

Mary J. Dunlop

Email: mjdunlop@gmail.com, Phone: 626-818-8680, Web: http://keaslinglab.lbl.gov/wiki/index.php/Mary_Dunlop

EDUCATION

CALIFORNIA INSTITUTE OF TECHNOLOGY

Ph.D., Mechanical Engineering (emphasis: Control Theory & Synthetic Biology) June 2008

M.S., Mechanical Engineering (emphasis: Biological Modeling) June 2004

PRINCETON UNIVERSITY

B.S.E., Mechanical and Aerospace Engineering (major), Computer Science (minor) June 2002

SUMMARY OF TECHNICAL QUALIFICATIONS

Technical Skills

- **Laboratory Skills:** Bacterial cell culture including experience with *E. coli*, *B. subtilis*, and various soil and marine bacteria, single-cell microscopy, site-directed mutagenesis, plasmid and chromosomal integration, dynamic fluorescence measurements, high throughput cloning methods
- **Modeling:** nonlinear ordinary differential equations, stochastic differential equations, stochastic modeling using chemical master equation
- **Analysis:** dynamic systems methods, bifurcation diagrams, stability analysis, parameter and system identification, sensitivity analysis
- **Programming Languages:** C, Matlab, Perl, Fortran

RESEARCH & PROFESSIONAL EXPERIENCE

JOINT BIOENERGY INSTITUTE, LAWRENCE BERKELEY NATIONAL LAB

Postdoctoral Scholar 2008-Present

Project: Exporting Biofuel using Efflux Pumps

Advisors: Aindrila Mukhopadhyay, Jay Keasling

- *Purpose:* Microbes can be engineered to produce biofuels, but fuel can be toxic to the microorganism when it builds up within the cell. Efflux pumps are channels in the cell membrane that excrete toxic substances, including biofuels. We are (1) building a library of efflux pumps to characterizing how they reduce biofuel toxicity and (2) designing feedback control systems that use efflux pumps to export biofuel.

CALIFORNIA INSTITUTE OF TECHNOLOGY

Graduate Research Assistant 2004-2008

Project/Thesis: Dynamics and Noise in Gene Regulation

Advisors: Michael Elowitz (Biology, Applied Physics), Richard Murray (Control & Dynamical Systems)

- *Purpose:* Cells use many genetic control mechanisms to respond to changes in their environment. To conserve resources only a subset of these control systems are active at a given time. Goal was to discriminate between active and inactive forms of genetic control, while preserving the context in which the gene circuit naturally operates.
- *Impact:* Developed a non-invasive method for determining gene circuit activity that uses temporal correlations in expression noise. Method requires no external inputs or modifications to the existing gene circuit.

LOS ALAMOS NATIONAL LABORATORY

Computational Science Graduate Fellowship Practicum Summer 2004

Project: Multiple Functions of a Feed-Forward Loop Gene Circuit

Advisor: Michael Wall (Computer, Computational, and Statistical Sciences Division)

- *Purpose:* Cells commonly use feed-forward loops to control gene expression. We explored the range of functions that can be produced by feed-forward loops and determined how sensitive the results were to genetic parameters.
- *Impact:* Showed that there is a very limited set of possible behaviors that can be produced by a feed-forward loop. Some functions are very robust to parameter variation, while others are extremely fragile.

OTHER RESEARCH EXPERIENCE

Graduate Research Assistant, California Institute of Technology

Project: Aerodynamic Modeling of Insect Flight 2003-2004

Project: Computational Fluid Dynamics Models of Airplane Engine Noise 2002-2003

Undergraduate Researcher, Princeton University

Project: Analysis of a Sailboat Design Using Computational Fluid Dynamics 2000-2002

OTHER PROFESSIONAL EXPERIENCE

Technical Student, Northrop Grumman Corporation

Project: Modeling Aircraft Resonance using Computational Fluid Dynamics summer 2001

Fluid Mechanics Research Internship, Pennsylvania State University

Project: Water Tunnel Measurements of Drag Forces summer 2000

PUBLICATIONS

THESIS

M. J. DUNLOP. "Dynamics and Correlated Noise in Gene Expression." California Institute of Technology, Ph.D. Thesis. 2008.

JOURNAL PAPERS

R. S. Cox, **M. J. DUNLOP**, M. B. Elowitz. "A Synthetic Three-Color Reporter Framework for Monitoring Genetic Regulation and Noise." (in review, available upon request)

M. J. DUNLOP, R. S. Cox, J. H. Levine, R. M. Murray, M. B. Elowitz. "Regulatory Activity Revealed by Dynamic Correlations In Gene Expression Noise." *Nature Genetics*. 40:1493-1498, 2008.

M. E. Wall, **M. J. DUNLOP**, W. S. Hlavacek. "Multiple Functions of a Feed-Forward Loop Gene Circuit." *Journal of Molecular Biology*. 349, 501-514. 2005.

CONFERENCE PAPERS

M. J. DUNLOP, E. Franco, R. M. Murray. "A Multi-Model Approach to Identification of Biosynthetic Pathways." In *Proceedings of the 26th American Control Conference* 2007.

J. Ugander, **M. J. DUNLOP**, R. M. Murray. "Analysis of a Digital Clock for Molecular Computing." In *Proceedings of the 26th American Control Conference* 2007.

M. J. DUNLOP, M. E. Wall. "Robustness in Gene Circuits: Clustering of Functional Responses." In *Proceedings of the 24th American Control Conference* 2005.

M. B. Reiser, J. S. Humbert, **M. J. DUNLOP**, D. Del Vecchio, R. M. Murray, M. H. Dickinson. "Vision as a Compensatory Mechanism for Disturbance Rejection in Upwind Flight." In *Proceedings of the 23rd American Control Conference* 2004.

