

Oleg A. Igoshin

Email: igoshin@rice.edu

Phone: 1(713)348-5502

Research Interests:

- **Computational system biology of signaling and genetic networks:** Evolutionary design principles of bacterial signaling networks; Bacterial development; Noise and population heterogeneity; Host-pathogen interaction during tuberculosis infection; Hematopoietic stem cells' gene regulatory networks; phenotypic switching networks in cancer; Dynamic-disorder effect on the network kinetics
- **Biophysical modeling of microbiological systems:** Pattern formation in bacterial populations, microbial biofilms, Bacterial gliding motility

Positions:**Dates:**

- Associate Professor, Department of Bioengineering, Rice University 07/13 -present
- Assistant Professor, Department of Bioengineering, Rice University 01/07 – 06/13
- Adjunct Faculty, UT Graduate School of Biomedical Sciences 11/07 - present
- Adjunct Faculty, Dept Of Systems Biology, MD Anderson 09/11 - present
- Postdoctoral Researcher, Department of Biomedical Engineering, UC Davis
Advisor: Prof. Michael Savageau 10/04 -12/06
Research Project: Signaling Pathways in *Bacillus Subtilis*

Education:

- PhD in Physics, Department of Physics, UC Berkeley 08/00 -08/04
Advisor: Prof. George Oster, Dept. Molecular and Cell Biology
Thesis committee: Carlos Bustamante, John Neu, Donald Glaser
Thesis topic: *Modeling of pattern formation in Myxobacteria*
- MSc, Chemical Physics Department, Feinberg Graduate School, Weizmann Institute of Science, Israel, 10/98-07/00
Advisor: Prof. A. I. Burshtein,
Thesis topic: *Diffusion-assisted electron and energy transfer*
- BSc *Summa Cum Laude*, Physics Department, Novosibirsk State University, Russia 09/94-06/98
Advisors: Prof. A.B. Doktorov, Dr. A.A. Kipiyanov
Thesis topic: *Nonequilibrium statistical mechanics of chemical reactions*

Honors and awards:

- Institute of Engineering and Technology (IET) Premium Award in Systems Biology 11/2011
- John C Dunn Foundation Collaborative Research Award 09/2009
- NSF CAREER Award 02/2009
- HHMI Predoctoral fellowship award 2001-2004
- Regents fellowship, UC Berkeley 2000-2001

List of publications (papers):h-index =18(Google Scholar)

1. Burshtein, A.I., Igoshin, O.A. *Photoconductivity and singlet oxygen generation in illuminated polymer in the air atmosphere*. Journal of Chemical Physics (1999) **111**: 2200-2209.
2. Krissinel, E.B., Igoshin, O.A., Burshtein, A.I. *Integral, unified and Markovian theories of biexcitonic photoionization*. Chemical Physics (1999) **247**: 261-273.
3. Igoshin, O.A., Kipriyanov, A.A., Doktorov, A.B. *Many-particle treatment of nonuniform reacting systems $A+B \rightarrow C$ and $A+B \rightarrow C+D$ in liquid solutions*. Chemical Physics (1999) **244**: 371-385.
4. Kipriyanov, A.A., Igoshin, O.A., Doktorov, A.B. *A new approach to the derivation of binary non-Markovian kinetic equations*. Physica A (1999) **268**: 567-606.
5. Igoshin, O.A., Burshtein, A.I. *Quenching of fluorescence by irreversible energy transfer at arbitrary strong pumping light*. Journal of Luminescence (2000) **92**: 123-132.
6. Frantsuzov, P.A., Igoshin, O.A., Krissinel, E.B. *Differential approach to the memory-function reaction kinetics*. Chemical Physics Letters (2000) **317**: 481-489.
7. Kipriyanov, A.A., Igoshin, O.A., Doktorov, A.B. *The effect of chemical displacement of B species in the reaction $A + B \rightarrow B$* . Physica A (2000) **275**: 99-133.
8. Igoshin, O.A., Burshtein, A.I. *Impurity quenching of fluorescence in intense light. Violation of the Stern-Volmer law*. Journal of Chemical Physics (2000) **112**: 10930-10940.
9. Igoshin, O.A., Mogilner, A., Welch, R.D., Kaiser, D., Oster, G. *Pattern formation and traveling waves in myxobacteria: theory and modeling*. Proc Natl Acad Sci U S A (2001) **98**: 14913-14918.
10. Lukzen, N.N., Krissinel, E.B., Igoshin, O.A., Burshtein, A.I. *Instantaneous and permanent photoionization*. Journal of Physical Chemistry A (2001) **105**: 19-28.
11. Wolgemuth, C.W., Igoshin, O., Oster, G. *The motility of mollicutes*. Biophys J (2003) **85**: 828-842.
12. Igoshin, O.A., Kaiser, D., Oster, G. *Breaking symmetry in myxobacteria*. Curr Biol (2004) **14**: R459-462.
13. Igoshin, O.A., Oster, G. *Rippling of myxobacteria*. Math Biosci (2004) **188**: 221-233.
14. Igoshin, O.A., Welch, R., Kaiser, D., Oster, G. *Waves and aggregation patterns in myxobacteria*. Proc Natl Acad Sci U S A (2004) **101**: 4256-4261.
15. Igoshin, O.A., Goldbeter, A., Kaiser, D., Oster, G. *A biochemical oscillator explains several aspects of Myxococcus xanthus behavior during development*. Proc Natl Acad Sci U S A (2004) **101**: 15760-15765.
16. Igoshin, O.A., Neu, J., Oster, G. *Developmental waves in myxobacteria: A distinctive pattern formation mechanism*. Phys Rev E Stat Nonlin Soft Matter Phys (2004) **70**: 041911.
17. Igoshin, O.A., Price, C.W., Savageau, M.A. *Signalling network with a bistable hysteretic switch controls developmental activation of the sigma transcription factor in Bacillus subtilis*. Mol Microbiol (2006) **61**: 165-184.
18. Igoshin, O.A., Brody, M.S., Price, C.W., Savageau, M.A. *Distinctive topologies of partner-switching signaling networks correlate with their physiological roles*. J Mol Biol (2007) **369**: 1333-1352.
19. Veening, J.W., Igoshin, O.A., Eijlander, R.T., Nijland, R., Hamoen, L.W., Kuipers, O.P. *Transient heterogeneity in extracellular protease production by Bacillus subtilis*. Mol Syst

