

Sumitabha Brahmachari, Ph.D.

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RESEARCH INTERESTS

Computational and theoretical modeling (Machine Learning, Molecular Dynamics, Statistical Mechanics),
Genome organization, Transcription regulation, DNA supercoiling, Chromosome biophysics.

RESEARCH EXPERIENCE

- **Post-doctoral Associate**, Rice University 2018 - present
Supervisor: Prof. José N. Onuchic
Summary: Developed simulation force-fields for chromosomes using Hi-C-derived information; Built machine learning models to learn statistical correlations between structure and epigenetics; Built numerical models exploring the role DNA mechanics in transcription; Mentored graduate and undergraduate students; Collaborated with experimental labs.
- **Graduate Researcher**, Northwestern University 2013-2018
Supervisor: Prof. John F. Marko
Summary: Built statistical mechanical models of DNA elucidating the role of mechanical forces and DNA structure in influencing in vivo processes; Collaborated with experimentalists.

EDUCATION

Ph.D. Physics , Department of Physics and Astronomy, Northwestern University	2013-2018
M.Sc. Physics , Department of Physics, Indian Institute of Technology Mumbai	2011-2013
B.Sc. Physics , Hindu College, University of Delhi	2008-2011

PUBLICATIONS (* indicates shared authorship)

- [1] [Preprint] [S Brahmachari](#), T Markovich, FC MacKintosh, JN Onuchic. Temporally correlated active forces drive chromosome structure and dynamics bioRxiv (2023) doi.org/10.1101/2023.04.23.528410
- [2] E Dodero-Rojas, MF Mello, [S Brahmachari](#), et al. PyMEGABASE: Predicting cell-type-specific structural annotations of chromosomes using the epigenome. **J. Mol. Biol.** 435 (15), p168180 (2023). doi.org/10.1016/j.jmb.2023.168180
- [3] BS Ruben, [S Brahmachari](#), VG Contessoto, et al. Structural reorganization and relaxation dynamics of axially stressed chromosomes. **Biophys. J.** 122 (9) p1633-1645 (2023). doi.org/10.1016/j.bpj.2023.03.029
- [4] [S Brahmachari](#) VG Contessoto, M Di Pierro, and JN Onuchic. Shaping the genome via lengthwise compaction, phase separation, and lamina adhesion. **Nucl. Acids Res.** 50, p4258-4271 (2022). doi.org/10.1093/nar/gkac231
- [5] S Tripathi, [S Brahmachari](#), JN Onuchic, and H Levine. DNA supercoiling-mediated collective behavior of co-transcribing RNA polymerases. **Nucl. Acids Res.** 50 (3), p1269-1279 (2022). doi.org/10.1093/nar/gkab1252
- [6] C Hoencamp*, O Dudchenko*, AMO Elbatsh*, [S Brahmachari*](#) et al. 3D genomics across the tree of life reveals condensin II as a determinant of architecture type. **Science** 372, p984-989 (2021). doi.org/10.1126/science.abc221

- [7] PR Desai, S Brahmachari, JF Marko, et al. Coarse-grained modelling of DNA plectoneme pinning in the presence of base-pair mismatches. **Nucl. Acids Res.** 48 (19), p10713-10725 (2020). doi.org/10.1093/nar/gkaa836
- [8] S Brahmachari and JF Marko. Chromosome disentanglement driven via optimal compaction of loop-extruded brush structures. **Proc. Natl. Acad. Sci. USA.** 116, p24956-24965 (2019). doi.org/10.1073/pnas.1906355116
- [9] S Brahmachari, A Dittmore, Y Takagi, et al. Defect-facilitated buckling in supercoiled double-helix DNA. **Phys. Rev. E** 97 (2), p022416 (2018). doi.org/10.1103/PhysRevE.97.022416
- [10] A Dittmore, S Brahmachari, Y. Takagi, J. F. Marko, and K. C. Neuman. Supercoiling locates mismatches. **Phys. Rev. Lett.** 119, 147801 (2017). doi.org/10.1103/PhysRevLett.119.147801
- [11] S Brahmachari*, KH Gunn*, RD Giuntoli, et al. Nucleation of multiple buckled structures in intertwined DNA double helices. **Phys. Rev. Lett.** 119, 188103 (2017). doi.org/10.1103/PhysRevLett.119.188103
- [12] S Brahmachari and JF Marko. Torque and buckling in stretched intertwined double-helix DNAs. **Phys. Rev. E** 95 (5), p052401 (2017). doi.org/10.1103/PhysRevE.95.052401
- [13] [Book chapter] S Brahmachari and JF Marko. DNA mechanics and topology. **Biomechanics in Oncology**, Advances in Experimental Medicine and Biology, vol 1092. p11-39 Springer, Cham. (2018). doi.org/10.1007/978-3-319-95294-9_2

