

Gaurav Bahl

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1206 W Green St., 4413 Mechanical Engineering Laboratory, Urbana, Illinois 61822

CURRENT AFFILIATIONS

Assistant Professor, Mechanical Science and Engineering University of Illinois at Urbana-Champaign	Aug 2012 – present
Affiliate Faculty , Electrical and Computer Engineering	Aug 2012 – present
Affiliate Faculty , Micro and Nanotechnology Laboratory (MNTL)	Aug 2012 – present
Affiliate Faculty , Center for Nanoscale Science and Technology	Jan 2013 – present

EDUCATION

PhD , Electrical Engineering, Stanford University, California, USA	September 2010
MS , Electrical Engineering, Stanford University, California, USA	June 2008
B.Eng , <i>Summa cum laude</i> , Electrical Engineering, McMaster University, ON, Canada	June 2005

PROFESSIONAL POSITIONS HELD

Optics and Photonics Laboratory Sept 2010 – July 2012

Postdoctoral Research Fellow, EECS, University of Michigan, Ann Arbor

- Research focus: Investigating fundamental light-matter interactions in resonant micro-cavities for optomechanical oscillators (OMOs). Modeling and experimental demonstration towards understanding phase noise, frequency tuning, stability, fabrication, reliability, and packaging of OMOs.
- Faculty mentor: Prof. Tal Carmon

Stanford Micro-Structures and Sensors Laboratory Apr 2006 – Aug 2010

Research Assistant/PhD Candidate, Mechanical Engineering, Stanford University

- Research focus: Modeling charging phenomena in dielectrics in MEMS, specifically SiO₂ – Si composite resonators; Silicon microresonator design and fabrication; Resonator-based thermometry and sensing; Circuit design for frequency references with active and passive temperature compensation; Developing systems-level techniques for circumventing charge-drift in resonant electrostatic MEMS.
- Primary advisor: Prof. Thomas W. Kenny; Co-advisor: Prof. Roger T. Howe

Information and Quantum Systems Laboratory June 2008 – Sept 2008

MEMS Research Group Intern, HP Labs, Palo Alto, California

- Developed the use of parametric resonance for avoiding charging-drifts in surface-electrode actuators.
- Tested and characterized micromechanical inertial sensors for temperature performance.
- Mentor: Dr. Peter G. Hartwell

HONORS AND AWARDS

- **UIUC Dean’s Award for Excellence in Research, 2018**
- **Office of Naval Research, Director of Research Early Career Grant, 2017**
- **UIUC Engineering Council Award for Excellence in Advising, 2017**
- **Elevation to Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), Feb 2016**
- Keynote speaker at the Workshop on Optomechanics and Brillouin Scattering (WOMBAT), Sydney, Australia, July 2015.
- **Air Force Office of Scientific Research Young Investigator Award, 2015**
- List of Teachers Ranked Excellent by their Students at UIUC (Fall 2012)
- **Ontario Professional Engineers Foundation for Education Gold Medal, 2005**
- Provost’s Honor Roll, McMaster University (2003 – 2004)
- Dean’s Honor List, McMaster University (2002 – 2005)
- Dr. H. L. Hooker Scholarship, McMaster University (2003 and 2004)
- Finalist, Computer Science, 50th Intel International Science and Engineering Fair, Philadelphia (1999). Member of the first team representing India at the competition.

PROFESSIONAL MEMBERSHIPS

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| • Senior Member, Institute of Electrical and Electronics Engineers (IEEE) | M’09, S’16 |
| • Member, Optical Society of America (OSA) | 2010 – Present |
| • Member, SPIE | 2010 – Present |
| • Member, American Society of Mechanical Engineers (ASME) | 2016 – Present |

EDITORSHIP

- Guest editor of Focus Collection on “Stimulated Brillouin Scattering” at the New Journal of Physics in 2015. <http://iopscience.iop.org/1367-2630/focus/Focus-on-Stimulated-Brillouin-Scattering>

CONFERENCE COMMITTEES

- Steering committee for **Workshop on Optomechanics and Brillouin Scattering (WOMBAT)** at University of Sydney in July 2015.
- On TPC for **SPIE Photonics West 2016** - Laser Resonators, Microresonators, and Beam Control XVIII
- On TPC for **SPIE Photonics West 2015** - Laser Resonators, Microresonators, and Beam Control XVII
- On TPC for the **IEEE Sensors Conference 2014**, Valencia, Spain, Nov 2014.
- On TPC for the **IEEE Sensors Conference 2013**, Baltimore, MD, Nov 2013.

PROFESSIONAL SERVICE - REVIEWER

Invited Reviewer for –

- Nature
- Nature Photonics
- Nature Physics
- Proceedings of the National Academy of Sciences (PNAS)
- Nature Communications
- Optica
- Laser & Photonics Reviews
- Applied Physics Letters
- Scientific Reports
- ACS Photonics
- APL Photonics
- Optics Letters
- Optics Express
- Journal of Applied Physics
- New Journal of Physics
- IEEE Transactions on Control System Technology
- IEEE Photonics Journal
- IEEE Journal of Microelectromechanical Systems
- IEEE Sensors Letters
- Transactions on Ultrasonics Ferroelectrics and Frequency Control
- Journal of Visualized Experiments
- Microsystems and Nanoengineering
- Analytical Chemistry

PROFESSIONAL SERVICE – REVIEW PANELS

- External Reviewer, Air Force Office for Scientific Research (AFOSR) Dec. 2015
Young Investigator Program 2016, Lasers & Optical Physics, Program Manager: Dr. John Luginsland
- External Reviewer, National Science Foundation DMR (Division of Materials Research) Mar. 2013
EPM Program (Electronic and Photonic Materials), Program Manager: Dr. Charles Ying
- Panel Reviewer, National Science Foundation ECCS (Electrical, Communications and Feb. 2013
Cyber Systems) CCSS Program (Communications, Circuits, and Sensing Systems)
Program Manager: Dr. Massoud Tabib Azar.

