media Minor: Mechanics of materials Adviser: Daniel I. Goldman	2008 - 2013
	<i>B.S. Physics</i> <b>University of California, Santa Barbara</b> Undergraduate Research Honors, 2004 & 2005	2001 - 2005
EXPERIENCE	<i>Postdoctoral fellow</i> <b>Harvard University</b> School of Engineering & Applied Sciences Department of Organismic and Evolutionary Biology Advisers: Robert J. Wood and Stacey A. Combes	2013 - 2016
	<i>Postdoctoral fellow</i> <b>Georgia Tech School of Physics</b> Adviser: Daniel I. Goldman Topic: Collective locomotion of ant colonies in the nest	2013
	<i>Faculty assistant</i> <b>Hands-on research in complex systems</b> Topic: Dynamics of animal locomotion Shanghai, China. June, 2012 Bueua, Cameroon. August, 2010 Sao Paolo, Brazil. August, 2009	2009 - 2012
	<i>Teaching assistant</i> <b>Georgia Tech School of Physics</b> Undergraduate physics, 2008-2009 Graduate/undergraduate nonlinear dynamics, 2010-2012	2008 - 2012
	<i>Research assistant</i> <b>Lewis &amp; Clark College</b> Full time research assistant studying biological and synthetic gecko adhesives Adviser: Kellar Autumn	2006 - 2009
AWARDS & HONORS	<b>IROS Best student paper.</b> <i>Contributing author to the best student paper at IROS 2015.</i>	2015
	<b>James S. McDonnell Postdoctoral Fellowship award.</b> \$200,000 <i>2-year postdoctoral research funding to study complex systems science.</i>	2013 - 2015

<b>Lindau Nobel laureate NSF fellowship.</b> <i>Fellowship to attend meeting of the nobel laureates in physics. Lindau, Germany.</i>	2012
<b>Georgia Tech Impact Scholarship. \$4000</b> <i>For positive impacts to the GA Tech community.</i>	2012
<b>Nominated for CETL/BP Outstanding Teaching Award.</b> <i>For exemplary teaching.</i>	2012
<b>School of Physics Amelio award recipient \$1000</b> <i>Awarded for excellence in research as a graduate student.</i>	2011
<b>SAIC paper competition winner. \$500</b> <i>Airfoil Effect in Sand: Drag Induced Lift with Yang Ding.</i>	2011
<b>Graduate student speaker finalist.</b> <i>Group on Statistical and Nonlinear Physics. APS March meeting.</i>	2011
<b>Georgia Tech Research and Innovation Fellowship. \$5000</b> <i>Best poster award: Force and flow transition in plowed granular media.</i>	2010
<b>Undergraduate research honors.</b> <i>Physics department, UC Santa Barbara.</i>	Both 2004 & 2005
<b>Undergraduate Research and Creative Activities grant. \$1000</b> <i>UC Santa Barbara astrophysics laboratory.</i>	2004

PUBLICATIONS

*Published & in review*

26. Crall, J., Gravish, N., Mountcastle, A., Kocher, S., Oppenheimer, R., Pierce, N., Combes, S. Spatial fidelity of workers predicts collective response to disturbance in a social insect. *Nature Communications*. 2018. *In press*
25. Gravish, N., and Lauder, G. Robotics inspired biology. *J. Exp. Bio.*
24. Chen, Y., Wang, H., Helbling, E.F., Jafferis, N., Zufferey, R., Ong, A., Ma, K., Gravish, N., Chirarattananon, P., Kovac, M., Wood R.J. A biologically inspired, flapping wing, hybrid aerial-aquatic microrobot. *Science Robotics*. 2017.
23. Peters, J.M., **Gravish, N.**, Combes, S.A. Wings as impellers: Honey bees co-opt flight gear to induce nest ventilation and generate pheromone plumes. *J. Exp. Bio.* 2015. *Vol. 220, pages: 2203-2209*
22. Chen, Y., **Gravish, N.**, Desbiens, A.L., Malka, R., and Wood, R.J. Experimental and computational studies of the aerodynamic performance of a flapping and passively rotating insect wing. *J. Fluid. Mech.* 2016. *791, 1-33.*
21. **Gravish, N.** and Goldman, D.I. Entangled granular media. *Book chapter. Fluids, Colloids and Soft Materials: An Introduction to Soft Matter Physics*. 2015. *341-354.*
20. **Gravish, N.**, Peters, J., Wood, R.J., & Combes, S.A. Collective flow enhancement by tandem flapping wings. *Physical Review Letters*. 2015. *115.*
19. Crall, J.D., **Gravish, N.**, Mountcastle, A.M., Combes, S.A. BEEtag: a low-cost, image-based tracking system for the study of animal behavior and locomotion. *PLoS One*. 2015. *Vol. 10, (9).*
18. **Gravish, N.**, Gold, G., Zangwill, A., Goodisman, M.A.D. and Goldman, D.I. Glass-like dynamics in confined and congested ant traffic. *Soft Matter*. 2015. *Vol. 11, 33, 6552-6561. (Cover article)*
17. Monaenkova, D., **Gravish, N.**, Rodriguez, G., Kutner, R., Goodisman, M.A.D, and Goldman, D.I. Behavioral and mechanical determinants of robust collective subsurface nest excavation. *Journal of Experimental Biology*. 2015. *Vol. 218, 1295-1305.*

