

# GASPER TKAČIK

---

ADDRESS	IST Austria	E-MAIL	gtkacik@ist.ac.at
	Am Campus 1	WEB	<a href="http://gtkacik.pages.ist.ac.at">http://gtkacik.pages.ist.ac.at</a>
	A-3400 Klosterneuburg	PHONE	+43 (0) 2243 9000 4501
	Austria, EU	FAX	+43 (0) 2243 9000 4501

DATE OF BIRTH 24<sup>th</sup> May 1979 (Ljubljana, Slovenija)  
NATIONALITY Slovenija, EU  
LANGUAGES Slovene (native), English (fluent), German (intermediate)

## POSITIONS

---

2019 **Visiting Faculty (May–August), Princeton, CUNY, Rockefeller U.**  
2017– **Professor, Institute of Science and Technology Austria**  
2011–2016 **Assistant Professor, Institute of Science and Technology Austria**

## ACADEMIC EDUCATION

---

2008–2010 **Postdoctoral Research Associate, University of Pennsylvania**  
Advisors: Vijay Balasubramanian, Phil Nelson  
2007 **Postdoctoral Research Associate, Princeton University**  
2002–2007 **Ph.D. in Physics, Princeton University**  
Advisors: William Bialek, Curtis G. Callan Jr.  
2001–2002 **Graduate Research Fellow**  
Faculty of Mathematics and Physics, University of Ljubljana  
1997–2001 **BSc. Mathematical Physics, University of Ljubljana**

## PROFESSIONAL

---

- **Main areas of research:** gene regulation, biophysics, computational neuroscience, neural coding, information theory, natural scene statistics, collective behavior, evolution
- **Professional activities:** Reviewer for *PNAS*, *Phys Rev Lett*, *Science*, *PLOS*, *Nature Physics*, *Nature Comms*, etc.; organizer of *Sensory Coding & Natural Environment 2012* and *Information, Probability and Inference in Systems Biology 2016* at IST Austria
- **International collaborations (last 5 years):** *Jonathan Victor* (Weill Cornell Medical College), *Thomas Gregor*, *William Bialek*, *Michael Berry 2nd* (Princeton University), *Elad Schneidman* (Weizmann Institute), *Vijay Balasubramanian* (University of Pennsylvania), *Aleksandra Walczak*, *Thierry Mora* (ENS Paris), *Olivier Marre* (Vision Institute, Paris), *Ulrich Gerland* (TU Munich, Germany), *Roozbeh Kiani* (NYU).

## GRANTS

---

- 2018–2021 **HFSP Program Grant** RGP0034/2018, \$350,000  
PIs: TKAČIK, Christian LANDRY (Laval University), Judit VILLEN (U Washington).  
Title: *Can evolution minimize spurious signaling crosstalk to reach optimal performance*
- 2016–2017 **Internal IST Interdisciplinary Project funding**, €70,000  
PIs: TKAČIK, Calin GUET  
Title: *Are gene regulatory networks predictable from their constituent parts*
- 2016–2019 **FWF (Austrian Science Fund) Stand Alone project** P28844, €340,547  
PI: TKAČIK  
Title: *Biophysics of information processing in gene regulation*
- 2013–2017 **FWF (Austrian Science Fund) Stand Alone project** P25651, €351,362  
PI: TKAČIK  
Title: *Sensitivity to higher-order statistics in natural scenes*
- 2012–2016 **HFSP Program Grant** RGP0065/2012, \$350,000  
PIs: TKAČIK, Elad SCHNEIDMAN (Weizmann Institute), Iain COUZIN (MPI Constanz).  
Title: *Information processing and computation in fish groups*

PUBLICATIONS (PREPRINTS IN GREY, REFEREED PUBLICATIONS IN BLACK)