PROFESSIONAL SERVICE – SESSION CHAIR

- Session Chair – Novel Microresonator Optics II – at Laser Resonators, Microresonators, Feb. 2016
and Beam Control XVIII, SPIE Photonics West.
- Session Chair – Sensing Techniques – at IEEE Sensors 2013 Nov. 2013
- Session Chair – Optomechanics II - at Frontiers in Optics 2011 / Laser Science XXVII Oct. 2011

PROFESSIONAL RECOGNITION

- “Experimental Observation of Brillouin Cooling” featured as a top-30 development in optics in the “Optics in 2012” special-issue of Optical Society of America Optics and Photonics News Magazine, 2012.
- “Bridging Two Worlds: Microfluidic Optomechanics” featured as a top-30 development in optics in the “Optics in 2013” special-issue of Optical Society of America Optics and Photonics News Magazine, 2013.

PUBLICATIONS

JOURNAL PUBLICATIONS IN REVIEW

1. C.W. Peterson, S. Kim, J.T. Bernhard, G. Bahl, “Reconfigurable arbitrary nonreciprocal transfer functions through nonreciprocal coupling,” arxiv:1702.06476, 2017.
2. X. Xu, S. Kim, G. Bahl, J.M. Taylor, “A quasi-mode theory of chiral phonons,” arXiv.org:1612.09240, Dec 2016.

ARCHIVAL JOURNAL PUBLICATIONS

1. Y.-C. Chen, I. Ghosh, A. Schleife, P.S. Carney, G. Bahl, “Optimization of anisotropic photonic density of states for Raman cooling,” **Phys. Rev. A** 97, 043835, 2018.
2. C.W. Peterson, W.A. Benalcazar, T.L. Hughes, G. Bahl, “Demonstration of a quantized microwave quadrupole insulator with topologically protected corner states,” **Nature**, 555, pp.346–350, doi:10.1038/nature25777, 2018, 2018.
3. D.B. Sohn, S. Kim, G. Bahl, “Time-reversal symmetry breaking with acoustic pumping of nanophotonic circuits,” **Nature Photonics**, 12, pp.91-97, Feb 2018.
4. J. Suh, K. Han, G. Bahl, “Imaging of acoustic pressure modes in opto-mechano-fluidic resonators with a single particle probe,” **Applied Physics Letters**, 112, 071106, 2018.
5. S. Kim, X. Xu, J.M. Taylor, G. Bahl, “Dynamically induced robust phonon transport and chiral cooling in an optomechanical system,” **Nature Communications**, 8, 205, doi:10.1038/s41467-017-00247-7, 2017.
6. J. Kim*, S. Kim*, G. Bahl [* = equal contribution], “Complete linear optical isolation at the microscale with ultralow loss,” **Scientific Reports**, 7:1647, 2017.
7. S. Kim, G. Bahl, “Role of Optical Density of States in Two-Mode Optomechanical Cooling,” **Optics Express** 25(2), pp.776-784, 2017.
8. J. Suh, K. Han, C.W. Peterson, G. Bahl “Real-time sensing of flowing nanoparticles with electro-opto-mechanics,” **APL Photonics** 2, 010801, doi:10.1063/1.4972299, 2017.
9. Y-C. Chen, S. Kim, G. Bahl, “Brillouin Cooling in a Linear Waveguide,” **New Journal of Physics**, 18, 115004, doi:10.1088/1367-2630/18/11/115004, 2016.
10. H. Keum, Z. Yang, K. Han, D.E. Handler, T.N. Nguyen, J. Schutt-Aine, G. Bahl, S. Kim, “Lego-like Microassembly of Heterogeneous Materials for 3D microsystems,” **Scientific Reports**, vol.6, 29925, doi:10.1038/srep29925, 2016.

11. G. Bahl, "Raman Cooling in a semiconductor," **Nature Photonics** 10, pp.566-567, doi:10.1038/nphoton.2016.142, July 2016.
12. K. Han, J. Kim, G. Bahl, "High-Throughput Long-Range Photonic Sensing of Flowing Microparticles with Opto-mechano-fluidics," **Optica** 3(6), p.585-591, 2016. * Cover article for June 2016 issue of Optica
13. K. Zhang, K. Han, S. Shi, G. Bahl, S. Tawfick, "Highly stretchable conductors made by laser draw-casting of ultralong metal nanowires," **Advanced Electronic Materials**, 1600003, doi:10.1002/aelm/201600003, 2016.
14. N. Dostart, S. Kim, G. Bahl, "Giant Gain Enhancement in Surface-Confined Resonant Stimulated Brillouin Scattering," **Laser & Photonics Reviews**, doi:10.1002/lpor.201500141, October 2015.
15. Y.C. Chen, G. Bahl, "Raman Cooling of Solids through Photonic Density of States Engineering," **Optica** 2(10), pp.893-899, October 2015.
16. J. Kim, M. Kuzyk, K. Han, H. Wang, G. Bahl, "Non-reciprocal Brillouin scattering induced transparency," **Nature Physics** 11, pp.275-280, doi:10.1038/nphys3236, 2015.
17. M.R. Gartia, S. Seo, J. Kim, T.-W. Chang, G. Bahl, M. Lu, G.L. Liu, J.G. Eden, "Injection-seeded optoplasmonic amplifier in the visible," **Scientific Reports**, vol.4, 6168, doi:10.1038/srep06168, 2014.
18. K. Zhu, K. Han, T. Carmon, X. Fan, G. Bahl, "Opto-Acoustic Biosensing with Optomechanofluidic Resonators ," **European Physical Journal Special Topics**, 223, 1937-1947, 2014.
19. K. Han, K. Zhu, G. Bahl, "Opto-Mechano-Fluidic Viscometer," **Applied Physics Letters**, 105, 024103, 2014.
20. K. Han, K. H. Kim, J. Kim, W. Lee, J. Liu, X. Fan, T. Carmon, and G. Bahl, "Fabrication and testing of microfluidic optomechanical oscillators," **Journal of Visualized Experiments**, vol.87, e51497, doi:10.3791.51497, 2014.
21. K. Han, J. Kim, G. Bahl, "Aerostatically tunable optomechanical oscillators," **Optics Express**, vol. 22, issue 2, pp. 1267-1276, 2014.
22. G. Bahl, K. H. Kim, W. Lee, J. Liu, X. Fan, T. Carmon, "Brillouin cavity optomechanics with microfluidic devices," **Nature Communications**, 4:1994, doi:10.1038/ncomms2994, 2013.
23. K. H. Kim*, G. Bahl*, W. Lee, J. Liu, M. Tomes, X. Fan, T. Carmon [* = equal contribution], "Cavity optomechanics on a microfluidic resonator with water and viscous liquids," **Light: Science and Applications**, 2, e110, doi:10.1038/lsa.2013.66, 2013.
24. G. Bahl, X. Fan, T. Carmon, "Acoustic whispering gallery modes in optomechanical shells," **New Journal of Physics**, vol.14, 115026, 2012.
25. G. Bahl, M. Tomes, F. Marquardt, and T. Carmon, "Observation of Spontaneous Brillouin Cooling," **Nature Physics**, doi:10.1038/nphys2206, 2012.
26. M. Tomes, F. Marquardt, G. Bahl, T. Carmon, "Quantum mechanical theory of optomechanical Brillouin cooling," **Physical Review A**, 84, 063806, 2011.
27. G. Bahl, J. Zehnpfennig, M. Tomes, T. Carmon, "Stimulated Optomechanical Excitation of Surface Acoustic Waves in a Microdevice," **Nature Communications**, 2:403, doi:10.1038/ncomms1412, 2011.
28. J. Zehnpfennig, G. Bahl, M. Tomes, T. Carmon, "Surface Optomechanics: Calculating optically excited acoustical whispering gallery modes in microspheres," **Optics Express**, Vol. 19, pp.14240-8, 2011.