16. Marvi, H., Gong, C., **Gravish, N.**, Hatton, R.L., Mendelson III., J.R., Choset, H., Hu, D.L., and Goldman, D.I. Sidewinding with minimal slip: snake and robot ascent of sandy slopes. *Science*. 2014. Vol. 346 (6206) pp. 224-229.
15. **Gravish, N.** and Goldman, D.I. Avalanche dynamics in granular material of varying volume fraction. *Physical Review E*. 2014. 90, 032202. **(Selected as an editors suggestion)**
14. **Gravish, N.**, Umbanhowar, P.B., and Goldman, D.I. Force and flow transition at onset of drag in granular media. *Physical Review E*. 2014. 89, 042202.
13. **Gravish, N.**, Monaenkova, D., Goodisman, M.A.D., and Goldman, D.I. Climbing, falling, and jamming during ant locomotion in confined environments. *PNAS*. 2013. Vol. 110 (24). **(Cover article)**.
12. **Gravish, N.**, Garcia, M., Mazouchova, N., Levy, L., Umbanhowar, P.B., Goodisman, M.A.D., and Goldman, D.I. Effects of worker size on the dynamics of fire ant tunnel construction. *J.R. Soc. Interface*. 2012. Vol. 12 (111).
11. **Gravish, N.**, Hu, D., Franklin, S.F., and Goldman, D.I. Entangled granular media. *Physical Review Letters*. 2012. 108(20). **(Selected as an editors suggestion and an APS physics synopsis) (Cover article)**
10. Ding, Y., **Gravish, N.**, and Goldman, D.I. Drag induced lift in granular media. *Physical Review Letters*. 2011. 106(2). **(Selected for an APS physics synopsis)**
9. **Gravish, N.**, Umbanhowar, P.B., and Goldman, D.I. Force and flow transition in plowed granular media. *Physical Review Letters*. 2010. 105(12). **(Cover article) (Featured as a physics update in Physics Today)**
8. Mazouchova, N., **Gravish, N.**, Savu, A., and Goldman, D.I. Utilization of granular solidification during terrestrial locomotion of hatchling sea turtles. *Biology letters*. 2010. 6(3).
7. **Gravish, N.**, Wilkinson, M., Sponberg, S., Parness, A., Esparza, N., Soto, D., Yamaguchi, T., Broide, M., Cutkosky, M., Creton, C., and Autumn, K. Rate-dependent frictional adhesion in natural and synthetic gecko setae. *J. R. Soc. Interface*. 2009. 7(41). **(Cover article)**.
6. Parness, A., Soto, D., Esparza, N., **Gravish, N.**, Wilkinson, M., Autumn, K., and Cutkosky, M. A microfabricated wedge-shaped adhesive array displaying gecko-like dynamic adhesion, directionality and long lifetime. *J. R. Soc. Interface*. 2009. 6(41).
5. Pesika, N.S., **Gravish, N.**, Wilkinson, M., Zhao, BX, Zeng, HB., Tian, Y., Israelachvili, J., and Autumn, K. The crowding model as a tool to understand and fabricate gecko-inspired dry adhesives. *Journal of Adhesion*. 2009. 85(8).
4. Yamaguchi, T., **Gravish, N.**, Autumn, K., and Creton, C. Microscopic modeling of the dynamics of frictional adhesion in the gecko attachment system. *J. Phys. Chem. B*. 2009. 113(12).
3. Autumn, K. and **Gravish, N.** Gecko adhesion: evolutionary nanotechnology. *Phil. Trans. Roy. Society A* 2008. 366(1870).
2. **Gravish, N.**, Wilkinson, M., and Autumn, K. Frictional and elastic energy in gecko adhesive detachment. *J. R. Soc. Interface*. 2008. 5(20).
1. Majidi, C., Groff, R.E., Maeno, Y., Schubert, B., Baek, S., Bush, B., Maboudian, R., **Gravish, N.**, Wilkinson, M., Autumn, K., and Fearing, R.S. High friction from a stiff polymer using microfiber arrays. *Physical Review Letters*. 2006. 97(7).

