TSVI TLUSTY

CV and Publications 12/2024

Center for Soft and Living Matter, Institute for Basic Science, Ulsan National Institute of Science and Technology (UNIST), Ulsan, Korea
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— Current Position

2015– *Distinguished Professor of Physics*, Department of Physics, UNIST, Ulsan
2015– *Group Leader*, Center for Soft and Living Matter, Institute for Basic Science

— Education and Previous Employment

2011–2015 *Long-term Member*, Institute of Advanced Study, Princeton.
2005–2013 *Senior researcher*, Physics of Complex Systems, Weizmann Institute.
2000–2004 *Fellow*, Center for Physics and Biology, Rockefeller University, New York. Host: Prof. Albert Libchaber
1995–2000 *Ph.D. in Physic*s, Weizmann Institute, *Universality in Microemulsions*, Supervisor: Prof. Samuel A. Safran.
1991–1995 *M.Sc. in Physics*, Weizmann Institute.
1988–1990 *B.Sc. in Physics and Mathematics* (Talpyot), Hebrew University, Jerusalem.

— Service

Teaching

Landmark Experiments in Biology (2006); Statistical Physics (2007, 2017-20); Information in Biology (2012); Errors and Codes (IAS, 2012); Theory of Living Matter (2016); Special Topics in Soft Matter (2023-24).

Review Board, Editor

Swiss National Fund, SystemsX.ch – Systems Biology in Switzerland (2010-2020).
CRI – Centre de Recherches Interdisciplinaires, Paris (2010-).
PNAS – guest editor.

Organizing committees

Physics 2 Biology school, Weizmann Institute (2010).
Workshop on Physics of Active and Charged Matter, IBS Ulsan (2016).

— Students and post-doctoral fellows

John Mcbride (postdoc, 2018-)
Kisung Lee (postdoc, 2023-)
Himanshu Swami (postdoc, 2023-)
Somya Mani (postdoc, 2018-2024)
Tamoghna Das (postdoc, 2018-2023) postdoc KIAS
Ashwani Tripathi (postdoc, 2018-2023) postdoc Technion
William Pineros (postdoc, 2019-2022) postdoc U. Luxemburg
Guolong Zhu (postdoc, 2021- 2022) Prof. at Hunan U.

Sandipan Dutta (postdoc, 2016-2021), Prof. at BIRS Pileni
Vladimir Reinharz (postdoc, 2018-2020), Prof. at U. Montreal.
YongSeok Jho (research fellow, 2016-2017), Prof. at GyeongSang U.
Yoni Savir (Ph.D., 2005-2011) Prof. at Technion.
Adam Lampert (Ph.D., 2008-2012) Prof. at Hebrew U. Rehovot
Arbel Tadmor (M.Sc., 2006-2008) researcher at TRON.
Maria Rodriguez Martinez (Postdoc, 2007-2009), PI at IBM Zurich
Rami Pugatch (Potdoc, 2010-2013), Prof. at Ben-Gurion University.
Tamar Friedlander (Postdoc, 2009 -2012) Prof. at Hebrew University.

Collaborations

Albert Libchaber (Rockefeller University)
Stanislas Leibler (Rockefeller University and Institute for Advanced Study)
Jean-Pierre Eckmann (Geneva University)
Hyuk Kyu Pak (IBS center for soft and living matter)
G.V. Shivashankar (PSI and ETH Zurich)
Jordi Soriano-Fradera (Barcelona University)
Elisha Moses (Physics, Weizmann Inst.)
Uri Alon (Molecular Cell Biology, Weizmann Inst.)
Roy Bar-Ziv (Materials and Interfaces, Weizmann Inst.)
Ron Milo (Plant Biology, Weizmann Inst.)
Yoni Savir (Technion)

List of Publications

Published, in press

107. Weinreb EM, McBride JM, Siek M, Rougemont J, Renault R, Peleg Y, Unger T, Albeck S; Sussman JL, Grzybowski BA, Zocchi G, Eckmann, J-P, Moses, E, Tlusty T (2024) High-shear regions in an enzyme impact viscoelastic mechanics and activity. *Nature Physics - accepted*.

