

Susanta Kumar Sarkar

Single Molecule Biophysics Laboratory
Department of Physics
Colorado School of Mines
Golden, Colorado 80401, USA.
<http://inside.mines.edu/~ssarkar/>

Office: 303-273-3657
Fax: 303-273-3919
Cell: 607-351-8063
Email: ssarkar@mines.edu
susantasarkarphysics@gmail.com

RESEARCH AREAS (\$2,249,696 as the lead PI from different sources, including NIH and NSF)

- Allosteric control of collagen fibril degradation by matrix metalloprotease-1
- Substrate-dependent selective control of matrix metalloprotease-1 activity using allosteric principles
- Modulating alpha-synuclein and amyloid-beta peptide aggregation by matrix metalloproteases
- Defining the roles of matrix metalloprotease-1 in coagulation and fibrinolysis
- SARS-CoV-2 protease 3CLpro as collagenase, blood coagulator, and promoter of neurodegeneration
- Background-free imaging of amyloid-beta and alpha-synuclein using nanodiamonds
- The gut-brain axis of Alzheimer's disease and Lewy body dementia via matrix metalloproteases
- Modulating cellular genotype and phenotype in extreme conditions

APPOINTMENTS

- January 2014 – **Assistant Professor**, Department of Physics, Colorado School of Mines.
- January 2008 – December 2013 **Research Fellow**, National Institutes of Health.
- July 2006 – December 2007 **Postdoctoral Associate**, Cornell University.

EDUCATION

- 2006 **Ph.D. (Physics)**. University of Oregon.
- 2002 **M.S. (Physics)**. University of Oregon.
- 1999 **M.S. (Physical Sciences)**. Indian Institute of Science, Bangalore, India.
- 1996 **B.Sc. (Physics Honors)**. University of North Bengal, West Bengal, India.

AWARDS

- 2019 NSF Reintegrating Biology Workshop, Austin, Texas.
- 2017 Outstanding Basic Science Award. National Heart, Lung, and Blood Institute, NIH.
- 2015 Orloff Science Award for Technical Achievement, NHLBI, NIH
- 2013 Orloff Science Award. National Heart, Lung, and Blood Institute, NIH.
- 2010 Fellows Award for Research Excellence (FARE). NIH.
- 2010 Performance Award. National Heart, Lung, and Blood Institute, NIH.
- 2009 Performance Award. National Heart, Lung, and Blood Institute, NIH.
- 2008 US National Research Council Postdoctoral Fellowship (declined).
- 2002 Watumull Scholarship. University of Oregon.
- 2001 Watumull Scholarship. University of Oregon.
- 1998 National Eligibility Test (NET). Council of Scientific and Industrial Research, India.
- 1995 National Scholarship. Government of India.

PUBLICATIONS **student, volunteer, and postdoctoral fellow as primary advisee; †Corresponding author.*

Under review

1. Sumaer Kamboj*, Chase Harms*, Derek Wright*, Anthony Nash, Judith Klein-Seetharaman, and Susanta K. Sarkar[†]. Identification of substrate-specific allosteric fingerprints in matrix metalloprotease-1 on

amyloid-beta peptide aggregates and drug screening with single molecule insights. **Submitted**, 2022.

†Corresponding author.

2. Derek Wright*, Chase Harms*, and Susanta K. Sarkar†. Identification of collagen-specific allosteric residues and changes at the catalytic site of matrix metalloprotease-1. **Submitted**, 2022. †Corresponding author.
3. Derek Wright*, Roshan Klein-Seetharaman*, and Susanta K. Sarkar†. A stochastic approach to quantifying the recurrence time for different particle statistics and showing the emergence of the arrow of time. **Submitted**, 2022. †Corresponding author.