PUBLICATIONS  
*In prep*

3. **Gravish, N.**, Mountcastle, A., Crall, J.D., Wood, R.J., and Combes, S.A. High-throughput biomechanics reveals strategies for fast, dynamic insect flight in cluttered environments. 2015 (expected). *In prep*.
2. **Gravish, N.**, Mountcastle, A., Crall, J.D., Wood, R.J., and Combes, S.A. Robust and flexible strategies for high-speed collision avoidance in bumblebee flight. 2015 (expected). *In prep*.
1. **Gravish, N.**, Mountcastle, A., and Wood, R.J. Bioinspired compliant mechanisms for pop-up robotics. 2015 (expected). *In prep*.

PUBLICATIONS  
*Refereed Conferences*

- 9C. Mange, S., Helbling, E.F., Gravish, N., Wood, R.J. An Actuated Gaze Stabilization Platform for a Flapping-Wing Microrobot. *Intl. Conf. on Robotics and Automation*. 2017.
- 8C. **Gravish, N.**, and Wood, R.J. Anomalous torque generation from passively pitching wings. *Intl. Conf. on Robotics and Automation*. 2016.
- 7C. Y. Chen, E.F. Helbling, **N. Gravish**, K. Ma, and R.J. Wood. Hybrid aerial and aquatic locomotion in an at-scale robotic insect. *Intelligent Robotics and Systems*. 2014. (**Best student paper**)
- 6C. **Gravish, N.**, Li. Chen., Marvi, H., Choset, H., Fearing, R., and Wood, R.J. Robotics-inspired biology. **Workshop Intl. Conf. on Robotics and Automation**. 2015.
- 5C. **Gravish, N.**, Chen, Y., Combes, S.A. and Wood, R.J. High-throughput study of flapping wing aerodynamics for biological and robotic applications. *Intelligent Robotics and Systems*. 2014.
- 4C. **Gravish, N.**, Combes, S.A. and Wood, R.J. A bio-inspired wing driver for the study of insect-scale flight aerodynamics. *Living Machines*. Milan, Italy, 2014.
- 3C. Umbanhowar, P.B., **Gravish, N.**, and Goldman, D.I. Impact, drag, and the granular critical state. *ESMC 2012 Mini-symposia, "Methods to Predict the Structural and Mechanical Properties of Dense Granular Media"*. 2012.
- 2C. Li, C., Ding, Y., **Gravish, N.**, Maladen, R.D., Masse, A., Umbanhowar, P.B., Komsuoglu, H., Koditschek, D.E., and Goldman, D.I., Towards a terramechanics for bio-inspired locomotion in granular environments. *NASA/ASCE Workshop on Granular Materials in Space Exploration*. 2012.
- 1C. Ding, Y., **Gravish, N.**, Li, C., Maladen, R.D., Mazouchova, N., Sharpe, S., Umbanhowar, P.B., and Goldman, D.I. Comparative studies reveal principles of movement on and within granular media. *IMA*. 2011. *IMA Springer Volume for the workshop: "Natural Locomotion in Fluids and on Surfaces: Swimming, Flying, and Sliding"*.

PATENTS

- 1P. **Gravish, N.**, Karpelson, M., Gu-Yeon, Wei., and Wood, R.J. Low-profile flapping thermal management device. *Provisional patent*. Filed January, 22nd. 2015.