106. Libchaber A, Tlusty T (2024) Life sets off a cascade of machines. *Proc Nat Acad Sci USA – accepted.*

105. McBride JM & Tlusty T (2024) AI-Predicted Protein Deformation Encodes Energy Landscape Perturbation. *Physical Review Letters* 133, 098401.

104. McBride JM, Koshevarnikov A, Siek M, Grzybowski BA, & Tlusty T (2024) Statistical Survey of Chemical and Geometric Patterns on Protein Surfaces as a Blueprint for Protein-mimicking Nanoparticles. *Small Structures*. 2400086.

103. Eckmann J-P, Sobolev YI, & Tlusty T (2024) Tumbling Downhill Along a Given Curve. *Notices of American Mathematical Society* 71(6): 740-747.

102. McBride JM & Tlusty T (2024) The Physical Logic of Protein Machines. *J Stat Mech*. 2024(2):024001.

101. Zhu G, Gao L, Wang Y, Tlusty T, & Yan L-T (2024) Programmable Potentials Choreograph Defects in a Colloidal Crystal Shell. *Physical Review Letters* 132(4):048201.

100. McBride JM, Polev K, Abdirasulov A, Reinharz V, Grzybowski BA, & Tlusty T (2023) AlphaFold2 Can Predict Single-Mutation Effects. *Physical Review Letters* 131(21):218401.

99. Saeed I, Pak HK, & Tlusty T (2023) Quasiparticles, flat bands and the melting of hydrodynamic matter. *Nature Physics* 19(4):536-544.
98. Sobolev YI, Dong R, Tlusty T, Eckmann JP, Granick S, & Grzybowski BA (2023) Solid-body trajectoids shaped to roll along desired pathways. *Nature* 620(7973):310-315.
97. Paneru G, Tlusty T, & Pak HK (2023) Bona fide stochastic resonance under nonGaussian active fluctuations. *Soft Matter* 19(7):1356-1362.
96. Mani S & Tlusty T (2023) Gene birth in a model of non-genic adaptation. *BMC Biology* 21(1):257.
95. McBride JM, Passmore S, & Tlusty T (2023) Convergent evolution in a large cross-cultural database of musical scales. *PLOS ONE* 18(12):e0284851.
94. Tripathi AK & Tlusty T (2022) Gauging Nanoswimmer Dynamics via the Motion of Large Bodies. *Physical Review Letters* 129(25):254502.
93. Tripathi AK, Das T, Paneru G, Pak HK, & Tlusty T (2022) Acceleration of enzymatic catalysis by active hydrodynamic fluctuations. *Communications Physics* 5(1):101.
92. Pineros WD & Tlusty T (2022) Spontaneous chiral symmetry breaking in a random driven chemical system. *Nat Commun* 13(1):2244.
91. McBride JM, Eckmann JP, & Tlusty T (2022) General Theory of Specific Binding: Insights from a Genetic-Mechano-Chemical Protein Model. *Mol Biol Evol* 39(11).
90. Das T & Tlusty T (2022) Positional information as a universal predictor of freezing. *Europhysics Letters* 138(5):57001.
89. Tlusty T (2021) Exceptional topology in ordinary soft matter. *Physical Review E* 104(2):025002.
88. Piñeros WD & Tlusty T (2021) Inverse design of nonequilibrium steady states: A large-deviation approach. *Physical Review E* 103(2):022101.
87. McBride JM & Tlusty T (2021) Slowest-first protein translation scheme: Structural asymmetry and co-translational folding. *Biophysical Journal* 120(24):5466-5477.
86. Mani S & Tlusty T (2021) A topological look into the evolution of developmental programs. *Biophysical Journal* 120(19):4193-4201.
85. Mani S & Tlusty T (2021) A comprehensive survey of developmental programs reveals a dearth of tree-like lineage graphs and ubiquitous regeneration. *BMC Biology* 19(1):111.
84. Eckmann J-P & Tlusty T (2021) Dimensional reduction in complex living systems: Where, why, and how. *BioEssays* 43(9):2100062.
83. Wang H, Park M, Dong R, Kim J, Cho Y-K, Tlusty T, & Granick S (2020) Boosted molecular mobility during common chemical reactions. *Science* 369(6503):537-541.
82. Reinharz V & Tlusty T (2020) αβDCA method identifies unspecific binding but specific disruption of the group I intron by the StpA chaperone. *RNA* 26(11):1530-1540.
81. Piñeros WD & Tlusty T (2020) Kinetic proofreading and the limits of thermodynamic uncertainty. *Physical Review E* 101(2):022415.
80. Paneru G, Dutta S, Tlusty T, & Pak HK (2020) Reaching and violating thermodynamic uncertainty bounds in information engines. *Physical Review E* 102(3):032126.
79. Paneru G, Dutta S, Sagawa T, Tlusty T, & Pak HK (2020) Efficiency fluctuations and noise-induced refrigerator-to-heater transition in information engines. *Nature Communications* 11(1):1012.
78. Libchaber A & Tlusty T (2020) Walking droplets, swimming microbes: on memory in physics and life. *Comptes Rendus. Mécanique* 348(6-7):545-554.
77. Jee A-Y, Tlusty T, & Granick S (2020) Master curve of boosted diffusion for 10 catalytic enzymes. *Proc Nat Acad Sci USA* 117(47):29435-29441.

