

TSVI TLUSTY

CV and Publications 07/2024

Center for Soft and Living Matter, Institute for Basic Science, Ulsan National Institute of Science and Technology (UNIST), Ulsan, Korea
tsvitlusty@gmail.com sns.ias.edu/~tlusty

— 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 Physics*, 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-)
Somya Mani (postdoc, 2018-)
Kisung Lee (postdoc, 2023-)
Himanshu Swami (postdoc, 2023-)
Tamoghna Das (postdoc, 2018-2023) postdoc KIAS
Ashwani Tripathi (postdoc, 2018-2023) postdoc Technion
William Pinos (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

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, Plev 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. Piñeros 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) $\alpha\beta$ DCA 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

106. Landy J, Tlusty T, Lee Y, & Jho Y (2023) Renormalization Group-Motivated Learning. *arXiv:2307.08936*.
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 (2023) High-shear regions in an enzyme impact viscoelastic mechanics and activity. *in review - Nature Physics*.
108. 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*.
109. 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*.
110. 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*.
111. Libchaber A, Tlusty T (2024) Life set off a cascade of machines. *in review*.