29. G. Bahl, J. Salvia, R. Melamud, B. Kim, R.T. Howe, and T. W. Kenny, "AC Polarization for Charge-Drift Elimination in Resonant Electrostatic MEMS and Oscillators," **Journal of Microelectromechanical Systems**, Vol. 20, No. 2, April 2011.
30. S. Yoneoka, J. Salvia, G. Bahl, R. Melamud, S. A. Chandorkar, and T. W. Kenny, "Active Electrostatic Compensation of Micromechanical Resonators Under Random Vibrations," **JMEMS Letters**, Vol. 19, No. 5, October 2010.
31. G. Bahl, R. Melamud, B. Kim, S. A. Chandorkar, J. Salvia, M. A. Hopcroft, D. Elata, R. G. Hennessy, R. N. Candler, R.T. Howe, and T. W. Kenny, "Model and observations of dielectric charge in thermally oxidized silicon resonators," **Journal of Microelectromechanical Systems**, Vol. 19, No. 1, Feb 2010.
32. R. Melamud, S. A. Chandorkar, B. Kim, H. K. Lee, J. Salvia, G. Bahl, M. A. Hopcroft, and T. W. Kenny, "Temperature Insensitive Composite Micromechanical Resonators," **Journal of Microelectromechanical Systems**, Vol. 18, No. 6, Dec 2009.
33. M. Agarwal, S. A. Chandorkar, H. Mehta, R. N. Candler, B. Kim, M. A. Hopcroft, R. Melamud, C. M. Jha, G. Bahl, G. Yama, T. W. Kenny, and B. Murmann, "A study of electrostatic force nonlinearities in resonant microstructures," **Applied Physics Letters**, Vol. 92, pp. 104106-3, 2008.
34. M. Agarwal, H. Mehta, R. N. Candler, S. A. Chandorkar, B. Kim, M. A. Hopcroft, R. Melamud, G. Bahl, G. Yama, T. W. Kenny and B. Murmann, "Scaling of A-f nonlinearities in electrostatically transduced microresonators," **Journal of Applied Physics**, Vol. 102, p. 74903, 2007.
35. C. M. Jha, G. Bahl, R. Melamud, S. A. Chandorkar, M. A. Hopcroft, B. Kim, M. Agarwal, J. Salvia, H. Mehta, and T. W. Kenny, "High resolution microresonator-based digital temperature sensor," **Applied Physics Letters**, Vol. 91, p. 74101, 2007.
36. M. A. Hopcroft, B. Kim, S. Chandorkar, R. Melamud, M. Agarwal, C. M. Jha, G. Bahl, J. Salvia, H. Mehta, H. K. Lee, R. N. Candler, and T. W. Kenny, "Using the temperature dependence of resonator quality factor as a thermometer," **Applied Physics Letters**, Vol. 91, p. 013505, 2007.

CONFERENCE PUBLICATIONS (REFEREED)

1. I. Grinberg, J. Kim, G. Bahl, "Eigenmode Optimization and Topologically Protected States in Magneto-Mechanical ULF Transmitter Arrays," at Solid State Sensors Actuators and Microsystems Workshop, Hilton Head Island, SC, June 2018.
2. I. Grinberg, M. Lin, W. Benalcazar, T. Hughes, G. Bahl, "Magneto-Mechanical Topological Lego," at APS March Meeting, Los Angeles, 2018.
3. C. Peterson, W. Benalcazar, T. Hughes, G. Bahl, "Measurement of topologically protected corner states in a microwave metamaterial quadrupole insulator," at APS March Meeting, Los Angeles, 2018.
4. J. Suh, K. Han, and G. Bahl, "Imaging of acoustic pressure field in opto-mechano-fluidic resonators with a single particle probe," *Frontiers in Optics 2017*, Washington DC, Sept 2017.
5. S. Kim., X. Xu, J.M. Taylor, and G. Bahl, "Optomechanical cooling without added damping," *Frontiers in Optics 2017*, Washington DC, Sept 2017.