Peer-reviewed

4. Sumaer Kamboj*, Chase Harms*, Derek Wright*, Anthony Nash, Lokender Kumar*, Judith Klein-Seetharaman, and Susanta K. Sarkar†. Identification of allosteric fingerprints of alpha-synuclein aggregates in matrix metalloprotease-1 and substrate-specific virtual screening with single molecule insights. **Scientific Reports**, 12, 2022. †Corresponding author.
5. A. Michelle Lawing, Michael McCoy, Beth A. Reinke, Susanta K. Sarkar†, Felisa A. Smith, Derek Wright*. A framework for investigating rules of life by establishing zones of influence. **Integrative and Comparative Biology**, 61, 6, 2095–2108, 2021. †Corresponding author. *NSF Integrating Biology Workshop*.
6. Lokender Kumar*†, Nathanael Brenner*, John Brice*, Judith Klein-Seetharaman, and Susanta K. Sarkar†. Cephalosporins target quorum-sensing receptor-ligand interactions and suppress virulence of *Pseudomonas aeruginosa* in *Caenorhabditis elegans* infection model. **Frontiers in Microbiology**, 12, 70, 2021. †Corresponding authors.
7. Sumaer Kamboj*, Chase Harms*, Lokender Kumar*, Daniel Creamer*, Colista West*, Judith Klein-Seetharaman†, and Susanta K. Sarkar†. A method of purifying alpha-synuclein in *E. coli* without chromatography", **Heliyon**, 7, 1, 2021. †Corresponding authors.
8. Lokender Kumar*, Joan Planas-Iglesias, Chase Harms*, Sumaer Kamboj*, Derek Wright*, Judith Klein-Seetharaman, and Susanta K. Sarkar†. Activity-dependent interdomain dynamics of matrix metalloprotease-1 on fibrin. **Scientific Reports**, 10, 2020. †Corresponding author.
9. Lokender Kumar*, Anthony Nash, Chase Harms*, Joan Planas-Iglesias, Derek Wright*, Judith Klein-Seetharaman, and Susanta K. Sarkar†. Allosteric Communications between Domains Modulate the Activity of Matrix Metalloprotease-1. **Biophysical Journal**, 119, 1-15, 2020. †Corresponding author.

Selected for the cover page. Recommended in Faculty Opinions by two experts. Dr. Jean-Pierre Changeux, one of the pioneers of allostery in proteins, commented: "***This is a very interesting joint experimental and computational work.***" Dr. Greg Fields, one of the well-known experts in MMPs, ***recommended the paper as being of special significance in its field.***

10. Lokender Kumar*, John Brice*, Linda Toberer*, Judith Klein-Seetharaman, Daniel Knauss, and Susanta K. Sarkar†. Antimicrobial biopolymer formation from sodium alginate and algae extract using aminoglycosides. **PLOS ONE**, 14, 3, 2019. **US Patent US11027019B2**. †Corresponding author.
11. Lokender Kumar*, Christopher Cox, and Susanta K. Sarkar†. Matrix metalloprotease-1 inhibits and disrupts *Enterococcus faecalis* biofilms. **PLOS ONE**, 14, 1, 2019. **Patent filed**. †Corresponding author.
12. Warren Colomb*, Matthew Osmond, Charles Durfee, Melissa D. Krebs, and Susanta K. Sarkar. Imaging and Analysis of Cellular Locations in Three-Dimensional Tissue Models. **Microscopy and Microanalysis**, 1-9, 2019. **3D imaging of cells in thick tissue models**. †Corresponding author.
13. Lokender Kumar*, Warren Colomb*, John Czerski*, Christopher Cox, and Susanta K. Sarkar†. Efficient protease based purification of recombinant matrix metalloproteinase-1 in *E. coli*. **Protein Expression and Purification**, 148, 59-67, 2018. **Patent filed**. †Corresponding author.