T. Colonius, **M. J. DUNLOP**, R. Reba, S. Narayanan. "A Study of the Role of Organized Structures in Jet Noise Generation." *AIAA Paper* 2003-3314. 2003.

LEADERSHIP EXPERIENCE

CALTECH PROJECT FOR EFFECTIVE TEACHING (CPET)

President, Member of Organizational Committee

2006-Present

- Organized the Teaching Assistant training program for all incoming graduate students (Fall 2006).
- Worked with faculty and administrators to expand the Teaching Assistant training program, substantially increasing the number of graduate students who receive training, and expanding the program to include undergraduates.
- Coordinated and developed a seminar series that brought speakers together to talk about teaching strategies, integrating teaching and research, and novel pedagogical methods.

MECHANICAL ENGINEERING STUDENT SEMINAR SERIES

2003-2004

- Coordinated a weekly departmental seminar series where graduate students give informal talks about their research for the benefit of other students in the department.

TEACHING & MENTORING EXPERIENCE

CALIFORNIA INSTITUTE OF TECHNOLOGY

Research Mentor

Summer 2007

Project: Predictive Models for Investigating Modularity in Gene Circuits

Head Teaching Assistant

Fall 2006

Course: Analysis and Design of Feedback Systems

- Supervised team of 4 teaching assistants for a class of 75 students.

Research Mentor

2006-2007

Project: Dynamic Systems Analysis of the Influenza Virus

Research Mentor

Summer 2006

Project: Design of a Digital Clock for Molecular Computing

Teaching Assistant

Fall 2005

Course: Analysis and Design of Feedback Systems

Research Mentor

Summer 2005

Project: Evolvability and Robustness in Synthetic Genetic Circuits

Teaching Assistant

Winter 2005

Course: Introduction to Control Theory

PRESENTATIONS

Talks

“Regulation Revealed by Correlations in Gene Expression Noise.” *Stochasticity in Biochemical Reaction Networks*, Banff, Alberta, Canada. 2009.

“Using Efflux Pumps to Improve Biofuel Production.” *Gordon Conference on Mechanisms of Membrane Transport*, Waterville, ME. 2009.

“Regulation Revealed by Correlations in Gene Expression Noise.” *Q-bio Conference*, Santa Fe, NM. 2007.

“A Multi-Model Approach to Identification of BioSynthetic Pathways.” *American Control Conference*, New York, NY. 2007.

“Correlation and Causality in Genetic Networks.” *Institute for Collaborative Biotechnologies Student Seminar*, Caltech, Pasadena, CA. 2007.

“System Identification for Genetic Regulatory Networks.” *Computational Science Graduate Fellowship Conference*, Washington DC. 2006.

“Robustness in Gene Circuits: Clustering of Functional Responses.” *American Control Conference*, Portland, OR. 2005.

“Inferring Function from Structure in Genetic Regulatory Feed-forward Loops.” *Southern California Nonlinear Controls Conference*, UCLA, Westwood, CA. 2004.

Posters

“Using Efflux Pumps to Improve Biofuel Production.” *Gordon Conference on Mechanisms of Membrane Transport*, Waterville, ME. 2009.

“Role of Efflux Pumps in E. coli Solvent Tolerance.” *SIM Conference: Symposium on Biotechnologies for Fuels and Chemicals*. San Francisco, CA. 2009.

“Regulatory Activity Revealed by Dynamic Correlations in Gene Expression Noise.” *Synthetic Biology 4.0*, Hong Kong. 2008.

"Regulation Revealed by Correlations in Gene Expression Noise." *Q-bio Conference*, Santa Fe, NM. 2008.

"Correlation and Causality in Genetic Networks." *Synthetic Biology 3.0*, Zurich, Switzerland. 2007.

"A Multi-Model Approach to Identification of Bio-Synthetic Pathways." *Engineering Principles in Biology*, Cold Spring Harbor Laboratory, NY. 2006.

"System Identification for Genetic Regulatory Networks." *Synthetic Biology 2.0*, Berkeley, CA. 2006.

"Reengineering Genetic Circuits." *Computational Science Graduate Fellowship Conference*, Washington DC. 2005.

"Design Principles for Gene Circuits: Ideas from Engineering." *Computational Science Graduate Fellowship Conference*, Washington DC. 2004.

"A Study of the Role of Organized Structures in Jet Noise Generation." *Computational Science Graduate Fellowship Conference*, Washington DC. 2005.

HONORS & AWARDS

<i>Dean's Award for Community Service</i> , California Institute of Technology (out of all Caltech graduates)	2008
<i>Computational Science Graduate Fellowship</i> , U.S. Dept. of Energy (5% acceptance rate)	2002-2006
<i>Best Student Paper</i> , American Control Conference (out of 250 papers considered)	2004
<i>John Marshall II Memorial Prize for Independent Research</i> , Princeton University (out of 25 students)	2002
<i>George J. Mueller Award</i> , Princeton University School of Engineering and Applied Science	2002
<i>Sigma Xi Scientific Research Society</i>	2002

ATHLETICS & HOBBIES

Nationally ranked epee fencer (1996-2002); Princeton women's fencing team captain (2001-2002); Backpacked 80-mile High Sierra Trail (2008); Backpacked 270-mile Vermont Long Trail (2002); Caltech Y hike leader (2002-2008); Princeton Outdoor Action backpacking trip leader (1999-2002), Caltech women's ultimate frisbee (2005-present); Voted most valuable defensive player (2007-2008).