6. C.W. Peterson, J.T. Bernhard, and G. Bahl, "Nonreciprocal zero-transmission filters through nonreciprocal coupling to resonators," International Frequency Control Symposium (IFCS), Besancon, France, July 2017.
7. D. Sohn, S. Kim, and G. Bahl, "Piezo-optomechanical nonreciprocal modulator," Workshop on Optomechanics and Brillouin Scattering: Fundamentals, Applications and Technology (WOMBAT), Besancon, France, July 2017.
8. D. Sohn, J. Kim, S. Kim, and G. Bahl, "Non-reciprocal Optomechanical Modulator," Conference on Lasers and Electro-Optics (CLEO), San Jose, CA, May 2017.
9. Y.-C. Chen, I. Ghosh, G. Bahl, "Optimization of anisotropic photonic density of states for Raman laser cooling," at SPIE Photonics West (Optical and Electronic Cooling of Solids II), Feb 2017.
10. J. Suh, K. Han, C.W. Peterson, G. Bahl, "High-throughput real-time sensing with microfluidic electro-optomechanical resonators," at SPIE Photonics West, Feb 2017.
11. S. Kim, X. Xu, J.M. Taylor, G. Bahl, "Dynamically induced chiral phonon transport in an optomechanical system," at Nanometa 2017, Seefeld, Austria, Jan 2017.
12. C.W. Peterson, J.T. Bernhard, G. Bahl, "Toward lossless nonreciprocity through spatiotemporal modulation," at Nanometa 2017, Seefeld, Austria, Jan 2017.
13. J. Kim, S. Kim, G. Bahl, "Ultralow loss optical isolation in silica microresonators," at Nanometa 2017, Seefeld, Austria, Jan 2017.
14. D. Sohn, J. Kim, G. Bahl, "Ultrahigh-Q Silica-AlN Hybrid Disk Optomechanical Modulator," IEEE MEMS 2017, Las Vegas, Jan 2017.
15. K. Han, J. Kim, and G. Bahl, "Opto-Mechano-Fluidic MEMS for Extremely High-Throughput Photonic Sensing of Flowing Microparticles," at Solid State Sensors Actuators and Microsystems Workshop, Hilton Head Island, SC, June 2016.
16. Y.-C. Chen, G. Bahl, "Raman cooling in silicon photonic crystals," at SPIE Photonics West (Optical and Electronic Cooling of Solids), San Francisco CA, Feb 2016.
17. Y.-C. Chen, G. Bahl, "Raman Cooling of Solids through Density of States Engineering," at Frontiers in Optics, San Jose, CA, Oct 2015.
18. K. Han, J. Kim, G. Bahl, "Towards High-Throughput Opto-Mechanical Flow Cytometry," at Frontiers in Optics, San Jose, CA, Oct 2015.
19. J. Kim, M. Kuzyk, K. Han, H. Wang, G. Bahl, "Magnet-Free Linear Nonreciprocity in Brillouin Systems," at 8th International Conference on Materials for Advanced Technologies (ICMAT), Materials Research Society of Singapore (MRS-S), Symposium F: Emerging Infrared Technologies and Applications, June 2015.
20. K. Zhang, S. Shi, K. Han, G. Bahl, S. Tawfick, "Flexible Transparent Conductor/Strain Sensors from Downsizing Traditional Metallic Wires to the Nanoscale", MRS Conference Spring, April 2015.
21. J. Kim, M. Kuzyk, K. Han, H. Wang, G. Bahl, "Observation of optical non-reciprocity in a Brillouin optomechanical system," at SPIE Photonics West (Laser Resonators, Microresonators, and Beam Control XVII), San Francisco CA, Feb 2015.

22. Ng, E., Y. Yang, V.A. Hong, C.H. Ahn, D.B. Heinz, I. Flader, Y. Chen, C.L.M. Everhart, B. Kim, R. Melamud, R.N. Candler, M.A. Hopcroft, J.C. Salvia, S. Yoneoka, A.B. Graham, M. Agarwal, M.W. Messana, K.L. Chen, H.K. Lee, S. Wang, G. Bahl, V. Qu, C.F. Chiang, T.W. Kenny, A. Partridge, M. Lutz, G. Yama, and G.J. O'Brien, "The long path from MEMS resonators to timing products," Proc. 28th IEEE MEMS 2015, Estoril, Portugal, 18-22 Jan 2015.
23. J. Kim, M. Kuzyk, K. Han, H. Wang, G. Bahl, "Magnet-free Non-reciprocity Demonstrated with Brillouin Scattering Induced Transparency," Postdeadline paper at Frontiers in Optics, Tucson AZ, Oct 2014.
24. J. Kim, M. Kuzyk, K. Han, H. Wang, G. Bahl, "Observation of Brillouin Scattering Induced Transparency in a Silica Microsphere Resonator," at Conference on Lasers and Electro-Optics (CLEO:2014), June 2014.
25. M.R. Gartia, S. Seo, J. Kim, T. Chang, G. Bahl, M. Lu, J.G. Eden, G. Liu, "Injection-Seeded Optoplasmonic Amplifier in the Visible," at Conference on Lasers and Electro-Optics (CLEO:2014), June 2014.
26. K. Han, K. Zhu, G. Bahl, "Optomechanical Viscometer," Solid State Sensors Actuators and Microsystems Workshop, Hilton Head Island, SC, June 2014.
27. G. Bahl, K.H. Kim, W. Lee, J. Liu, X. Fan, T. Carmon, "Brillouin cavity optomechanics with microfluidic devices (invited)," SPIE Laser Resonators, Microresonators, and Beam Control XVI (Photonics West), San Francisco, CA, January 2014.
28. K. Han, J. H. Kim, G. Bahl, "Radiation driven optomechanical pressure sensor," Frontiers in Optics 2013/Laser Science XXIX, Orlando, FL, Oct 2013.
29. K.H. Kim, G. Bahl, W. Lee, J. Liu, M. Tomes, X. Fan, T. Carmon, "Microfluidic Optomechanics," Frontiers in Optics 2013/Laser Science XXIX, Orlando, FL, Oct 2013. [*Winner of Emil Wolf Best Student Paper Award*]
30. G. Bahl, K. H. Kim, W. Lee, J. Liu, X. Fan, and T. Carmon, "Brillouin actuation of whispering-gallery modes in microfluidic optomechanical oscillators," Conference on Lasers and Electro-Optics (CLEO), San Jose CA, June 9-14, 2013.
31. G. Bahl, M. Tomes, F. Marquardt, and T. Carmon, "Observation of Spontaneous Brillouin Cooling (invited)," at Phonons 2012, Ann Arbor, MI, USA, July 8-12, 2012.
32. G. Bahl, K. H. Kim, W. Lee, J. Liu, X. Fan, and T. Carmon, "Microfluidic Optomechanical Oscillators," at the Solid-State Sensors, Actuators and Microsystems Workshop, Hilton Head Island, SC, USA, June 3-7, 2012.
33. G. Bahl, M. Tomes, F. Marquardt, and T. Carmon, "Observation of Brillouin Cooling (invited)," at Conference on Lasers and Electro-Optics (CLEO:2012), San Jose, CA, USA, May 2012.
34. G. Bahl, M. Tomes, F. Marquardt, and T. Carmon, "Optical filtering of Stokes lines for cooling (invited)," at SPIE Laser Refrigeration of Solids V (Photonics West), San Francisco, CA, USA, January 2012.
35. G. Bahl, M. Tomes, F. Marquardt, and T. Carmon, "Observation of Brillouin Cooling," at Frontiers in Optics 2011, San Jose, CA, USA, Oct 16-20 2011.
36. G. Bahl, J. Zehnpfennig, M. Tomes, and T. Carmon, "Characterization of Surface Acoustic Wave Optomechanical Oscillators," at the International Frequency Control Symposium (IFCS 2011), San Francisco, CA, May 2011.