GRANTS

**Current**

**STIR: Army Research Office**

Dynamical templates for sub-milligram locomotion

Investigators: Nick Gravish

Total dollar amount: \$60,000

2016

SELECTED PRESENTATIONS	<i>Stanford ME</i> <b>Invited talk</b>	2016
	<i>Caltech MCE</i> <b>Invited talk</b>	2016
	<i>UCLA MAE</i> <b>Invited talk</b>	2016
	<i>NYU ME</i> <b>Invited talk</b>	2016
	<i>UCSD MAE</i> <b>Invited talk</b>	2016
	<i>EPFL Robotics seminar</i> <b>Invited talk</b>	2015
	<i>MIT Civil &amp; Environmental Eng.</i> <b>Invited talk</b>	2015
	<i>Hosoi lab @ MIT.</i> <b>Invited talk</b>	2014
	<i>Harvard Squishy Physics.</i> <b>Invited talk</b>	2014
	<i>Society of Industrial and Applied Math (SIAM) 2014.</i> <b>Invited talk</b>	2014
	<i>Lewis Sigler Institute for Genomics, Princeton, NJ.</i> <b>Invited biophysics seminar</b>	2013
	<i>Lorentz Center, Leiden, NL.</i> <b>Invited hot-topics talk</b>	2011
	<i>Society for Integrative &amp; Comparative Biology.</i> Contributed talks	2006-Present
	<i>American Physical Society March meeting.</i> Contributed talks	2011-Present
	<i>American Physical Society Division of Fluid Dynamics.</i> Contributed talks	2009-Present
	<i>Lewis &amp; Clark College</i> <b>Invited biology seminar</b>	2008
	SELECTED PRESS	bioGraphic <i>Lens of Time: Bumper Bees</i>
Chemistry world <i>Glass transition in ant traffic jams</i>		2015
BBC <i>Ants may hold key to improving search and rescue techniques</i>		2015
Nature world news <i>Fire Ants: How Expert Excavators Make the Best Invaders</i>		2015
BBC News <i>Invasive ants are extreme excavators</i>		2015
New York Times <i>Secrets of the Sidewinder</i>		2014
Washington Post <i>Creepy robots help researchers understand the mysterious sidewinder snake</i>		2014
National Geographic <i>Snake Robots Crack Mystery of How Reptiles Climb Dunes</i>		2014
Los Angeles Times <i>Robot Snake Reveals Secrets of Sidewinders' Distinctive Slither</i>		2014
NBC News <i>Secrets of the Sidewinder</i>		2014
BBC News <i>Ant studies to aid design of search and rescue robots</i>		2013
BBC Radio Interview <i>The World Tonight episode 5/21/2013</i>		2013
Txchnologist <i>Robotic Fire Ants May Lead the March Into Future Search and Rescue Missions</i>		2013
Los Angeles Times <i>Could secret of nasty fire ant tunnels help design rescue robots?</i>		2013
Popular Mechanics <i>Fire Ants Could Inspire the Next Rescue Robots</i>		2013
Wired magazine UK <i>Study: ants use antennae to avoid underground falls, inspire rescue robots</i>		2013
Discovery news <i>Swarming Ants Offer Robot Rescue Tips</i>		2013
Scientific American blog <i>Tunnel Vision: Probing the Physics of Fire Ants</i>		2013
Physics today: quick study <i>Geometric cohesion in granular materials</i>		2012
Science daily: ScienceShot <i>The Science of Collapsing Staples</i>		2012
Physics world <i>Shaken staples stick together</i>	2012	
APS Physics synopsis <i>Grainy picture</i>	2011	
Physics today: physics update <i>Plowing through a granular medium</i>	2010	
SERVICE	Micro-robotics demonstration at the Wellesley high school science fair	2015
	REU Mentor for the micro-robotics lab, student Waad Kahouli	2014
	Micro-robotics demonstration at the Wellesley high school science fair	2014

Reviewer: Physical Review Letters, Physical Review E, Journal of Exp. Bio., Bioinsp. & Biomim., & ICRA	2011-Present
Non-linear dynamics lab instructor and web admin. <a href="http://nldlab.gatech.edu/">http://nldlab.gatech.edu/</a>	2010-2012
GA Tech undergraduate research opportunities program symposium judge	2011 & 2012
GA Tech SURE program graduate student mentor	2010
Instructor of table top scientific research training course for Atlanta high school teachers	2010

SOCIETY  
MEMBERSHIPS

American Physical Society	2009-Present
IEEE	2014-Present
Society of Industrial and Applied Mathematicians	2014-Present
Society of Comparative & Integrative Biology	2007-Present
National Society of Collegiate Scholars	2004-2005

## REFERENCES

**Daniel I. Goldman**

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**Robert J. Wood**

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**Stacey A. Combes**

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Physiology, and Behavior  
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