76. Ha MY, Yoon TJ, Tlusty T, Jho Y, & Lee WB (2020) Universality, Scaling, and Collapse in Supercritical Fluids. *J Phys Chem Lett* 11(2):451-455.
75. Jee A-Y, Chen K, Tlusty T, Zhao J, & Granick S (2019) Enhanced Diffusion and Oligomeric Enzyme Dissociation. *Journal of the American Chemical Society* 141(51):20062-20068.
74. Eckmann J-P, Rougemont J, & Tlusty T (2019) Colloquium: Proteins: The physics of amorphous evolving matter. *Reviews of Modern Physics* 91(3):031001.
73. Paneru G, Lee DY, Tlusty T, & Pak HK (2018) Lossless Brownian Information Engine. *Physical Review Letters* 120(2):020601.
72. Jee AY, Dutta S, Cho YK, Tlusty T, & Granick S (2018) Enzyme leaps fuel antichemotaxis. *Proc Nat Acad Sci USA* 115(1):14-18.
71. Jee AY, Cho YK, Granick S, & Tlusty T (2018) Catalytic enzymes are active matter. *Proc Nat Acad Sci USA* 115(46):E10812-E10821.
70. Ha MY, Yoon TJ, Tlusty T, Jho Y, & Lee WB (2018) Widom Delta of Supercritical Gas-Liquid Coexistence. *J Phys Chem Lett* 9(7):1734-1738.
69. Dutta S, Eckmann JP, Libchaber A, & Tlusty T (2018) Green function of correlated genes in a minimal mechanical model of protein evolution. *Proc Nat Acad Sci USA* 115(20):E4559-E4568.
68. Condon A, Kirchner H, Larivière D, Marshall W, Noireaux V, Tlusty T, & Fourmentin E (2018) Will biologists become computer scientists? *EMBO reports*.
67. Tlusty T, Libchaber A, & Eckmann JP (2017) Physical Model of the Genotype-to-Phenotype Map of Proteins. *Physical Review X* 7(2).
66. Beatus T, Shani I, Bar-Ziv RH, & Tlusty T (2017) Two-dimensional flow of driven particles: a microfluidic pathway to the nonequilibrium frontier. *Chemical Society Reviews*.
65. Tlusty T (2016) Self-referring DNA and protein: a remark on physical and geometrical aspects. *Philos T R Soc A* 374(2063).
64. Savir Y, Kagan J, & Tlusty T (2016) Binding of Transcription Factors Adapts to Resolve Information-Energy Tradeoff. *Journal of Statistical Physics* 162(5):1383-1394.
63. Mitchell MR, Tlusty T, & Leibler S (2016) Strain analysis of protein structures and low dimensionality of mechanical allosteric couplings. *Proc Nat Acad Sci USA* 113(40):E5847-E5855.
62. Lampert A & Tlusty T (2016) Where Two Are Fighting, the Third Wins: Stronger Selection Facilitates Greater Polymorphism in Traits Conferring Competition-Dispersal Tradeoffs. *Plos One* 11(2).
61. Friedlander T, Mayo AE, Tlusty T, & Alon U (2015) Mutation Rules and the Evolution of Sparseness and Modularity in Biological Systems (vol 8, e70444, 2013). *Plos One* 10(3).
60. Friedlander T, Mayo AE, Tlusty T, & Alon U (2015) Evolution of bow-tie architectures in biology. *PLoS Comput Biol* 11(3):e1004055.
59. Shani I, Beatus T, Bar-Ziv RH, & Tlusty T (2014) Long-range orientational order in two-dimensional microfluidic dipoles. *Nature Physics* 10(2):140-144.
58. Joseph C, Tseng CY, Zocchi G, & Tlusty T (2014) Asymmetric Effect of Mechanical Stress on the Forward and Reverse Reaction Catalyzed by an Enzyme. *Plos One* 9(7).
57. Savir Y & Tlusty T (2013) The Ribosome as an Optimal Decoder: A Lesson in Molecular Recognition. *Cell* 153(2):471-479.
56. Lampert A & Tlusty T (2013) Resonance-induced multimodal body-size distributions in ecosystems. *Proc Nat Acad Sci USA* 110(1):205-209.
55. Friedlander T, Mayo AE, Tlusty T, & Alon U (2013) Mutation Rules and the Evolution of Sparseness and Modularity in Biological Systems. *Plos One* 8(8).