37. G. Bahl, J. Zehnpfennig, M. Tomes, and T. Carmon, "Surface Optomechanics: Observation of Surface Acoustic Resonances in Whispering Gallery Resonators," at the Conference on Lasers and Electro-Optics (CLEO 2011), Baltimore, MD, USA, May 2011.
38. J. Zehnpfennig, G. Bahl, M. Tomes, and T. Carmon, "Surface Optomechanics: Observation of Surface Acoustic Resonances," at Frontiers in Optics 2010, Rochester, NY, USA, Oct 24-28, 2010.
39. G. Bahl, J. Salvia, H. K. Lee, R. Melamud, B. Kim, R.T. Howe, and T. W. Kenny, "Heterodyned Electrostatic Transduction Oscillators Evade Low Frequency Noise Aliasing," at Solid-State Sensors, Actuators, and Microsystems Workshop, Hilton Head 2010, Hilton Head, SC, USA, 2010.
40. H. K. Lee, J. Salvia, S. Yoneoka, G. Bahl, Y. Q. Qu, R. Melamud, S. Chandorkar, M. A. Hopcroft, B. Kim, and T. W. Kenny, "Stable Oscillation of MEMS Resonators Beyond the Critical Bifurcation Limit," at Solid-State Sensors, Actuators, and Microsystems Workshop, Hilton Head 2010, Hilton Head, SC, USA, 2010.
41. G. Bahl, J. Salvia, I. Bargatin, S. Yoneoka, R. Melamud, B. Kim, S. Chandorkar, M. A. Hopcroft, R. Bahl, R. T. Howe, and T. W. Kenny, "Charge-Drift Elimination in Resonant Electrostatic MEMS," in Proc. 23rd IEEE MEMS 2010, Hong Kong, China, Jan. 24-28, 2010.
42. S. Yoneoka, Y. Q. Qu, S. Wang, M. W. Messana, A. B. Graham, J. Salvia, B. Kim, R. Melamud, G. Bahl, and T. W. Kenny, "High-Cyclic Fatigue Experiments of Single Crystal Silicon in an Oxygen-Free Environment," in Proc. 23rd IEEE MEMS 2010, Hong Kong, China, Jan. 24-28, 2010.
43. H. K. Lee, J. Salvia, G. Bahl, R. Melamud, S. Yoneoka, Y. Q. Qu, S. Chandorkar, M. A. Hopcroft, B. Kim, and T. W. Kenny, "Influence of the Temperature Dependent A-f Effect on the Design and Performance of MEMS Oscillators," in Proc. 23rd IEEE MEMS 2010, Hong Kong, China, Jan. 24-28, 2010.
44. H. K. Lee, S. Yoneoka, G. Bahl, J. Salvia, Y. Q. Qu, R. Melamud, S. Chandorkar, B. Kim, M. A. Hopcroft, and T. W. Kenny, "A Novel Characterization Method for Temperature Compensation of Composite Resonators," in Proc. 23rd IEEE MEMS 2010, Hong Kong, China, Jan. 24-28, 2010.
45. G. Bahl, R. G. Walmsley, B. E. DeMartini, K. L. Turner, and P. G. Hartwell, "Passivated Electrode Actuator with Stable Resonance Amplitude," in Proc. 22nd IEEE MEMS 2009, Sorrento, Italy, Jan. 25-29, 2009.
46. S. Yoneoka, G. Bahl, J. Salvia, K. L. Chen, A. B. Graham, H. K. Lee, G. Yama, R. N. Candler, and T. W. Kenny, "Acceleration Compensation of MEMS Resonators Using Electrostatic Tuning," in Proc. 22nd IEEE MEMS 2009, Sorrento, Italy, Jan. 25-29, 2009.
47. J. Salvia, M. Messana, M. Ohline, M. A. Hopcroft, R. Melamud, S. Chandorkar, H. K. Lee, G. Bahl, B. Murmann, T.W. Kenny, "Exploring the Limits and Practicality of Q-Based Temperature Compensation for Silicon Resonators," in Technical Digest 2008 International Electron Devices Meeting, San Francisco, CA, USA, pp. 671-674, December 15-17, 2008.
48. G. Bahl, R. N. Candler, R. Hennessy, D. Elata, R. Melamud, S. Chandorkar, B. Kim, M. Hopcroft, J. Salvia, C. M. Jha, S. Yoneoka, G. Yama, R. T. Howe, and T. W. Kenny, "Observation of Fixed and Mobile Charge in Composite MEMS Resonators," in Solid-State Sensors, Actuators, and Microsystems Workshop, Hilton Head 2008, Hilton Head, SC, USA, pp 102-105, 2008.

49. C. M. Jha, G. Bahl, R. Melamud, S. A. Chandorkar, M. A. Hopcroft, B. Kim, M. Agarwal, J. Salvia, H. Mehta, and T. W. Kenny, "CMOS-Compatible Dual-Resonator MEMS Temperature Sensor with Millidegree Accuracy," in *Transducers'07*, Lyon France, Vol. 1, pp. 229-232, 2007.
50. B. Kim, R. Melamud, M. A. Hopcroft, S. A. Chandorkar, M. Agarwal, G. Bahl, M. Messana, R. N. Candler, G. Yama, and T. W. Kenny, "Si-SiO₂ Composite MEMS Resonators in CMOS Compatible Wafer-scale Thin-film Encapsulation," in *IEEE Frequency Control Symposium*, Geneva, Switzerland, 2007.
51. M. A. Hopcroft, H. K. Lee, B. Kim, R. Melamud, S. A. Chandorkar, M. Agarwal, C. M. Jha, J. Salvia, G. Bahl, H. Mehta, and T. W. Kenny, "A High-Stability MEMS Frequency Reference," in *Transducers'07*, Lyon France, vol. 2, pp. 1307-1310, 2007.
52. M. Agarwal, H. Mehta, R. N. Candler, S. Chandorkar, B. Kim, M. A. Hopcroft, R. Melamud, G. Bahl, G. Yama, T. W. Kenny, and B. Murmann, "Impact of Miniaturization of the Current Handling of Electrostatic MEMS Resonators," in *Proc. 20th IEEE MEMS 2007*, Kobe, Japan, pp. 783-786, 2007.
53. S. Chandorkar, H. Mehta, M. Agarwal, M. A. Hopcroft, R. N. Candler, G. Yama, G. Bahl, B. Kim, R. Melamud, K. E. Goodson, and T. W. Kenny, "Non-Isothermal Micromechanical Resonators," in *Proc. 20th IEEE MEMS 2007*, Kobe, Japan, pp. 211-214, 2007.
54. S. Dumitrescu, X. Wu, and G. Bahl, "Fast Algorithms for Optimal Two-Description Scalar Quantizer Design," in *Data Compression Conference (DCC 2004)*, pp.42-51, 2004.