---

- [1] Bialek W, Gregor T, Tkačik G, **Action at a distance in transcriptional regulation.** *arxiv.org*: 1912.08579 (2019).
- [2] Młynarski W, Hledik M, Sokolowski TR, Tkačik G, **Statistical analysis and optimality in biological systems.** *bioRxiv.org*: 848374 (2019).
- [3] Kačič B, Tkačik G, Bollenbach T, **Mechanistic origin of drug interactions between translation-inhibiting antibiotics.** *bioRxiv.org*: 843920 (2019).
- [4] Chalk M, Tkačik G, Marre O, **Inferring the function performed by a recurrent neural network** *bioRxiv.org*: 598086 (2019).
- [5] Maoz O, Esteki MS, Tkačik G, Kiani R, Schneidman E, **Learning probabilistic representations with randomly connected neural circuits** *bioRxiv.org*: 478545 (2018).
- [6] Berry MJ 2nd, Tkačik G, **Clustering of neural activity: a design principle for population codes.** *Frontiers Comput Neurosci*, in press (2020).
- [7] Tomanek I<sup>≠</sup>, Grah R<sup>≠</sup>, Lagator M, Andersson AMC, Bollback JP, Tkačik G, Guet CC, **Gene amplification as a form of population-level gene expression regulation.** *Nat Ecol Evol*, in press (2020).
- [8] Cepeda-Humerez SA, Ruess J, Tkačik G, **Estimating information in time-varying signals.** *PLOS Comput Biol* **15**: e1007290 (2019).
- [9] Hledik M, Sokolowski TR, Tkačik G, **A tight upper bound on mutual information.** *arxiv.org*: 1812.01475 (2018), *IEEE ITW* (2019).
- [10] Ruess J, Pleska M, Guet CC, Tkačik G, **Molecular noise shapes bacteria-phage ecologies.** *PLOS Comput Biol*, **15**: e1007168 (2019).
- [11] Petkova M\*, Tkačik G\*, Bialek W, Wieschaus EF, Gregor T, **Optimal decoding of cellular identities in a genetic network.** *Cell* **176**: 844–855 (2019).
- [12] Iglér C, Lagator M, Tkačik G, Bollback JP, Guet CC, **Evolutionary potential of transcription factors for gene regulatory rewiring.** *Nat Ecol Evol* **2**: 1633–1643 (2018).
- [13] De Martino D, Andersson AMC, Bergmiller T, Guet CC, Tkačik G, **Statistical mechanics for metabolic networks during steady-state growth.** *Nature Comms* **9**: 2988 (2018).
- [14] Ferrari U, Deny S, Chalk M, Tkačik G, Marre O, Mora T, **Population model learned on different stimulus ensembles predicts network responses in the retina.** *Phys Rev E* **98**: 042410 (2018).
- [15] Granados AA, Pietsch JM, Cepeda-Humerez SA, Farquhar IL, Tkačik G, Swain PS, **Distributed and dynamic intracellular organization of extracellular information.** *Proc Nat'l Acad Sci USA* **115**: 6088–6093 (2018).
- [16] Chalk M, Marre O, Tkačik G, **Towards a unified theory of efficient, predictive, and sparse coding.** *Proc Nat'l Acad Sci USA* **115**: 181–191 (2018).
- [17] Botella-Soler V, Deny S, Martius G, Marre O, Tkačik G, **Nonlinear decoding of a complex movie from the mammalian retina.** *PLOS Comput Biol* **14**: e1006057 (2018).
- [18] Savin C, Tkačik G, **Maximum entropy models as a tool for building precise neural controls.** *Curr Opin Neurosci* **46**: 120–126 (2017).
- [19] Chait R\*, Ruess J\*, Bergmiller T, Tkačik G, Guet CC, **Shaping bacterial population behavior through computer-interfaced control of individual cells.** *Nature Comms* **8**: 1535 (2017).
- [20] Harpaz R, Tkačik G, Schneidman E, **Discrete modes of social information processing predict individual behavior of fish in a group.** *Proc Nat'l Acad Sci USA* **114**: 10149–10154 (2017).
- [21] Deny S, Ferrari U, Mace E, Yger P, Caplette R, Picaud S, Tkačik G, Marre O, **Multiplexed computations in retinal ganglion cells of a single type.** *Nature Comms* **8**: 1964 (2017).
- [22] Humplik J, Tkačik G, **Probabilistic models for neural populations that naturally capture global coupling and criticality.** *PLOS Comput Biol* **13**: e1005763 (2017).

