Paul Grayson

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Future Research Interests

Single-molecule imaging of viruses and the infection process, modeling of antibody-target interactions, automated microscopy and high-throughput techniques, low-cost devices for education and medicine.

Education

Ph.D. in Physics, with Prof. Rob Phillips. California Institute of Technology, 2002-2007 (est. June).

> Researched the role of internal pressure in DNA delivery by viruses, focusing on the tailed dsDNA bacteriophage family, including phages lambda, phi29, T5, and P22. Measured internal pressure of lambda at 20-25 atm and observed DNA ejection in real time, determining a velocity of up to 60 kbp/s. Analyzed phages using a variety of bulk and single-molecule techniques; modeled phages at many levels with mathematical and computational techniques to guide the direction of research.

Graduate research with Prof. Klaus Schulten. University of Illinois, Urbana-Champaign, 2001-2002.

> Implemented the new technique *Interactive Molecular Dynamics,* interfacing molecular dynamics simulations to haptic force-feedback to allow users to literally feel simulated molecules. Contributed this feature to the source code of VMD and NAMD, the group's molecular visualization and simulation software, in parallel with scientific studies on the bacterial aquaglyceroporin GlpF and glycerol kinase.

S.B. in Physics with Electrical Engineering. Massachusetts Institute of Technology, 2001.
S.B. in Mathematics. Massachusetts Institute of Technology, 2001.

Non-academic Experience

Co-founder, Pololu Corporation, Las Vegas, NV, 2000-present.

> Founded with two other MIT students to develop high-quality robotics components for education and research. Wrote motor control software now in thousands of devices shipped around the world. Consulting on various issues and managing online presence as sales have grown to ~$350,000 (2006).

Publications

1. Real time visualization of in vitro genome ejection from bacteriophage lambda: adjusting the translocation speed with genome length and ions. Paul Grayson, Lin Han, Tabita Winther, and Rob Phillips. In preparation, 2007.
2. Biological Consequences of Tightly Bent DNA: The Other Life of a Macromolecular Celebrity. Hernan G. Garcia, Paul Grayson, Lin Han, Mandar Inamdar, Jané Kondev, Philip C. Nelson, Jonathan Widom and Paul A. Wiggins. Biopolymers, in press, 2007. [Online text]
3. The effect of genome length on ejection forces in bacteriophage lambda. Paul Grayson, Alex Evilevitch, Mandar M. Inamdar, Prashant K. Purohit, William M. Gelbart, Charles M. Knobler, and Rob Phillips. Virology, 348(2):430-436, 2006. [Online text]
4. Forces During Bacteriophage DNA Packaging and Ejection. Prashant Purohit, Mandar Inamdar, Paul Grayson, Todd Squires, Jané Kondev, and Rob Phillips. Biophysical Journal, 88:851-866, 2005. [Online text]
5. Conductance and physical asymmetry of the Escherichia coli glycerol facilitator GlpF. Deyu Lu, Paul Grayson, and Klaus Schulten. Biophysical Journal, 85:2977-2987, 2003. [Online text]
6. Mechanisms of selectivity in channels and enzymes studied with interactive molecular dynamics. Paul Grayson, Emad Tajkhorshid, and Klaus Schulten. Biophysical Journal, 85:36-48, 2003. [Online text]
7. A System for Interactive Molecular Dynamics Simulation. John E. Stone, Justin Gullingsrud, Klaus Schulten, Paul Grayson. In ACM Symposium on Interactive 3D Graphics, John F. Hughes and Carlo H. Sequin, editors, pages 191-194, New York, ACM SIGGRAPH, 2001. [Online text]

Recent External Presentations

1. Real time visualization of genome ejection from bacteriophages. Single Molecule Biophysics Conference, Aspen, CO, 2007.
2. Real time visualization of genome ejection from bacteriophage lambda: how internal pressure drives the translocation of DNA (poster). Physical and Chemical Aspects of Molecular Biology Conference, Puebla, Mexico, 2007.
3. Real time visualization of genome ejection from bacteriophage lambda: how internal pressure drives the translocation of DNA. Special Biophysics Seminar, Northwestern University, Evanston, IL, 2006.
4. Pressure in bacteriophages. Theoretical Biophysics Seminar, University of Illinois, Urbana, IL, 2005.
5. Viruses: designed by evolution, constrained by physics. Guest lecture for Nature's Designs, an undergraduate course at the Art Center, Pasadena, CA, 2005.
6. Pressure in bacteriophages. Phage/Virus Assembly Meeting, Winter Park, CO, 2005.
7. Measurements of pressurized DNA in phage capsids (poster). Biophysical Society Meeting, Long Beach, CA, 2005.

Teaching

1. Caltech Bi1: The Biology and Biophysics of Viruses, 2007.

   Organizing new course with Profs. Phillips and Pamela Bjorkman; biology for freshman non-majors taught through the example of HIV; relating physics, math, biology, and issues in public policy and personal health. For example, students will write Matlab programs to simulate evolution, following Korber et al. (2000) to estimate the timing of the transfer of HIV to humans.

2. MBL Physiology Course, Woods Hole, MA, 2006.

   Invited with Prof. Phillips to this intense summer program; led students on an experiment to observe single viruses with fluorescence microscopy, making observations of DNA ejection into cells.

3. Summer student advising, 2003-2005.

   Mentored summer students: an undergraduate who generated phage lambda mutants with different genome lengths, a high school student who studied DNA ejection from phages with unknown receptors, and an undergraduate who measured the pressure within lambda phages.

4. Sophomore Physics Laboratory/Electronics Laboratory, Caltech, 2002-2003.

   Taught year-long series on the fundamentals of electronic circuits as well as classic results in physics such as the Stern-Gerlach experiment that demonstrates the quantization of spin. Responsible for a group of 6-8 students, including explaining the projects, running a discussion section, monitoring the lab, and grading lab reports.

Awards

1. National Science Foundation Graduate Research Fellowship, 2002-2006.