OTHER PUBLICATIONS

1. G. Bahl, K.H. Kim, W. Lee, J. Liu, M. Tomes, X. Fan, and T. Carmon, "Bridging two worlds: Microfluidic optomechanics," *Optics and Photonics News*, "Optics in 2013", Vol. 24, Issue 12, p.39 (2013).
2. G. Bahl, M. Tomes, F. Marquardt, and T. Carmon, "Experimental observation of spontaneous Brillouin cooling," *Optics and Photonics News*, "Optics in 2012", Vol. 23, Issue 12, p.43 (2012).

BOOK CHAPTERS

1. G. Bahl, "Microfluidic Optomechanics," *Encyclopedia of Nanotechnology*, Ed: Bharat Bhushan, Dordrecht: Springer Netherlands, 2015. ISBN: 978-94-007-6178-0 (**invited**)
2. G. Bahl and T. Carmon, "Brillouin Optomechanics," *Cavity Optomechanics*, Eds: Markus Aspelmeyer, Tobias Kippenberg, Florian Marquardt, Verlag Berlin Heidelberg: Springer, 2014. ISBN:978-3-642-55312-7 (**invited**)

PATENTS

1. US Patent # 9,594,257. Mar 14, 2017. System and Method for Brillouin Scattering Induced Transparency. Authors: Gaurav Bahl, JunHwan Kim, Hailin Wang, Mark Kuzyk. (UIUC OTM# TF14123-PRO, Provisional patent: 62/064,648. Oct 16, 2014).
2. Provisional Patent: 62/104,391. Jan 16, 2015. System and method for linear non-reciprocal communication and isolation. Authors: Gaurav Bahl. (UIUC OTM# TF14137-PRO)

3. Provisional Patent: 62/234,182. Sept 29, 2015. System and Method for Nano-Opto-Mechanical-Fluidic Sensing of Particles. Authors: Gaurav Bahl, Kewen Han. (UIUC OTM# UIUC2015-086)
4. Provisional Patent: 62/234,178. Sept 29, 2015. System and Method for High-Throughput, Optomechanical Flow Cytometry. Authors: Gaurav Bahl, Kewen Han. (UIUC OTM# UIUC2015-087)
5. Disclosure filed with UIUC. Oct 7, 2016. Real-time sensing of flowing nanoparticles with electro-opto-mechanics. (OTM# UIUC2016-214)

TALKS

INVITED KEYNOTE

1. Keynote speaker at Workshop on Optomechanics and Brillouin Scattering: Fundamentals Applications and Technologies (WOMBAT) at The University of Sydney, July 2015. Hosted by Prof. Benjamin Eggleton and Prof. Christopher Poulton.

INVITED SCIENTIFIC TUTORIALS

1. "Brillouin optomechanical systems" at IEEE International Frequency Control Symposium (IFCS), New Orleans, May 2016. Host: Prof. Gianluca Piazza.
2. "Cavity optomechanics: Theory and phenomenology," Tutorial at Workshop on Optomechanics and Brillouin Scattering: Fundamentals Applications and Technologies (WOMBAT) at The University of Sydney, July 2015. Invited by Prof. Benjamin Eggleton and Prof. Christopher Poulton.
3. "Optomechanical sensors and actuators," a 90-minute tutorial session at IEEE Sensors 2013 in Baltimore, November 3rd, 2013. Invited by Prof. Masood Tabib-Azar.

INVITED TALKS

1. (*upcoming*) "Extremely high-throughput nanoparticle detection with opto-mechano-fluidics", at Gordon Research Conference on Lasers in Micro, Nano and Bio Systems, June 17-22, 2018. Host: Prof. Xudong Fan and Prof. Seok-Hyun Yun.
2. "Non-reciprocal photonics with optomechanical resonator systems," at Indian Institute of Technology Delhi, IEEE EDS Seminar, New Delhi, India, 21 March, 2018. Host: Dr. Samaresh Das.
3. "Chirality and nonreciprocity in optomechanical resonator systems," at Gordon Research Conference on Mechanical Systems in the Quantum Regime, Feb 25 - Mar 2, 2018. Host: Dr. John Teufel and Prof. Markus Aspelmeyer.
4. "Non-reciprocal and chiral acoustics in optomechanical systems," at International Congress on Ultrasonics, Hawaii, Dec 2017. Host: Prof. Vincent Laude.
5. "Non-reciprocal photonics and acoustics with optomechanical resonator systems," at Army Research Lab, Adelphi, MD, Nov 13th 2017. Host: Dr. Robert Benoit.

