Kyung Hyuk Kim

Acting Assistant Professor
Bioengineering at the University of Washington, Seattle

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Education:

Ph.D. in Physics	University of Washington, Seattle	9/1999 – 12/2006
M.S. in Physics	University of Washington, Seattle	9/1999 – 3/2001
Ph.D. Program in Physics	University of California, Davis	10/1998 – 6/1999
B.S. in Physics	Seoul National University	3/1992 – 1/1998

Skills:

- Expertise in stochastic processes and stochastic differential equations
- Extensive knowledge in C, Python, Mathematica, R. Working knowledge of SQL, JavaScript, AJAX, Perl and Java.
- Simulation: Monte-Carlo, ordinary differential equation, partial differential equation, Langevin equation.
- Machine learning: linear and nonlinear regression, decision tree, MCMC, support vector machine, etc.
- Lab skills: Primer design, DNA extraction, polymerase chain reaction, gel electrophoresis, DNA purification, restriction enzyme digest, DNA ligation, DNA sequencing, Gibson assembly, transformation, flow cytometry, single cell microscopy.

Achievements:

- NSF grant award as a role of a PI, MCB Systems and Synthetic Biology $500K (computation/experiment) (2016-2018)
- Two NSF grant awards as a role of a co-investigator, MCB and Advancing Theory in Biology (computation/experiment).
- 24 journal publications/book chapters/conference papers
- 26 oral presentations in international conferences, workshops, and research institutes.

Work Experience:

Acting Assistant Professor, Bioengineering, University of Washington **12/2012 – Present**

Principal Investigator for multiple computational projects in systems and synthetic biology.
Current group members: 2 postdocs, 1 graduate and 3 undergraduate students.

- Project 1 (Computation/Experiment): NSF-awarded project from Molecular and Cellular Biosciences (MCB), Systems and Synthetic Biology, $500K, 2 years, 2016-2018, Standard Grant #1515280. PI – Kyung Kim (NSF award link)
  Title: Engineering functionally robust gene regulatory networks with fitness landscape design.
  The goal of this research is to develop design principles for enhancing functional robustness of genome-edited or genetically-modified cells (*E. coli*, yeast, human stem cell) under mutation pressure by providing mathematical and statistical models for cellular networks, in particular, gene regulatory networks.
- Project 2 (Computation/Experiment): Algorithmic design of gene regulatory networks with statistical and mechanistic models (Approximate Bayesian Computation and its variant).
- Project 3 (Computation): Predicting genetic mutations in yeast (*S. cerevisiae*) under stress environments. Advising one undergrad to perform flux balance analysis on yeast metabolism. Collaborator: Maitreya Dunham (UW Genome Science)
- Project 4 (Computation/Experiment): Engineering cellular networks using stochastic measurements. (1) Developed an intuitive but fully quantitative analysis method for designing and understanding noise-induced cellular phenotypes [5]. Predicted that the genetic regulation functions (e.g., Hill-type equations) can be significantly affected by the fluctuations (noise) in intracellular protein (transcription factor) copy numbers. (2) Demonstrated the noise level of *E. coli* transcription factors can be controlled and varied up to ten fold, while mean concentrations remain fixed [2, 3]. Used a flow cytometer (EC800 Sony Biotechnology) with custom python codes and a single cell microscope with Matlab codes.

Senior Fellow to Dr. Herbert M. Sauro, Bioengineering, University of Washington **6/2007 – 12/2012**

Systems and synthetic biology: Computational and mathematical analysis of gene regulatory and metabolic networks in both the stochastic and deterministic regimes.

- Extended the Metabolic Control Analysis (MCA) to the stochastic regime. Developed a sensitivity analysis method for controlling gene expression noise [7, 10]. Applied the engineering concept of fan-out to gene regulatory networks to quantify the maximum number of downstream regulation links [8, 9].
- **Two successful NSF grant proposals** on computational analysis methods for stochastic bio-systems.
  - Theoretical research: Extension of Metabolic Control Analysis and Biochemical Systems Theory to Stochastic Systems. NSF Advancing Theory in Biology, $660K (2009-2012) (co-investigator).
  - Experimental research: Characterizing and Engineering Cellular Networks using Stochastic Measurements. NSF Molecular and Cellular Biosciences – Systems and Synthetic Biology, $546K (2012-2015) (co-investigator).

Research Assistant to Dr. den Nijs (Graduate Advisor), Physics, Univ. of Washington **2004 – 12/2006**

Statistical Physics (Non-equilibrium critical phenomena; KPZ-equations; interacting particle systems)

- Developed and analyzed stochastic models for the dynamics of 1-D many-body particle systems (two-species of interacting particles) by performing Monte-Carlo simulations and solving analytical solutions of the models [11].