MANUSCRIPTS IN PREPARATION

- [1] S Brahmachari, S Tripathi, JN Onuchic, H Levine. Regulation of chromatin transcription via DNA supercoiling. (2023)
- [2] S Brahmachari, AB Oliveira Jr., VG Contessoto, JN Onuchic. Bacterial chromosomes inferred from entropy maximization reveal structural nuances of chromosome segregation. (2023)

AWARDS AND FELLOWSHIPS

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| • Robert A. Welch Postdoctoral Fellow, Rice University | 2018-2022 |
| • Shirley Chan student travel grant sponsored by DBIO, APS | 2017 |
| • Molecular Biophysics Training Program Fellow, Northwestern University | 2014-2016 |
| • Innovation in Science Pursuit for Inspired Research (INSPIRE) scholarship, sponsored by the Department of Science and Technology, Government of India | 2008-2013 |

PROFESSIONAL SERVICE

- Proposed and co-organized a DBIO-sponsored focus session: DNA Mechanics and Gene Expression, at the American Physical Society March Meeting 2023. Also organizing the session in the 2024 meeting.
- Organized workshop on Quantitative Approaches to Modeling Biological Systems (January 2023) hosted by the Center for Theoretical Biological Physics, Rice University.
- Member of the American Physical Society (2017 to present).
- Peer-reviewed for PLOS One, iScience, Journal of Royal Society Interface, Clinical and Translational Medicine, and eLife.

TEACHING EXPERIENCE

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| 2023 | Mentoring Rice University graduate students Esteban Dodero-Rojas and Matheus F. Mello |
| 2022 | Mentored Rice University graduate student Esteban Dodero-Rojas |
| 2021 | Mentored Rice University graduate student Shubham Tripathi |

2020 Mentored Frontiers in Science Summer Internship student Kyle Lare
 2019 Mentored Rice University undergraduate student Benjamin Ruben
 2017 Teaching Assistant (Northwestern University) for Quantitative Biology (IBiS-410)
 2016 Teaching Assistant (Northwestern University) for Quantum Mechanics II (Phys 412-2)
 2015 Teaching Assistant (Northwestern University) for Quantum Mechanics III (Phys 412-3)
 2014 Teaching Assistant (Northwestern University) for General Physics Laboratory (Phys 136-1)

SELECTED PRESENTATIONS

2023 Invited talk at the International Plant and Animal Genome Conference, Perth, Australia (September)
 Invited talk at Indian Institute of Technology Bombay (IITB), Mumbai, India (September)
 Invited talk at Jawaharlal Nehru Center for Advanced Scientific Research, Bengaluru, India (Sep)
 Invited talk at International Center for Theoretical Sciences (ICTS), Bengaluru, India (September)
 Invited talk at National Center for Biological Sciences (NCBS), Bengaluru, India (September)
 Invited talk at the American Physical Society (APS) March Meeting, Las Vegas, US (March)
 2022 Contributed talk at the American Physical Society March Meeting, Chicago, US (March)
 2020 Contributed talk at the Genome Organization Workshop, held virtually at MIT, US (June)
 2019 Contributed talk at APS March meeting, Boston, US (March)
 Poster at Gordon Research Conference on Chromosome Dynamics, Newry, US (June)
 Poster at Genome Architecture Meeting, Varna, Bulgaria (July)
 2018 Contributed talk at the APS March meeting, Los Angeles, US (March)
 2017 Contributed talk at the APS March meeting, New Orleans, US (March)
 Poster at Chromosome segregation and structure meeting, Cold Spring Harbor Lab, US (June)