54. Savir Y, Waysbort N, Antebi Y, Tlusty T, & Friedman N (2012) Balancing speed and accuracy of polyclonal T cell activation: a role for extracellular feedback. *BMC Systems Biology* 6(1):111.
53. Maeda YT, Tlusty T, & Libchaber A (2012) Effects of long DNA folding and small RNA stem-loop in thermophoresis. *Proc Nat Acad Sci USA* 109(44):17972-17977.
52. Levary D, Eckmann J-P, Moses E, & Tlusty T (2012) Loops and Self-Reference in the Construction of Dictionaries. *Physical Review X* 2(3):031018.
51. Iyer KV, Maharana S, Gupta S, Libchaber A, Tlusty T, & Shivashankar GV (2012) Modeling and Experimental Methods to Probe the Link between Global Transcription and Spatial Organization of Chromosomes. *Plos One* 7(10).
50. Beatus T, Bar-Ziv RH, & Tlusty T (2012) The physics of 2D microfluidic droplet ensembles. *Physics Reports* 516(3):103-145.
49. Lampert A & Tlusty T (2011) Density-Dependent Cooperation as a Mechanism for Persistence and Coexistence. *Evolution* 65(10):2750-2759.
48. Tlusty T (2010) A colorful origin for the genetic code: Information theory, statistical mechanics and the emergence of molecular codes. *Physics of Life Reviews* 7(3):362-376.
47. Savir Y & Tlusty T (2010) RecA-Mediated Homology Search as a Nearly Optimal Signal Detection System. *Molecular Cell* 40(3):388-396.
46. Savir Y, Noor E, Milo R, & Tlusty T (2010) Cross-species analysis traces adaptation of Rubisco toward optimality in a low-dimensional landscape. *Proc Nat Acad Sci USA* 107(8):3475-3480.
45. Rodríguez Martínez M, Soriano J, Tlusty T, Pilpel Y, & Furman I (2010) Messenger RNA fluctuations and regulatory RNAs shape the dynamics of a negative feedback loop. *Physical Review E* 81(3):031924.
44. Eckmann JP, Moses E, Stetter O, Tlusty T, & Zbinden C (2010) Leaders of neuronal cultures in a quorum percolation model. *Frontiers in Computational Neuroscience* 4.
43. Cohen O, Kesselman A, Soriano J, Moses E, & Tlusty T (2010) Quorum percolation in living neural networks. *EuroPhys Lett* 89(1):18008.
42. Tlusty T & Eckmann JP (2009) Remarks on bootstrap percolation in metric networks. *J Phys A* 42(20).
41. Tlusty T (2009) The physical language of molecular codes: A rate-distortion approach to the evolution and emergence of biological codes. *2009 43rd Annual Conference on Information Sciences and Systems*:841-846.
40. Savir Y & Tlusty T (2009) Molecular Recognition as an Information Channel: The Role of Conformational Changes. *2009 43rd Annual Conference on Information Sciences and Systems*, :835-840.
39. Lampert A & Tlusty T (2009) Mutability as an altruistic trait in finite asexual populations. *Journal of Theoretical Biology* 261(3):414-422.
38. Beatus T, Tlusty T, & Bar-Ziv R (2009) Burgers Shock Waves and Sound in a 2D Microfluidic Droplets Ensemble. *Physical Review Letters* 103(11).
37. Tlusty T (2008) Rate-distortion scenario for the emergence and evolution of noisy molecular codes. *Physical Review Letters* 100(4).
36. Tlusty T (2008) A simple model for the evolution of molecular codes driven by the interplay of accuracy, diversity and cost. *Physical Biology* 5(1).
35. Tlusty T (2008) Casting polymer nets to optimize noisy molecular codes. *Proc Nat Acad Sci USA* 105(24):8238-8243.
34. Tadmor AD & Tlusty T (2008) A coarse-grained biophysical model of E. coli and its application to perturbation of the rRNA operon copy number. *PLoS Comp Bio* 4(5).