- Biol (2008) **4**: 184.
20. Igoshin, O.A., Alves, R., Savageau, M.A. *Hysteretic and graded responses in bacterial two-component signal transduction*. Mol Microbiol (2008) **68**: 1196-1215.
 21. Chaudhury, S., Igoshin, O.A. *Dynamic Disorder-Driven Substrate Inhibition and Bistability in a Simple Enzymatic Reaction*. Journal of Physical Chemistry B (2009) **113**: 13421-13428.
 22. Tiwari, A., Balazsi, G., Gennaro, M.L., Igoshin, O.A. *The interplay of multiple feedback loops with post-translational kinetics results in bistability of mycobacterial stress response*. Phys Biol (2010) **7**: 036005.
 23. Eswaramoorthy, P., Dinh, J., Duan, D., Igoshin, O.A., Fujita, M. *Single-cell measurement of the levels and distributions of the phosphorelay components in a population of sporulating Bacillus subtilis cells*. Microbiology (2010) **156**: 2294-2304.
 24. Chaudhury, S., Igoshin, O.A. *Dynamic Disorder in Quasi-Equilibrium Enzymatic Systems*. PLoS One (2010) **5**: e12364.
 25. Ray, J.C., Igoshin, O.A. *Adaptable functionality of transcriptional feedback in bacterial two-component systems*. PLoS Comput Biol (2010) **6**: e1000676.
 26. Narula, J., Smith, A.M., Gottgens, B., Igoshin, O.A. *Modeling reveals bistability and low-pass filtering in the network module determining blood stem cell fate*. PLoS Comput Biol (2010) **6**: e1000771.
 27. Narula, J., Igoshin, O.A. *Thermodynamic models of combinatorial gene regulation by distant enhancers*. IET Syst Biol (2010) **4**: 393-408.
 28. Xie, C.Y., Zhang, H., Shimkets, L.J., Igoshin, O.A. *Statistical image analysis reveals features affecting fates of Myxococcus xanthus developmental aggregates*. Proc Natl Acad Sci U S A (2011) **108**: 5915-5920.
 29. Tiwari, A., Ray, J.C., Narula, J., Igoshin, O.A. *Bistable responses in bacterial genetic networks: designs and dynamical consequences*. Math Biosci (2011) **231**: 76-89.
 30. Ray, J.C.J., Tabor, J.J., Igoshin, O.A. *Non-transcriptional regulatory processes shape transcriptional network dynamics*. Nature Reviews Microbiology (2011) **9**: 817-828.
 31. Zhang, H.Y., Angus, S., Tran, M., Xie, C.Y., Igoshin†, O.A., Welch†, R.D. *Quantifying Aggregation Dynamics during Myxococcus xanthus Development*. J Bacteriol (2011) **193**: 5164-5170. [† co-corresponding authors.]
 32. Ray, J.C.J. and Igoshin, O.A., *Interplay of Noisy Gene Expression and Ultrasensitive Dynamics Influences Bacterial Operon Organization*, PLoS Comp Bio (2012), **8**:e1002672.
 33. Tiwari, A., and Igoshin, O.A., *Coupling between feedback loops in autoregulatory networks affects bistability range, open-loop gain and switching times*, Physical Biology (2012) Phys. Biol. **9**: 055003.
 34. Zhang, H., Vaksman, Z., Litwin D., Shi P., Kaplan H., Igoshin, O.A. *The Mechanistic Basis of Myxococcus xanthus Rippling Behavior and Its Physiological Role during Predation*, PLoS Comp Biology (2012), **8**: e1002715. [Featured-image(cover) story]
 35. Narula, J., Devi, SN, J., Fujita†, M. and Igoshin†, O.A., *Ultrasensitivity of B. subtilis sporulation decision*, (2012) Proc Natl Acad Sci U S A, **109**: 20196–20197 and E3513–E3522 [† co-corresponding authors.]
 36. Narula*, J., Williams*, CJ, Tiwari*, A., Marks-Bluth, J., Pimanda, J.E. and Igoshin, O.A., *Mathematical model of a gene regulatory network reconciles effects of genetic perturbations on hematopoietic stem cell emergence*, Developmental Biology (2013) **379**: 258–269 [* - equal contribution]
 37. Vishnoi* M, Narula* J, Devi SN, Dao HA, Igoshin†, O.A., Fujita† M., *Triggering*