6. "Chirality and nonreciprocity in optomechanical resonator systems," at University of North Texas, Physics Colloquium, Oct 31st 2017. Host: Prof. Arup Neogi.
7. "Chirality and nonreciprocity in optomechanical resonator systems," at Banff International Research Station for Mathematical Innovation and Discovery (BIRS) Photonic Topological Insulators Workshop, in Banff, Canada, Sept 2017. Host: Prof. Mikael Rechtsman.
8. "Nonreciprocity and chirality in optomechanical resonators," at 2017 Napa Institute Microsystems Workshop sponsored by the Transducers Research Foundation (TRF), Aug 2017. Hosts: Prof. Sunil Bhawe and Prof. David Horsley.
9. "Exploring nonreciprocity and high throughput sensing with optomechanical interactions," at Atominstitut, TU Wien, Vienna, Austria, July 2017. Host: Prof. Arno Rauschenbeutel.
10. "Brillouin Optomechanics in Microresonators," at OSA Incubator on Materials for Optomechanical Actuation, June 2017. Host: Dr. Antti Makinen (Office of Naval Research).
11. "Exploring nonreciprocity and induced chirality for light and sound with opto-mechanical coupling in fiber resonators," at ONNA: Optical Nanofibre Applications 2017 at Okinawa Institute of Science and Technology (OIST), Japan. June 2017. Host: Prof. Sile Nic Chormaic.
12. "Exploring nonreciprocity and high-throughput nanoparticle sensing with opto-mechanical interactions," Cornell University Electron Devices Society (EDS) seminar series, 24th Feb 2017. Host: Prof. Amit Lal.
13. "Nonreciprocal slow and fast light with whispering gallery optomechanics" at SPIE Photonics West (OE122), San Francisco CA, 28 Jan - 2 Feb 2017. Host: Prof. Selim Shahriar.
14. "Ultra-high throughput microfluidic optomechanical sensors" at SPIE Photonics West (OE114), San Francisco CA, Feb 2017. Host: Dr. Giuseppe Leo.
15. "Exploring optical isolation with silica microresonators" at SPIE Photonics West (LA203), San Francisco CA, Feb 2017. Host: Dr. Vladimir Ilchenko.
16. "Exploring optical isolation and nonreciprocity with resonators" at SPIE Photonics West (OE109), San Francisco CA, Feb 2017. Host: Prof. Xudong Fan.
17. "Exploring nonreciprocity and induced chirality for light and sound with opto-mechanical microresonators," Stanford University Ginzton Lab Optics & Electronics Seminar, 31st Oct 2016. Host: Dr. Jonathan Fan.
18. "Exploring nonreciprocity and induced chirality for light and sound with opto-mechanical microresonators," MIT Micro-Nano Seminar, 26th Oct 2016. Host: Dr. Nicholas X. Fang
19. "Exploring nonreciprocity and high-throughput sensing with optomechanical interactions," Special AMO seminar, Northwestern University Department of Physics. 31 May 2016. Host: Prof. Selim Shahriar.
20. "Brillouin optomechanics and optomechanofluidics." seminar at Lehigh University Physics Department Colloquium. 28 April 2016. Host: Prof. Jean Toulouse.
21. "Brillouin and Raman cooling in resonant and non-resonant systems," at SPIE Photonics West, San Francisco CA, 13-18 February 2016. Host: Prof. Denis Seletskiy.
22. "Slow and fast light through Brillouin Scattering Induced Transparency," at SPIE Photonics West, San Francisco CA, 13-18 February 2016. Host: Prof. Selim Shahriar.

23. "Nonreciprocal transparency and isolation with WGRs," at IEEE Photonics Conference (IPC), Reston VA, 4-8 October 2015. Host: Dr. Andrey Matsko.
24. "Nonreciprocal transparency and isolation with whispering-gallery resonators," at DARPA MTO Workshop on Emerging Nonreciprocal Technologies for RF Devices and Systems, 5th October 2015. Host: Dr. Troy Olsson.
25. "Optomechanics and light-vibration interactions : Research and outreach at the Bahl Research Group," at the UIUC Illinois Scholars Undergraduate Research Program (ISUR) fall luncheon, 16 Sept 2015. Host: Dr. Natasha Mamaril.
26. "Brillouin Optomechanics, Nonreciprocity, and Opto-Mechano-Fluidics," UIUC Condensed Matter Physics seminar, 4th September 2015. Host: Dr. Lucas Wagner.
27. "Brillouin Optomechanics, Brillouin Cooling, and Raman Cooling," at 8th International Conference on Materials for Advanced Technologies (ICMAT), Materials Research Society of Singapore (MRS-S), Symposium: Laser cooling of solids and optical refrigeration, June 2015. Host: Prof. Qihua Xiong.
28. Invited speaker at Nanyang Technological University, School of Physical and Mathematical Sciences, in Singapore, 30th June 2015. Host: Prof. Qihua Xiong.
29. Speaker for the MoLES Nanotechnology Seminar Series organized by the Molecular Engineering and Sciences Institute at the University of Washington, 31 March 2015. Hosted by Prof. Karl Bohringer.
30. "Brillouin Optomechanics," at Nano-EP Seminar Series at UIUC, November 10th 2014.
31. "Brillouin Optomechanical Systems and Optomechanical Non-Reciprocity," at Oklahoma State University (Physics Department colloquium), October 9th, 2014. Hosted by Prof. Girish Agarwal.
32. "Microfluidic optomechanics," Photonics West 2014, LASE symposium, February 2014. Host: Dr. Vladimír Ilchenko.
33. "OptoMechanoFluidic Sensors," at IEEE Sensors 2013 in Baltimore, November 4th, 2013. Host: Prof. Yogesh Gianchandani.
34. "Observation of spontaneous Brillouin cooling," at Phonons 2012, Ann Arbor, MI, July, 2012.
35. "Observation of Brillouin cooling," at Conference on Lasers and Electro-Optics (CLEO), San Jose, CA, May 2012.
36. "Cooling by optical filtering of Stokes lines," at SPIE Photonics West, Laser cooling of solids, San Francisco, CA, January 2012.
37. "Surface Acoustic Wave Optomechanical Oscillators," at Electron Devices Society seminar series, Cornell University, Ithaca, NY, May 2011.
38. "MEMS Frequency References and Charge-Drift Control," University of Michigan, Apr 2010.
39. "Charge-Drift in Micromechanical Resonators," at SiTime Corporation, Sunnyvale, CA; Oct 2009.
40. "Overview of Charge Phenomena in Oxide-Coated Flexural Mode Resonators," at Hewlett-Packard Laboratories, Palo Alto, CA; 28th November 2007.