14. John Czerski*, Warren Colomb*, Frank Cannataro*, and Susanta K. Sarkar[†]. Spectroscopic identification of fluorophores at single molecule level using photoluminescence excitation spectra. *Journal of Microscopy*, 270 (3), 261-271, 2018. ***Spectroscopic identification of single molecules: Can also be used for MMP stoichiometry and labeling efficiency quantification.*** [†]Corresponding author.
15. John Czerski* and Susanta K. Sarkar[†]. High-resolution and high-contrast fluorescence imaging with carbon nanomaterials for pre-clinical and clinical applications. Invited book chapter, **Carbon Nanomaterials for Bioimaging, Bioanalysis and Therapy**, Wiley, 63-85, 2018. [†]Corresponding author.
16. Warren Colomb*, John Czerski*, Jaydeep Sau, and Susanta K. Sarkar[†]. Estimation of microscope drift using fluorescent nanodiamonds as fiducial markers. *Journal of Microscopy*, 266(3), 298-306, 2017. ***FNDs as fiducial markers for high-resolution functional imaging with less than 5 nm accuracy and precision.*** [†]Corresponding author. ***One of the top 20 downloaded papers in Journal of Microscopy.***
17. Andrew Dittmore, Jonathan Silver, Susanta K. Sarkar, Barry Marmer, Gregory Goldberg, and Keir C. Neuman. Internal Strain Drives Spontaneous Periodic Buckling in Collagen and Regulates Remodeling. *PNAS*, 113, No 30, 8436-8441, 2016. ***Role of fibril (substrate) in collagen degradation.***
18. Kristina M. Herbert, Susanta K. Sarkar, Maria Mills, Hilda C. Delgado De la Herran, Keir C. Neuman, and Joan A. Steitz. A heterotrimer model of the complete Microprocessor complex revealed by single-molecule subunit counting. *RNA*, 22: 175-183, 2016.
19. Kelsie Merchant* and Susanta K. Sarkar[†]. Fluorescent nanodiamonds for molecular and cellular bioimaging. The IEEE Journal of Selected Topics in Quantum Electronics, *IEEE JSTQE*, 2015. ***Invited Review.*** [†]Corresponding author.
20. W. Colomb* and Susanta K. Sarkar[†]. Digging deeper into noise. Reply to comment on "Extracting physics of life at the molecular level: A review of single-molecule data analyses." *Physics of Life Reviews*, June 13:153-154, 2015. Commentary. [†]Corresponding author.
21. W. Colomb* and Susanta K. Sarkar[†]. Extracting Physics of Life at the Molecular Level: A Review of Single-molecule Data Analyses. *Physics of Life Reviews*, 13, 107-137, 2015. ***Single molecule Data analysis to determine states and interconversion between states.*** [†]Corresponding author.
22. Susanta K. Sarkar[†], Ambika Bumb[†], Xufeng S. Wu, Kem A. Sochacki, Peter Kellman, Martin W. Brechbiel, and Keir C. Neuman. Wide-field in vivo background free imaging by selective magnetic modulation of nanodiamond fluorescence. *Biomedical Optics Express* 5 (4), 1190–1202, 2014. [†]Equal contributions. ***US Patent 9449377.***
23. Susanta K. Sarkar, Ambika Bumb, Maria Mills, and Keir C. Neuman. Single-Molecule Fluorescence. *Cell* 153(6):1408-1408.e1, 2013.
24. Ambika Bumb[†], Susanta K. Sarkar[†], Martin W. Brechbiel, and Keir C. Neuman. Silica encapsulation of fluorescent nanodiamonds for colloidal stability and facile surface functionalization. *J. Am. Chem. Soc.*, 135 (21), 7815–7818, 2013. [†]Equal contributions. ***Selected for cover page illustration.***
Highlighted in Nature Methods.
Spotlighted in JACS.
25. Arthur Z. Eisen, Susanta K. Sarkar, Keir C. Neuman, Gregory A. Bannikov, and Gregory I. Goldberg. Matrix metalloproteinase 9 / gelatinase B. **Invited book chapter in the Handbook of Proteolytic Enzymes**, 3rd Edition, Neil D. Rawlings, Editor, 2012. ***Importance of MMP9 in collagen degradation.***
26. Susanta K. Sarkar, Barry Marmer, Gregory Goldberg, and Keir C. Neuman. Single-molecule tracking of collagenase on native type I collagen fibrils reveals degradation mechanism. *Current Biology*, 22, 1-10, June 19, 2012. ***Mechanistic details of collagen fibril degradation.***
Published as an Article.
Selected for cover page illustration.

