Benjamin Gamari

45 N. East St. Apt. 1

Amherst, MA 01002

United States

ben@smart-cactus.org

http://smart-cactus.org/~ben

http://github.com/bgamari

+1 (413) 362-4774

▰▰▰ Education

2009 — 2014 (expected)   **Ph.D., Physics**; University of Massachusetts (Amherst, MA)

In Lori Goldner's single-molecule biophysics group,

"Droplet encapsulation: Tools for single-molecule sensitive dynamical studies"

2005 — 2009   **BS, Physics**; The George Washington University (Washington, DC)

▰▰▰ Experience

2009 — 2014: Research Assistant

Working towards a Ph.D. in Lori Goldner's single-molecule biophysics group at University of Massachusetts, Amherst.

- Developed FPGA-based hardware, firmware, and associated software for acquiring time-tagged photon events for fluorescence spectroscopy. This work was **released** under an open-source license and is now used at institutions beyond our lab.
- Devised, derived, and implemented inference algorithms for a variety of graphical probabilistic models for analysis of fluorescence spectroscopic trajectories. Developed and maintain a set of analysis tools (**photon-tools** and **hphoton**) for analysis of fluorescence data.
- Modelled latent fluorescence spectroscopic processes in the light of molecular dynamics simulation data.
- Designed and implemented data-acquisition **hardware**, **software** (Haskell), and optics for a back focal plane particle tracking system
- Used above tracking system to examine the folding dynamics single molecules of quadruplex DNA.

Undergraduate Researcher (2007 — 2009)

Working with Dr. Andrei Alexandru of the Physics Department at The George Washington University.

- Implemented a **package** for numerically solving quantum chromodynamical systems on a discrete lattice on distributed nVidia GPU hardware
- Implemented and optimized a variety of linear algebra routines for CPU execution
- Gained experience with efficient algorithm design and implementation in a distributed message passing environment and low-level software optimization on a highly parallel GPU architecture

▬▬▬▬ Technical Experience

Open Source (2004 — 2014)

Committer to the **Glasgow Haskell Compiler** focusing on support for the ARM architecture, the runtime system, and LLVM code generation backend. Principal contributor to the **Zinc** embedded framework for the Rust programming language focusing on exploring the uses of strong typing in embedded systems programming. Author and maintainer of almost two dozen packages on Hackage, the Haskell package repository. These include **optimization**, a library of non-linear optimization methods, **b-tree**, a on-disk B+ tree implementation, and **bayes-stack**, a framework for Markov Chain Monte Carlo inference for generative probabilistic models. Various contributions to projects as diverse as the **Linux kernel**, **matplotlib**, **sympy**, **libopencm3**, **haskell-chart**, **Yesod**, and **HackRF**. See **Github** for a full listing of contributions.

Ubiquitous sensing hardware (2013 — 2014)

Principal developer of the hardware, firmware (embedded C and eventually Rust), and host software (Haskell and web technologies) for the **Riffle** water quality sensing platform. The Riffle is a deeply embedded sensor for long-term field measurements of electrical conductivity, temperature, depth, flow, and a variety of optical properties. The project began as a collaboration with the Public Laboratory for Technology and Science.

Programming Languages

Python: Extensive experience in experimental data analysis with **scipy**, **numpy**, **matplotlib**, and **sympy**. Experience building variety of command-line and graphical tools for interfacing with experimental instrumentation. Experience with **Pyrex** for optimization of inner loops as well as writing CPython extensions.

C++: Work on GWU-QCD involved heavy use of templates for optimization of linear algebra targetting both GPU (CUDA) and SIMD CPU execution. Experience developing and optimizing MPI-based message passing schemes for highly-distributed computation. During Ph.D. developed **timetag-tools** to interface with FPGA timetagger hardware over USB. This project required concurrent, multiplexed I/O over a low-level hardware interface. Extensive work on **Smoothie** motion control firmware for 3D printers and CNC machines.

Haskell: Experience began with building probabilistic inference framework for machine learning with social network data (see Dietz, Gamari 2012 in *Publications*). Since this project I have moved most of my experimental data analysis and instrument integration over to Haskell. Spare time projects include an unreleased information retrieval system built in Haskell, the Riffle web frontend (see above), and the above-mentioned Hackage packages.

Rust: Extensive work on **Zinc**. Various contributions to the **rustc** compiler. Author of **succinct.rs**, a library of succinct data structures implemented in Rust.

Working knowledge of **C**, **bash**, **x86 and ARM assembly**, **Verilog**, **Javascript**, **Coffeescript**, **HTML5**, and **CSS**. Enjoy poking around in **Idris** and other dependently-typed lanaguages.

Miscellanea

- Spare time activities include working on my RepRap, hiking, and listening to good music.
- *2014*. Served as **Google Summer of Code mentor** for Public Laboratory for Technology and Science.
- Honors, awards and fellowships,
  - *2013*. University of Massachusetts Institute for Computational Biology, Biostatistics, and Bioinformatics' **Open-Source Software Innovation (OSSI) award**, first place
  - *2012*. **Dandamudi Rao Scholarship** in Biological Physics, University of Massachusetts, Amherst.
  - *2009*. **GWU Peverley Prize** for Excellence in Undergraduate Research for both my work in Lattice QCD and experimental biophysics.

Publications

- B. Gamari, D. Zhang, R. Buckman, *et al.* "Inexpensive electronics and software for photon statistics and correlation spectroscopy." *American Journal of Physics* (2014).
- P. Milas, B. D. Gamari, L. Parrot, B. P. Krueger, S. Rahmanseresht, J. Moore, and L. S. Goldner. "Indocyanine Dyes Approach Free Rotation at the 3' Terminus of A-RNA: A Comparison with the 5' Terminus and Consequences for Fluorescence Resonance Energy Transfer." *Journal of Chemical Physics B* (2013).
- L. Dietz, B. Gamari, J. Guiver, E. Snelson, R. Herbrich. "De-Layering Social Networks by Shared Tastes of Friendships". *International Conference on Weblogs and Social Media* (2012).
- A. Alexandru, C. Pelissier, B. Gamari, F.X. Lee. "Multi-mass solvers for lattice QCD on GPUs." *Journal of Computational Physics* (2012).
- A. Alexandru, M. Lujan, C. Pelissier, B. Gamari. F. X. Lee. "Efficient Implementation of the Overlap Operator on Multi-GPUs." *Application Accelerators in High-Performance Computing (SAAHPC)* (2012).
- J. Hoffmann, B. Gamari, D. Raghu, M. Reeves. "Tip preparation for near-field ablation at mid-infrared wavelengths". *Reviews of Scientific Instrumentation* (2012).

ben@smart-cactus.org • +1 (413) 362-4774 • 28 years old
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