- [23] Friedlander T\*, Prizak R\*, Barton NH, Tkačik G, **Evolution of new regulatory functions on biophysically realistic fitness landscapes.** *Nature Comms* **8**: 216 (2017).
- [24] Zagorski M, Tabata Y, Brandenberg N, Lutolf M, Tkačik G, Bollenbach T, Briscoe J, Kicheva A, **Decoding of position in the developing neural tube from antiparallel morphogen gradients.** *Science* **356**: 1379–1383 (2017).
- [25] Bergmiller T\*, Andersson AMC\*, Tomasek K, Balleza E, Kiviet DJ, Hauschild R, Tkačik G, Guet CC, **Biased partitioning of the multi-drug efflux pump AcrAB-TolC underlies long-lived phenotypic heterogeneity.** *Science* **356**: 311–315 (2017).
- [26] Prentice JS, Marre O, Ioffe M, Loback AR, Tkačik G, Berry MJ 2nd, **Error-robust modes of the retinal population code.** *PLOS Comput Biol* **12**: e1005148 (2016).
- [27] Savin C, Tkačik G, **Estimating nonlinear neural response functions using GP priors and Kronecker methods.** *Adv Neural Info Proc Syst* **29** (2016).
- [28] Chalk M, Marre O, Tkačik G, **Relevant sparse codes with variational information bottleneck.** *Adv Neural Info Proc Syst* **29** (2016).
- [29] Hillenbrand P, Gerland U, Tkačik G, **Beyond the French Flag model: Exploiting spatial and gene regulatory interactions for positional information.** *PLOS One* **11**: e0163628 (2016).
- [30] Friedlander T, Roshan P, Guet CG, Barton NH, Tkačik G, **Intrinsic limits to gene regulation by global crosstalk.** *Nature Comms* **7**: 12307 (2016).
- [31] Bodova K, Tkačik G, Barton NH, **A general approximation for the dynamics of quantitative traits.** *Genetics* **202**: 1523–1548 (2016).
- [32] Tkačik G, Bialek W, **Information processing in biological systems.** *Annu Rev Cond Matt Phys* **7**: 89–117 (2016).
- [33] Sokolowski TR, Walczak AM, Bialek W, Tkačik G, **Extending the dynamic range of transcription factor action by translational regulation.** *Phys Rev E* **93**: 022404 (2016)
- [34] Cepeda-Humerez SA, Riech G, Tkačik G, **Stochastic proofreading mechanism alleviates crosstalk in transcriptional regulation.** *Phys Rev Lett* **115**: 248101 (2015).
- [35] Tugrul M, Paixao T, Barton NH, Tkačik G, **Dynamics of transcription binding site evolution.** *PLOS Genet* **11**: e1005639 (2015).
- [36] Tkačik G, Mora T, Marre O, Amodei D, Berry MJ 2nd, Bialek W, **Thermodynamics for a network of neurons: Signatures of criticality.** *Proc Nat'l Acad Sci USA* **112**: 11508 (2015).
- [37] Marre O, Botella-Soler V, Simmons KD, Mora T, Tkačik G, Berry MJ 2nd, **High accuracy decoding of dynamical motion from a large retinal population.** *PLOS Comput Biol* **11**: e1004304 (2015).
- [38] Tkačik G, Dubuis JO, Petkova MD, Gregor T, **Positional information, positional error, and read-out precision in morphogenesis: a mathematical framework.** *Genetics* **199**: 39–59 (2015).
- [39] Sokolowski TR, Tkačik G, **Optimizing information flow in small genetic networks. IV. Spatial coupling.** *Phys Rev E* **91**: 062710 (2015).
- [40] Hermundstad AM, Briguglio JJ, Conte MM, Victor JD, Balasubramanian V, Tkačik G, **Variance predicts salience in central sensory processing.** *eLife* **10.7554** (2014).
- [41] Riech G, Tkačik G, **Noise and information transmission in promoters with multiple internal states.** *Biophys J* **106**: 1194–1204 (2014).
- [42] Tkačik G, Marre O, Amodei D, Schneidman E, Bialek W, Berrry MJ 2nd, **Searching for collective behavior in a large network of sensory neurons.** *PLOS Comput Biol* **10**: e1003408 (2014).
- [43] Tkačik G, Ghosh A, Schneidman E, Segev R, **Adaptation to changes in higher-order stimulus statistics in the salamander retina.** *PLOS ONE* **9**: e85841 (2014).
- [44] Dubuis JO<sup>=</sup>, Tkačik G<sup>=</sup>, Wieschaus EF, Gregor T, Bialek W, **Positional information, in bits.** *Proc Nat'l Acad Sci USA* **110**: 16301–16308 (2013)
- [45] Simmons KD, Prentice JS, Tkačik G, Homann J, Yee HK, Palmer SE, Nelson PC, Balasubramanian V, **Transformation of stimulus correlations by the retina.** *PLOS Comput Biol* **9**: e1003344 (2013).