Commentary in Current Biology.
Selected by Faculty of 1000 twice.

27. Ambika Bumb, Susanta K. Sarkar, Xufeng S. Wu, Martin W. Brechbiel, and Keir C. Neuman. Quantitative characterization of fluorophores in multi-component nanoprobe by single-molecule fluorescence. **Biomedical Optics Express**, 10, 2762-2769, 2011. *New high-throughput method to accurately characterize dyes using single-molecule counting.*
28. Ashley H. Hardin, Susanta K. Sarkar, Yeonee Seol, Grace F. Liou, Neil Osheroff, and Keir C. Neuman. Direct measurement of DNA bending by type IIA topoisomerases: implications for non-equilibrium topology simplification. **Nucleic Acid Research**, 1-15, 2011. *Disproved one of the most accepted models in the field.*
Selected by Faculty of 1000.
29. Nesha May Andoy, Susanta K. Sarkar, Qi Wang, Jaime J. Benitez, Aleksandr Kalininskiy, and Peng Chen. Single-molecule study of metalloregulator CueR-DNA interactions using Engineered Holliday junctions. **Biophysical Journal**, 97, 844–852, 2009.
Selected for Cover page illustration.
30. Susanta K. Sarkar, Nesha May Andoy, Jaime J. Benitez, Peng R. Chen, Jason S. Kong, Chuan He, and Peng Chen. Engineered Holliday junctions as single molecule reporters for protein-DNA interactions with application to a MerR-family regulator. **J. Am. Chem. Soc.**, 129, 12461-12467, 2007. *New method to study protein-DNA interactions at single-molecule level.*
31. Yan Guo, Susanta K. Sarkar, and Hailin Wang. Pulse propagation near exciton resonance: Anomalous transition between slow and fast light. Conference paper, Slow and fast light, Salt Lake City, Utah, 2007. *Velocity of light and propagation of optical pulses.*
32. Susanta K. Sarkar, Yan Guo, and Hailin Wang. Tunable optical delay via carrier induced exciton dephasing in semiconductor quantum wells. **Optics Express**, 14 (7), 2845, 2006. *First tunable velocity of light using incoherent optical process.*
Invited to present at the Slow and Fast Light Topical Meeting, Washington DC, 2006.
33. Susanta K. Sarkar, Phedon Palinginis, Hailin Wang, Pei-Cheng Ku, Connie J. Chang-Hasnain, N.H. Kwong, and R. Binder. Inducing electron spin coherence in GaAs quantum well waveguides: Spin coherence without spin precession. **Physical Review B**, 72, 035343, 2005. *First electron spin coherence without magnetic field in a quantum well waveguide.*

Not peer-reviewed

34. Andrew P. Proudian, and Susanta K. Sarkar[†]. Modeling the effect of transient violations of the second law of thermodynamics on heat transfer in silicon nanowire. arXiv:1606.01997, 2016.[†]Corresponding author.
35. Susanta K. Sarkar[†]. Single Molecule Biophysics and Poisson Process Approach to Statistical Mechanics. Institute of Physics, UK/ Morgan-Claypool, Concise Physics Series. **Book**. 2016.
[†]Corresponding author. *Second edition invited and in process.*

PATENTS

1. Sumaer Kamboj*, Chase Harms*, Lokender Kumar*, Daniel Creamer*, Colista West*, Judith Klein-Seetharaman, and **Susanta K. Sarkar**. Purification of alpha-synuclein and preparing *E. coli* based Lewy body model leveraging amyloidogenic property. **Patent filed**, CSM, 2020.
2. Lokender Kumar*, John Brice*, Linda Toberer*, Judith Klein-Seetharaman, Daniel Knauss, and **Susanta K. Sarkar**. Antimicrobial biopolymer formation from sodium alginate and algae extract using aminoglycosides. **Awarded, US Patent US11027019B2**, 2021.