- sporulation in Bacillus subtilis with artificial two-component systems reveals the importance of proper Spo0A activation dynamics*, Mol Microbiol (2013) **90**: 181–194 [† co-corresponding authors, * - equal contribution]
38. Balagam, R., Litwin, D.B., Czerwinski, F., Sun, M., Kaplan, H.B., Shaevitz, J.W., Igoshin, O.A., *Myxococcus xanthus* gliding motors are elastically coupled to the substrate as predicted by the focal adhesion model of gliding motility, PLoS Comp Biol, (2014) **10**: e1003619
39. Lee*, J., Tiwari*, A., Shum, V., Mills, G.B., Mancini, M.A., Igoshin†, O.A., Balazsi†, G., *Unraveling the regulatory connections between two controllers of breast cancer cell fate*, Nucleic Acid Research, (2014) **42**: 6839-6849 [† co-corresponding authors, * - equal contribution]
40. Judd, J., Ho, M.L., Tiwari, A., Gomez, E.J., Dempsey, C., Van Vliet, K., Igoshin, O.A., Silberg, J.J., Agbandje-McKenna, M., Suh, J., *Tunable Protease-Activatable Virus nanonodes programmed to compute proteolytic signatures*, ACS Nano (2014) **8**: 4740-4746
41. Castillo-Hair, S.M., Igoshin, O.A. and Tabor, J.J. How to train your microbe: methods for dynamically characterizing gene networks, Current Opinion in Microbiology, (2015) **24**: 113–123
42. Datta, P., Ravi, J. Hancioglu, B., Guerrini, V., Chauhan, R., Neiditch, M.B. Shell, S.S., Fortune, S.M., Hancioglu, B., Igoshin, O.A. and Gennaro, M.L., *The Psp system of Mycobacterium tuberculosis integrates envelope stress sensing and envelope preserving functions*, Molecular Microbiology, (2015) doi:10.1111/mmi.13037
43. Narula*, J., Kuchina*, A., Lee, D.-Y., Fujita, M., Süel†, G.M. and Igoshin†, O.A., *Chromosomal arrangement of phosphorelay genes couples sporulation and DNA replication*, Cell, (2015) **162**: 328–337 [† co-corresponding authors, * - equal contribution]
44. Balagam, R. and Igoshin, O.A., *Mechanism for collective cell alignment in Myxococcus xanthus bacteria*, PLoS Comp Biol, submitted

List of publications (book chapters):

1. Balazsi, G., Igoshin, O.A. and Gennaro, M.L., *The transcriptional regulatory network of Mycobacterium tuberculosis*, in *Bacterial Gene Regulation and Transcriptional Networks*, ed. M.M. Babu, Caister Academic Press, 2013; **ISBN: 978-1-908230-14-0**
2. Harvey, C.W., Igoshin, O.A., Welch R.D., Alber M. and Shimkets L.J., *Computational Biology: From Observation to Statistical Image Analysis to Modeling and Back to Biology*, in *Myxobacteria: Genomics, Cellular and Molecular Biology*, eds. Z. Yang and P.I. Higgs, Caister Academic Press, 2014 **ISBN: 978-1-908230-34-8**

List of publications (books):

1. Igoshin, O.A., *Integral Encounter Theory of Photochemical Transfer Reactions: Formalism and Applications*, LAP Lambert Academic Publishing AG&Co, Koln, Germany, **2009**, **ISBN: 978-3-8383-0101-3**