- [46] Granot-Atedgi E<sup>=</sup>, Tkačik G<sup>=</sup>, Segev R, Schneidman E, **Stimulus-dependent maximum entropy models of neural population codes.** *PLoS Comput Biol* **9**: e1002922 (2013).
- [47] Tkačik G, Marre O, Mora T, Amodei D, Berry MJ 2nd, Bialek W, **The simplest maximum entropy model for collective behavior in a neural network.** *J Stat Mech*: P03011 (2013).
- [48] Berry MJ 2nd, Tkačik G, Dubuis J, Marre O, Azerado da Silveira R, **A simple method for estimating the entropy of neural activity.** *J Stat Mech*: P03015 (2013).
- [49] Tkačik G, Granot-Atedgi E, Segev R, Schneidman E, **Retinal metric: a stimulus distance measure derived from population neural responses.** *Phys Rev Lett* **110**: 058104 (2013).
- [50] Stephens GJ, Mora T, Tkačik G, Bialek W, **Statistical thermodynamics of natural images.** *Phys Rev Lett* **110**: 018701 (2013).
- [51] Rajan K, Marre O, Tkačik G, **Learning quadratic receptive fields from neural responses to natural stimuli.** *Neural Comput* **25**: 1661–1692 (2013).
- [52] Tkačik G, Walczak AM, Bialek W, **Optimizing information flow in small genetic networks. III. A self-interacting gene.** *Phys Rev E* **85**: 041903 (2012).
- [53] Little SC<sup>=</sup>, Tkačik G<sup>=</sup>, Kneeland TB, Wieschaus EF, Gregor T, **The formation of the Bicoid morphogen gradient requires protein movement from anteriorly localized source.** *PLoS Biology* **9**: e1000596 (2011).
- [54] Tkačik G, Garrigan P, Ratliff C, Milčinski G, Klein JM, Seyfarth LH, Sterling P, Brainard D, Balasubramanian V, **Natural images from the birthplace of the human eye.** *PLoS One* **6**: e20409 (2011).
- [55] Walczak AM, Tkačik G, **Information transmission in genetic regulatory networks: a review.** *J Phys Condens Matt* **23**: 153102 (2011).
- [56] Prentice JS, Homann J, Simmons KD, Tkačik G, Balasubramanian V, Nelson PC, **Fast, scalable, Bayesian spike identification for multi-electrode arrays.** *PLoS One* **6**: e19884 (2011).
- [57] Tkačik G, Prentice JS, Victor JD, Balasubramanian V, **Local statistics in natural scenes predict the saliency of synthetic textures.** *Proc Nat'l Acad Sci USA* **107**: 18149–54 (2010).
- [58] Tkačik G, Prentice JS, Balasubramanian V, Schneidman E, **Optimal population coding by noisy spiking neurons.** *Proc Nat'l Acad Sci USA* **107**: 14419–14424 (2010).
- [59] Walczak A, Tkačik G, Bialek W, **Optimizing information flow in small genetic networks. II. Feed-forward interactions.** *Phys Rev E* **81**: 041905 (2010).
- [60] Kryazhinskiy S<sup>=</sup>, Tkačik G<sup>=</sup>, Plotkin JB, **The dynamics of adaptation on correlated fitness landscapes.** *Proc Nat'l Acad Sci USA* **106**: 18638–43 (2009).
- [61] Tkačik G, Walczak AM, Bialek W, **Optimizing information flow in small genetic networks.** *Phys Rev E* **80**: 031920 (2009).
- [62] Tkačik G, Callan CG Jr, Bialek W, **Information flow and optimization in transcriptional regulation.** *Proc Nat'l Acad Sci USA* **105**: 12265–12270 (2008).
- [63] Tkačik G, Callan CG Jr, Bialek W, **Information capacity of genetic regulatory elements.** *Phys Rev E* **78**: 011910 (2008).
- [64] Tkačik G, Bialek W, **Diffusion, dimensionality and noise in transcriptional regulation.** *Phys Rev E* **79**: 051901 (2009).
- [65] Tkačik G, Gregor T, Bialek W, **The role of input noise in transcriptional regulation.** *PLoS ONE* **3**: e2774 (2008).
- [66] Tkačik G, Magnasco MO, **Decoding spike timing: the differential reverse correlation method.** *Biosystems* **93**: 90–100 (2008).
- [67] Kinney JB, Tkačik G, Callan CG Jr, **Precise physical models of protein-DNA interaction from high-throughput data.** *Proc Nat'l Acad Sci USA* **104**: 501–506 (2007).
- [68] Slonim N, Atwal GS, Tkačik G, Bialek W, **Information-based clustering.** *Proc Nat'l Acad Sci USA* **102**: 18297 (2005).