3. Lokender Kumar* and **Susanta K. Sarkar**. Matrix metalloprotease-1 as antibiofilm agent. Patent application: 16/355,090, 2018.
4. Lokender Kumar* and **Susanta K. Sarkar**. Purification of active soluble recombinant matrix metalloproteinase-1 in *Escherichia Coli*. Patent application: 16/265,600, 2017.
5. **Susanta K. Sarkar**, Ambika Bumb, and Keir C. Neuman. Imaging methods and computer-readable media. This patent is on background-free imaging by selective modulation of nanodiamond fluorescence using a magnetic field. **Awarded, US Patent 9449377**, 2016.
6. Keir Cajal Neuman, Han Wen, Jennifer Hong, Chang Kuyn Yi, Ambika Bumb, **Susanta Kumar Sarkar**, A.K. Manna, L.E. Samelson. Fluorescent nanodiamonds for use as fiducial markers for microscopy and fluorescence imaging. Patent application: **US20180356343A1**, 2015.
7. Ambika Bumb, **Susanta K. Sarkar**, Martin W. Brechbiel, and Keir C. Neuman. Method of preparing silica-coated nanodiamonds. Patent applications: **CA2879407A1, WO2014014970A1**, 2014.

ENTREPRENEURSHIP

I have co-founded SARKAR-KLEIN Labs, a joint venture with Dr. Judith Klein-Seetharaman, to commercialize proteins purified using methods developed at my laboratory and patented by Mines. Currently, an NSF STTR Phase I grant funds the company. I have obtained training through the NSF I-CORPS program at the Colorado State University, Traxion Foundations Program in Golden, NSF Beat the Odds Bootcamp, and NSF-sponsored Dawnbreaker program. One of my former Ph.D. students, Sumaer Kamboj, won the first prize for a business plan for managing COVID-19 resources using artificial intelligence and machine learning and served as the PI of an NSF STTR Phase I grant and the Chief Technology Officer.

TALKS

1. Looking at life through randomness. Colloquium, Center for Biological Physics, Arizona State University, Tempe, September 21, 2022.
2. Looking at life through randomness. Colloquium, Department of Physics, Oklahoma State University, Stillwater, March 08, 2022.
3. Allosteric communications via substrate and linker between domains modulate protein function. Focus Session: Physics of Proteins: Progress on Structure-Function Relationships I. American Physical Society March Meeting, Denver, CO, USA, 2021.
4. Allosteric communications via substrate and linker between domains modulate protein function. Focus session: Physics of Proteins: Progress on Structure-Function Relationships I. American Physical Society March Meeting, Denver, CO, USA, March 02, 2020.
5. Allosteric communications between domains modulate activity of matrix metalloprotease-1. Colorado Single Molecules and Membranes Meeting, Denver, CO, USA, January 10, 2020.
6. Looking at life through randomness. Colloquium, University of Denver, May 22, 2019.
7. Looking at life through randomness. Colloquium, Department of Physics, Indiana University Purdue University, Indianapolis (IUPUI), February 14, 2019.
8. Looking at life through randomness. Colloquium, Department of Physics, Colorado State University, October 22, 2018.
9. Single-molecule spectroscopy of nanoparticles. Frontiers and Challenges in Laser-Based Biological Microscopy, Telluride, CO, USA, August 3 – 7, 2015.
10. Studying Molecules One-by-One Using Single Molecule Techniques. Colloquium, Department of Physics, Colorado School of Mines, November 04, 2014.
11. Background-free imaging with fluorescent nanodiamonds. New Laser Scientists Conference, Sponsored by the American Physical Society Division of Laser Science, Tucson Ballroom G, JW Marriott Hotel, Tucson, Arizona, October 24, 2014.
12. Mechanism of collagen fibril degradation: application of single molecule tracking. Colloquium, CSU School of Biomedical Engineering, Colorado State University, September 29, 2014.