33. Soriano J, Martinez MR, Tlusty T, & Moses E (2008) Development of input connections in neural cultures. *Proc Nat Acad Sci USA* 105(37):13758-13763.
32. Savir Y & Tlusty T (2008) Optimal Design of a Molecular Recognizer: Molecular Recognition as a Bayesian Signal Detection Problem. *IEEE J Select Topics Sign Proc* 2(3):390-399.
31. Beatus T, Bar-Ziv R, & Tlusty T (2008) One-Dimensional Microfluidic Crystals Far from Equilibrium - Acoustic Phonons, Instabilities and Confinement. *Progress of Theoretical Physics Supplement* (175):123-130.
30. Tlusty T (2007) A relation between the multiplicity of the second eigenvalue of a graph Laplacian, Courant's nodal line theorem and the substantial dimension of tight polyhedral surfaces. *Electron J Linear Al* 16:315-324.
29. Tlusty T (2007) A model for the emergence of the genetic code as a transition in a noisy information channel. *Journal of Theoretical Biology* 249(2):331-342.
28. Soriano J, Breskin I, Moses E, & Tlusty T (2007) Percolation approach to study connectivity living neural networks. *Aip Conf Proc* 887:96-106.
27. Savir Y & Tlusty T (2007) Conformational Proofreading: The Impact of Conformational Changes on the Specificity of Molecular Recognition. *Plos One* 2(5).
26. Eckmann J-P, Feinerman O, Gruendlinger L, Moses E, Soriano J, & Tlusty T (2007) The physics of living neural networks. *Physics Reports* 449(1-3):54-76.
25. Beatus T, Bar-Ziv R, & Tlusty T (2007) Anomalous microfluidic phonons induced by the interplay of hydrodynamic screening and incompressibility. *Physical Review Letters* 99(12).
24. Tlusty T (2006) Screening by symmetry of long-range hydrodynamic interactions of polymers confined in sheets. *Macromolecules* 39(11):3927-3930.
23. Shinar G, Dekel E, Tlusty T, & Alon U (2006) Rules for biological regulation based on error minimization. *Proc Nat Acad Sci USA* 103(11):3999-4004.
22. Sagi D, Tlusty T, & Stavans J (2006) High fidelity of RecA-catalyzed recombination: a watchdog of genetic diversity. *Nucleic Acids Research* 34(18):5021-5031.
21. Itzkovitz S, Tlusty T, & Alon U (2006) Coding limits on the number of transcription factors. *Bmc Genomics* 7.
20. Breskin I, Soriano J, Moses E, & Tlusty T (2006) Percolation in living neural networks. *Physical Review Letters* 97(18).
19. Beatus T, Tlusty T, & Bar-Ziv R (2006) Phonons in a one-dimensional microfluidic crystal. *Nature Physics* 2(11):743-748.
18. Safran SA, Gov N, Nicolas A, Schwarz US, & Tlusty T (2005) Physics of cell elasticity, shape and adhesion. *Physica A* 352(1):171-201.
17. Biron D, Alvarez-Lacalle E, Tlusty T, & Moses E (2005) Molecular model of the contractile ring. *Physical Review Letters* 95(9).
16. Tlusty T, Bar-Ziv R, & Libchaber A (2004) High-fidelity DNA sensing by protein binding fluctuations. *Physical Review Letters* 93(25).
15. Zilman A, Tlusty T, & Safran SA (2003) Entropic networks in colloidal, polymeric and amphiphilic systems. *J Phys-Condens Mat* 15(1):S57-S64.
14. Bar-Ziv R, Tlusty T, & Libchaber A (2002) Protein-DNA computation by stochastic assembly cascade. *Proc Nat Acad Sci USA* 99(18):11589-11592.
13. Tlusty T & Safran SA (2001) Entropic networks in colloidal self-assembly. *Philos T Roy Soc A* 359(1782):879-881.
12. Tlusty T, Safran SA, & Strey R (2000) Topology, phase instabilities, and wetting of microemulsion networks. *Physical Review Letters* 84(6):1244-1247.