CONTRIBUTED TALKS

1. "Magnet-Free Nonreciprocity in Brillouin Systems," at 8th International Conference on Materials for Advanced Technologies (ICMAT), Materials Research Society of Singapore (MRS-S), Symposium: Emerging infrared technologies and applications, June 2015.
2. "Brillouin actuation of whispering-gallery modes in microfluidic optomechanical oscillators," at Conference on Lasers and Electro-Optics (CLEO), San Jose CA, June, 2013.
3. "Brillouin Optomechanics," at 11th Annual UIUC Center for Nanoscale Science and Technology (CNST) Nanotechnology Workshop, May 3rd, 2013.
4. "Brillouin MEMS," at UIUC iOptics Seminar Series 2013, on 3/12/2013.
5. "Microfluidic Optomechanical Oscillators," at Solid-State Sensors, Actuators and Microsystems Workshop, Hilton Head Island, SC, June, 2012.
6. "Observation of Brillouin Cooling," Frontiers in Optics 2011, San Jose, CA, Oct 2011.
7. "Characterization of Surface Acoustic Wave Optomechanical Oscillators," at IEEE International Frequency Control Symposium (IFCS), San Francisco, CA, May 2011.
8. "Surface Optomechanics: Observation of Surface Acoustic Resonances," at Frontiers in Optics 2010, Rochester, NY; 27th October 2010.
9. "Charge-Drift Elimination in Resonant Electrostatic MEMS," at IEEE Intl. Conf. on Micro Electro Mechanical Systems (MEMS), Hong Kong, China; 26th January 2010.
10. "Observation of Static and Mobile Charge in Oxide-Coated Resonators," at IEEE Solid State Sensors, Actuators and Microsystems Workshop, Hilton Head Island, SC; 5th June 2008.

ENGAGEMENT AND OUTREACH

EDUCATIONAL OUTREACH ACTIVITIES

1. "Accelerometers" at Girls Building Awesome Machines (G-BAM) during Girls' Adventures in Math Engineering and Science (GAMES) summer camp in July 2013 at the University of Illinois.
Participants: Gaurav Bahl, Joseph Muskin
Sponsorship: UIUC MechSE
2. "Paper accelerometers," for a sub-freshmen class at University of Illinois High School (teacher Elizabeth Westfall) in November 2013.
Participants: Elizabeth Westfall, Joseph Muskin, Gaurav Bahl
Sponsorship: UIUC MechSE
3. "Paper MEMS devices," for a senior engineering class at University of Illinois High School (teacher Elizabeth Westfall) in December 2013.
Participants: Elizabeth Westfall, Joseph Muskin, Gaurav Bahl
Sponsorship: UIUC MechSE

4. "Opto-Mechanical Sensors," at Girls Building Awesome Machines (G-BAM) during Girls' Adventures in Math Engineering and Science (GAMES) summer camp in July 2014 at the University of Illinois.
Participants: Shengtai Shi, Joseph Muskin, Gaurav Bahl
Sponsorship: National Science Foundation ECCS-1408539 and UIUC MechSE
5. "Opto-Mechanical Sensors in the Classroom," for senior class at University of Illinois High School (teacher Sharlene Denos) in September 2014.
Participants: Shengtai Shi, Donggyu Benjamin Sohn, Sharlene Denos, Joseph Muskin, Gaurav Bahl
Sponsorship: National Science Foundation ECCS-1408539 and UIUC MechSE
6. "Converting light to mechanical motion," at Girls Building Awesome Machines (G-BAM) during Girls' Adventures in Math Engineering and Science (GAMES) summer camp in June 2015 at the University of Illinois.
Participants: Joanna Bober, Eric Currier, Indronil Ghosh, Joseph Muskin, Peter Du, Gaurav Bahl
Sponsorship: National Science Foundation ECCS-1408539 and UIUC MechSE
7. "Opto-Mechanical Sensors in the Classroom," for senior class at University of Illinois High School (teacher Sharlene Denos) in Sept-Oct 2015.
Participants: Donggyu Benjamin Sohn, Christopher Peterson, Sharlene Denos, Joseph Muskin, Gaurav Bahl
Sponsorship: National Science Foundation ECCS-1408539 and UIUC MechSE
8. "Converting light to mechanical motion," at Campus Middle School for Girls, March 2017.
Participants: Anudeep Mangu, Inbar Grinberg, Indronil Ghosh, Gaurav Bahl
Sponsorship: National Science Foundation ECCS-1408539.

STUDENT-LED OUTREACH

1. Christopher Peterson – Curriculum development on "Introduction to CAD, 3D printing, and rapid prototyping" for 6th Grade students at Jefferson, Edison, and Franklin Middle Schools in Champaign, IL. Oct 2015 – May 2016.
2. Donggyu Benjamin Sohn – "Introduction to engineering: Paper rockets, popsicle catapults, hot chocolate machines" for 3rd Grade students at Dr. Howard Elementary School in Champaign, IL. Oct-Nov 2014.
3. Nathan Dostart – "Introduction to engineering" for 4th Grade students at Stratton Elementary School in Champaign, IL. Oct 2013.

OTHER ACTIVITIES

McMaster Solar Car Project Sept 2002 – Aug 2005

Electrical Team Leader, McMaster University

- Designed electrical subsystems (battery protection, telemetry, lighting, signaling) for solar powered competitive racing vehicles
- Participated in the Canadian Solar Tour (2004), North American Solar Challenge (2003) and Formula Sun Grand Prix (2004).

AWARDS AND FELLOWSHIPS FOR STUDENTS

- 2018, Distinguished Graduate Student, UIUC Mechanical Science and Engineering award for Seunghwi Kim.
 - 2018, Outstanding Mechanical Engineering PhD Dissertation, for Kewen Han.
 - 2017, Chinese Government Award for Outstanding Self-Financed Students Abroad, for Kewen Han. Award amount: \$6,000.
 - **2016, National Science Foundation Graduate Research Fellowship** (NSF GRF), for Christopher Peterson. Award amount: \$138,000.
 - 2016 Yee Fellowship, UIUC College of Engineering, for Kewen Han, Award amount: \$5,000.
 - 2016, Illinois Scholars Undergraduate Research Program (ISUR), grant for Indronil Ghosh. Sponsor: Semiconductor Research Corporation. Award amount: \$1,000.
 - 2016, Illinois Scholars Undergraduate Research Program (ISUR), grant for Alan Luo. Sponsor: Semiconductor Research Corporation, Intel. Award amount: \$1,000.
 - 2015 Distinguished Graduate Student, UIUC Mechanical Science and Engineering award for Kewen Han.
 - 2015, UIUC MechSE Society for Engineering Mechanics, Undergraduate research grant for Jafir Haidri. Award amount: \$2,000.
 - **2015, National Science Foundation Graduate Research Fellowship** (NSF GRF), for Donggyu Benjamin Sohn. Award amount: \$132,000.
 - **2014, National Science Foundation Graduate Research Fellowship** (NSF GRF), for Nathan Dostart. Award amount: \$132,000.
 - 2013, UIUC MechSE Society for Engineering Mechanics, Undergraduate research grant for Kaiyuan Zhu. Award amount: \$2,000.
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