13. Single-molecule tracking of MMP1 and MMP9 on type I collagen fibrils. Collagen Gordon Research Conference, Colby-Sawyer College, New London, NH, USA, July 14 – 19, 2013.
14. Single-Molecule Tracking of Enzymes on Extended Substrates. National Institute of Standards and Technology, May 10, 2013.
15. Mechanism of collagen degradation revealed by single-molecule tracking of matrix metalloprotease MMP1 on type I collagen fiber. Gordon Research Seminar on Signal Transduction by Engineered Extracellular Matrices, University of New England, Biddeford, ME, USA, July 07 – 08, 2012.
16. Mechanism of collagen degradation revealed by single-molecule tracking of matrix metalloprotease MMP1 on type I collagen fiber. Collagen Gordon-Kenan Research Seminar, Colby-Sawyer College, New London, NH, USA, July 16 – 17, 2011.
17. Investigation of protein-DNA interactions at single molecule level using Engineered Holliday junctions. Oregon Center for Optics and Department of Physics, University of Oregon, Oregon, April 21, 2008.
18. Engineered Holliday junctions as generic single molecule reporters of protein-DNA interactions: application to MerR-type metalloregulators. National Institutes of Health, Bethesda, Maryland, 2007.
19. Tunable all-optical delay via nonlinear optical processes in semiconductor quantum wells. National Renewable Energy Laboratory (NREL), Denver, Colorado, September 11, 2006.

RESEARCH FUNDING (Total: \$2,249,696, Direct + Indirect costs)

- NIH R01 GM145210 (Lead PI) \$1,138,208
Allosteric control of collagen fibril degradation by matrix metalloprotease-1
Duration: 09/20/2022 – 07/31/2026.
- NIH R15 Supplement (Lead PI; co-PI Dr. Judith Klein-Seetharaman) \$51,628
Single molecule insights into interactions of matrix metalloprotease-1 with amyloid-beta aggregates
Duration: 08/01/2022 – 07/31/2022.
- Colorado Office of Economic Development & International Trade (Lead PI) \$150,000
Inexpensive recombinant alpha-synuclein and amyloid-beta peptide and aggregates
Duration: 01/10/2022 – 02/29/2024.
- NSF STTR 2001749 (Lead PI from Mines) \$225,000
STTR Phase I: Protease-based purification of recombinant human matrix metalloproteases
SARKAR-KLEIN Labs, a joint venture with Dr. Judith Klein-Seetharaman
Duration: 02/01/2021 – 01/31/2022
- NIH R15 GM137295 (Lead PI; co-PI Dr. Judith Klein-Seetharaman) \$366,928
Understanding fibrin degradation by matrix metalloprotease-1 at the single molecule level
Duration: 04/01/2020 – 03/31/2023
- Colorado Office of Economic Development & International Trade and MATTI (Lead PI) \$35,000
A \$14.3 billion per year market for human matrix metalloprotease-1?
Duration: 04/01/2019 – 03/31/2020
- Mines Applied Technology Transfer, Inc. (MATTI) (Lead PI) \$40,000
Novel highly effective contact lens cleaner for prevention and treatment of bacterial biofilms using MMP1
Duration: 04/01/2018 – 03/31/2019
- Colorado Office of Economic Development & International Trade and MATTI (Lead PI) \$50,500
Proof-of-concept for phage-based identification and antibiotic resistance profiling of priority Gram negative pathogens
Duration: 04/19/2018 – 04/30/2019
- Slater Foundation (Lead PI) \$40,000
Ultra low-cost production of reducing sugars from invasive algae using novel bacteria
Duration: 02/01/2018 – 01/31/2019
- REMRSEC Seed Grant (Lead PI) \$5,000
Biomass processing using MMP1

Duration: 06/01/2017 – 05/31/2018

- TechFee (Lead PI)
Biophysics Infrastructure for the Students by the Students
Duration: 06/01/2015 – 05/31/2016

\$147,432

LABORATORY PERSONNEL

I did not establish my research alone. My research and facilities enable diverse career options for students. *I practice inclusivity of diverse researchers* irrespective of sex, religion, national origin, age, disability, parental status, veteran status, mental health, and societal background. The list of researchers below has representations from each of these groups. I consciously try to prevent imposter syndrome in my laboratory. In addition to colleagues at Mines and collaborators outside Mines, I collaborated with researchers at my Single Molecule Biophysics Laboratory as below:

- **Special Volunteer** (1): Linda Toberer (2017). Linda, a retired physiotherapist, joined my laboratory for fun and one day ended up mixing aminoglycoside antibiotics (the same kind used in Neosporin) with algae extract (the same algae used in Miso soup). This mix-up led to antimicrobial alginate biopolymer, 1 publication, and 1 patent (awarded). I worked with two retired scientists at NIH and published.
- **Sabbatical Visitor** (1): Dr. Horia Petrache (2019). Dr. Petrache, a professor at Indiana University–Purdue University Indianapolis (IUPUI), visited my laboratory for a sabbatical. Dr. Petrache has a sustained record of obtaining beam time at the Argonne National Laboratory and Oak Ridge National Laboratory for Small Angle X-ray Scattering (SAXS) and Small-Angle Neutron Scattering (SANS). We will collaborate to obtain structural information on protein aggregates in neurodegeneration using SAXS and SANS.
- **Postdoctoral Fellow** (1): Dr. Lokender Kumar (Physics, 2016-2018, Research Assistant Professor, 2018-present). We published 8 papers, disclosed 4 patents, and more importantly, I helped him formulate an independent research direction to submit NIH grants and independent faculty applications.
- **Ph.D.** (4): **Derek Wright** (expected to join in Fall 2023, currently I am supporting him as a research faculty hourly to get rid of his student loan, career aspiration in big data analysis); **Chase Harms** (Physics, Expected Defense in Summer 2023, career aspiration in drug discovery); **Sumaer Kamboj** (Quantitative Biosciences and Engineering, Defended thesis in July 2021, currently working as project manager and obtained DARPA funding); **Warren Colomb** (Physics, Defended thesis in March 2018, currently Optical Engineer at Double Helix). *All Ph.D. students must have three first-authored publications before graduating from my group.*

My student Warren Colomb received \$1.8 million NIH grant as the PI and beat me in the grant game!

- **M.S.** (4): Derek Wright (Applied Physics, December 2019); John Brice (Electrical, May 2019, Patent Analyst at Sheridan Ross, John's career choice); John Czerski (Applied Physics, December 2018, Ph.D. at Mines); Frank Cannataro (Mechanical, May 2015, Nuclear Engineer at Puget Sound Naval Shipyard). *All M.S. students published work done at my laboratory.*
- **B.S.** (39): Armand Ovanessians; Violet Ross; Jakob Wallin; Katherine Newberry; Ashley Turnage; Mai Phuong Le (Fiona); Anthony Bosch; Jacob Wolf; *Colista West*; Logan Cummings; *Daniel Creamer*; Danielle Forristall; *Chase Harms*; Logan Cummings; Avery Tyndall; Patrick Losique; Cason Cropp; Chase Schumacher; *Sumaer Kamboj*; Tristan Cain; Hannah North; Madison Clark; *John Brice*; Nathaniel Britten; Nathanael Brenner; Kelsey Hoon; Zachary Czajkowski; Allison Pelzel; *Kelsie Merchant*; Tristan Seawalt; Ty Coleman; Evan Mendoza; Raymond Simmons; *John Czerski*; *Derek Wright*; Eric Willems; Todd Shaklee; Scott Strachan; *Frank Cannataro*. *9 undergraduates in italicized bold published work done at my laboratory.*
- **K12** (3): Roshan Klein-Seetharaman; Brandon Gehrke; Arianna Castro. All three students continued their studies in STEM. *Roshan wrote a paper with me and joined Yale in Fall 2021.*

Advising philosophy. I provide hands-off advising to nurture students' work ethic and independent thinking. They are encouraged to call me out if I am wrong. I mix structured technical training with open-

ended problem-solving. Structured technical training helps my students secure jobs before their degrees. Also, my students must solve open-ended problems on their own so that they develop adaptability to survive the rapidly changing technology landscape in the future. ***I develop written individualized career plans to nurture hard and soft skills for each graduate student in line with their career aspirations*** and update the plan 2-3 times a year. My students can change their career plans at any time, but they must have a written plan at all times. In this way, I respond to nationwide concerns about increasing time-to-PhD and decreasing job satisfaction, both of which are NSF's concerns.