11. Tlusty T & Safran SA (2000) Microemulsion networks: the onset of bicontinuity. *J Phys-Condens Mat* 12(8A):A253-A262.
10. Tlusty T & Safran SA (2000) Defect-induced phase separation in dipolar fluids. *Science* 290(5495):1328-1331.
9. Bernheim-Groswasser A, Tlusty T, Safran SA, & Talmon Y (1999) Direct observation of phase separation in microemulsion networks. *Langmuir* 15(17):5448-5453.
8. Bar-Ziv R, Tlusty T, Moses E, Safran SA, & Bershadsky A (1999) Pearling in cells: A clue to understanding cell shape. *Proc Nat Acad Sci USA* 96(18):10140-10145.
7. Tlusty T, Meller A, & Bar-Ziv R (1998) Optical gradient forces of strongly localized fields. *Physical Review Letters* 81(8):1738-1741.
6. Meller A, Bar-Ziv R, Tlusty T, Moses E, Stavans J, & Safran SA (1998) Localized dynamic light scattering: A new approach to dynamic measurements in optical microscopy. *Biophysical Journal* 74(3):1541-1548.
5. Tlusty T, Safran SA, Menes R, & Strey R (1997) Scaling laws for microemulsions governed by spontaneous curvature. *Physical Review Letters* 78(13):2616-2619.
4. BarZiv R, Meller A, Tlusty T, Moses E, Stavans J, & Safran SA (1997) Localized dynamic light scattering: Probing single particle dynamics at the nanoscale. *Physical Review Letters* 78(1):154-157.
3. Bar-Ziv R, Tlusty T, & Moses E (1997) Critical dynamics in the pearling instability of membranes. *Physical Review Letters* 79(6):1158-1161.
2. Safran SA & Tlusty T (1996) Curvature elasticity models of microemulsions. *Ber Bunsen Phys Chem* 100(3):252-263.
1. Tlusty T & Berger J (1992) A Simple Maximization Technique for Statistical-Mechanics Expressions. *American Journal of Physics* 60(4):379-380.

In review, preprints

108. Landy J, Tlusty T, Lee Y, & Jho Y (2023) Renormalization Group-Motivated Learning. *arXiv:2307.08936*.
109. McBride JM, Phillips E, Savage PE, Brown S, Tlusty T (2024) Melody predominates over harmony in the evolution of musical scales across 96 countries. *arXiv:2408.12633 – in review Nature Human Behavior.*
110. McBride JM, Kim N, Nishikawa Y, Saadakeev M, Pearce MT, Tlusty T (2024) Information and motor constraints shape melodic diversity across cultures. *arXiv:2408.12635 in review.*
111. Mani S, Tlusty T (2024) Spatial model of cell-fate choice uncovers strong links between tissue morphology and tissue regeneration. *bioRxiv: 2024.2008.2025.609579.*