Research Assistant to Dr. Hong Qian (Graduate Co-Advisor), Applied Math, Univ. of Washington **2000 – 2003**

Senior Fellow to Dr. Hong Qian **1/2007 – 5/2007**

Stochastic biological reaction systems and nonequilibrium thermodynamics under differential feedback control

- Analytically studied non-equilibrium stochastic processes (fluctuation theorems and Jarzynstki equality).
- Two papers: Physical Review Letter [13] and Physical Review E [12].

Selected Publications (out of 24 including 2 book chapters):

1. **KH Kim**, BA Bartley, WB Copeland, HM Sauro. Synthetic Biology – Building Genetic Networks from Scratch. Biophysical Journal (review paper; in preparation).
2. **KH Kim**, HM Sauro. Biological noise affects Hill-coefficients in genetic regulation in *E. coli*. (in preparation)
3. **KH Kim**, K Choi, BA Bartley, HM Sauro. Controlling *E. coli* gene expression noise. IEEE Transactions on Biomedical Circuits and Systems, 9:497—504 (2015) doi: 10.1109/TBCAS.2015.2461135. PMID: 26372647.
4. P Meyer, T Cokelaer, D Chandran, **KH Kim**, P-R Loh, G Tucker, M Lipson, B Berger, C Kreutz, A Raue, B Steiert, J Timmer, HM Sauro, G Stolovitzky. Network topology and parameter estimation: from experiments to gene regulatory network kinetics using a community based approach. BMC Systems Biology 8:13 (2014) doi: 10.1186/1752-0509-8-13. PMID: 24507381.
5. **KH Kim**, H Qian, HM Sauro. Nonlinear Biochemical Signal Processing via Noise Propagation. Journal of Chemical Physics 139:144108-1—9 (2013) doi: 10.1063/1.4822103. PMID: 24116604.
6. HM Sauro, **KH Kim**. It's an analog world. Nature 497:572—573 (2013) PMID: 23676675 (news and views)
7. **KH Kim**, HM Sauro. Adjusting Phenotypes by Noise Control. PLoS Comp. Biol. 8:e1002344-1—14 (2012) doi: 10.1371/journal.pcbi.1002344. PMID: 22253584.
8. **KH Kim**, HM Sauro. Measuring the Degree of Modularity from Gene Expression Noise in Gene Regulatory Circuits. Biophysical Journal 100:1167—1177 (2011) doi: 10.1109/CDC.2012.6425827.
9. **KH Kim**, HM Sauro. Fan-out in Gene Regulatory Networks. J. Biological Engineering 4:16-1—14 (2010) doi: 10.1186/1754-1611-4-16. PMID: 21167053.
10. **KH Kim**, HM Sauro. Sensitivity Summation Theorems for Stochastic Biochemical Reaction Systems. Mathematical Biosciences 226:109—119 (2010) doi: 10.1016/j.mbs.2010.04.004. PMID: 20447412.
11. **KH Kim**, M den Nijs. Dynamic Screening in a Two-Species Asymmetric Simple Exclusion Process. Phys. Rev. E 76:021107-1—14 (2007) doi: 10.1103/PhysRevE.76.021107. PMID: 17930006.
12. **KH Kim**, H Qian. Fluctuation Theorems of a Molecular Refrigerator. Phys. Rev. E 75:022102-1—4 (2007) doi: 10.1103/PhysRevE.75.022102. PMID: 17358382.
13. **KH Kim**, H Qian. Entropy Production of Brownian Macromolecules with Inertia. Phys. Rev. Lett. 93:120602-1—4 (2004) doi: 10.1103/PhysRevLett.93.120602.
14. **KH Kim**. Stochastic Driven Systems Far From Equilibrium (Doctoral Dissertation). Retrieved from ProQuest Dissertations and Theses. (2006) (Accession Order No. AAI3241916)

Selected Oral Presentations (out of 26 invited and contributed talks):

1. American Physical Society March Meeting, Baltimore, MD. March 15, 2016
2. Seminar in the Department of Biomedical Engineering at the University of Michigan, Ann Arbor. Feb. 4, 2016
3. NIAC (Northwest Institute for Advanced Computing) Seminar at the Pacific Northwest National Laboratory, Richland, WA. Jan 4, 2016
4. Departmental Seminar in Bioengineering at the University of Washington, Seattle, WA. Mar. 12, 2015
5. Synthetic Biology Center Symposium at MIT, Boston, MA. Nov. 20, 2014
6. Biomedical Engineering Society (BMES) Annual Meeting, San Antonio, TX. Oct. 22-25, 2014