TEACHING

Courses taught (evaluations, number of students)

PHGN200 Electromagnetism and Optics (4.2/5.0, 136 students)

PHGN341 Thermal Physics (3.9/5.0, 73 students)

PHGN333/433 Biophysics (4.3/5.0, 7 students)

CBEN402 Chemical Engineering Design (5.0/5.0, ~10 students)

PHGN481/491/482/492 Senior Design (5.0/5.0, ~4 students)

PHGN530 Statistical Mechanics (4.3/5.0, 7 students)

PHGN599/699 Independent Study

PHGN707/BIOL707 Graduate Thesis/Research (graduated 2 Ph.D. and 4 M.S. students)

PROFESSIONAL SERVICES AND MEMBERSHIPS

Mines.

- Committees: Physics Graduate/Research Council; Physics Admission Committee (2014-2016); University Research Council; and University Biosafety Committee. Also, I have taken a very active part in developing the Quantitative Biosciences and Engineering (QBE) Program at the Colorado School of Mines. The QBE program serves a unique need of training researchers with experience in experiments and computations. I have been involved in the QBE program at Mines from the beginning: (1) development of the curriculum at B.S./M.S./Ph.D. levels, (2) development of the rules and bylaws, (3) teaching faculty as well as director search committees (both successful), (4) regular QBE faculty meetings, (5) QBE qualifying exam committee, and (6) graduate student advisory committees. I also wrote an NSF grant with faculty members from different departments for training students in quantitative biosciences and engineering.

As a member of the admission committee in physics, I organized the first two graduate recruiting weekends in 2014 and 2015. Although I had to spend a significant amount of time organizing the logistics, this effort made a lasting contribution because we have continued to have recruiting weekends since then.

For graduate physics reform, I wrote and submitted an NSF grant as the lead PI involving 11 faculty members from the department. This effort took a significant amount of time and demonstrated that it is possible to have a collective discussion about this pioneering effort. I also wrote another grant on data analysis and error bars in the graduate curriculum.

- Graduate student committees: Ph.D. (Marie A. McLain, Physics; Diego Alcala, Physics; Alex Wilhelm, Physics; Jingjing Gong, CBE; Megan Jewell, CBE; Meghana Shivananda Murthy, QBE); M.S. (Logan Hillberry, Physics; Anna Thomas, Physics).
- Participated in high school outreach programs at Mines.
- Pedagogy: Participated in a month-long intensive training on pedagogy (Trefny Center, Mines, 2016) and in a week-long conference on learning funded by HHMI (University of Colorado, Boulder, 2015).

External.

- Invited to the ***NSF Reintegrating Biology*** Workshop, Austin, December 3-6, 2019.

As the corresponding author, I wrote an invited paper that ***may have a durable influence***. The editor of Integrative and Comparative Biology noted: "Dear Dr. Sarkar,...I am particularly grateful that you and your coauthors are ***building a conceptual framework for Rules of Life. I am confident that your paper will be very useful to the biological community.***" One reviewer noted: "***This framework will be beneficial***

in terms of improving our understanding of biological phenomenon and the underlying mechanisms, but also for stimulating new lines of inquiry."

- Served on 9 NSF panels and 2 NIH panels. I prepared the initial draft of an NIH solicitation on nanodiamonds while working at NIH as a research fellow.
- Reviewer for Biophysical Journal, Journal of American Chemical Society, Journal of Physical Chemistry, Optics Express, Optics Letter, Proceedings of National Academy of Sciences, Methods, Materials, Nanoscale Research Letters, Informatics, Process Biochemistry, Cell Biology and Toxicology, Pattern, Journal of Selected Topics in Quantum Electronics, and Nature Communications.
- Reviewer for American Chemical Society Petroleum Research Fund (ACS PRF), Maryland Technology Development Corporation (TEDCO), Polish National Foundation, and Netherlands Organization for Scientific Research.
- Member: American Physical Society, Optical Society of America, and Biophysical Society of America.