MATT BIERBAUM

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Employment

2017 - 2019 **Research Specialist** - Cornell University, advisor Paul Ginsparg

2016 **Postdocal Researcher** - Cornell University, advisor James P. Sethna

Education

2009 - 2016 **Cornell University** - Ph.D. Physics, advisor James P. Sethna

2009 - 2012 **Cornell University** - M.S. Physics, advisor James P. Sethna

2005 - 2009 **Northwestern University** - B.A. Physics and Integrated Science, advisor Frederic Rasio

Experience & Skills

Specialization
Numerical simulation | Python programming | Physics | Web services | Machine Learning
High performance computing and GPUs | PDEs, Monte Carlo, automata | Constraint satisfaction | Data analysis

Languages & Tools
Python (numpy, scipy, Keras, pytorch) | C | C++ | CUDA | Javascript | Typescript | Lua | Moonscript
Linux | AWS | git | node | Vim | Docker | HTML | CSS

Selected Projects

arXiv

Web service development

- Created Flask-based services for text classification, PDF to text conversion, and plagiarism detection, each packaged into Docker images and deployed to kubernetes.
- Developed a citation and reference overlay for display on abstract pages, which uses data APIs from arXiv partners to augment users' navigation on arXiv.

Data curation

- Cleaning and curation of metadata and text for 1.5 million articles spanning 27 years.
- Researched and implemented algorithms for author disambiguation, DOI cleaning and linking, reference extraction, and citation tree building.

Precision Image Analysis

Confocal images of Colloids

- Developed a Bayesian method to extract particle positions and sizes from confocal microscope images at the information limit, achieving ~1nm precision, 10-100x better than state of the art.
- Created optimized open-source Python package available on PyPI, `peri`.

Image alignment

- Found and described the bias and error in standard alignment methods using statistical field theory.
- Develop a new method that models the underlying image in order to reach highest precision possible in shift parameters, while also generating a super resolution image.

Fun Physics

Collective motion at heavy metal concerts

- Described the phase transition between mosh and circle pit using custom GPU simulations of 1M agents.
- Covered by NPR, Times, Atlantic, PopSci, NBC, NatGeo with 0.7M pageviews. **Website**

Zombie disease dynamics

- Modelled spread of zombieism across the continental US.
- Created high performance interactive web simulation in JavaScript that simulates the full US population.
- Featured on WaPo, WSJ, CBS, NBC, CBC, Smithsonian, HuffPo with 1.7M pageviews. **Website**

Publications

Published

Image registration and super resolution from first principles – Clement, Bierbaum, Sethna – arXiv:1809.05583

Biases in particle localization algorithms – Leahy, Bierbaum, Sethna, Cohen – arXiv:1801.03581

Light Microscopy at Maximal Precision – Bierbaum, Leahy, Alemi, Cohen, Sethna – Phys Rev X 7.4: 041007 2017

Determining Quiescent Colloidal Suspension Viscosities Using the Green-Kubo Relation and Image-Based Stress Measurements – Lin, Bierbaum, Cohen – Phys Rev Lett 119, 138001 2017

Deformation of crystals: Connections with statistical physics – Sethna et. al – Annual Review of Materials Research 47 217-246 2017

Measuring nonlinear stresses generated by defects in 3D colloidal crystals – Lin, Bierbaum, Schall, Sethna, Cohen – Nature Materials 2016

The weirdest martensite: Smectic liquid crystal microstructure and Weyl-Poincare invariance – Liarte, Bierbaum, Mosna, Kamien, Sethna – Phys Rev Lett 116, 147802 2016

"Irregularization" of Systems of Conservation Laws – Swan, Choi, Papanikolaou, Bierbaum, Chen, Sethna – Materials Theory 2.1 (2018): 5

You can run, you can hide: The epidemiology and statistical mechanics of zombies – Alemi, Bierbaum, Myers, Sethna – Phys Rev E 92, 052801 2015

Visualization, coarsening and flow dynamics of focal conic domains in simulated Smectic-A liquid crystals – Liarte, Bierbaum, Zhang, Leahy, Cohen, Sethna – Phys Rev E 92 6, 062511 2014

Collective motion of humans in mosh and circle pits at heavy metal concerts – Silverberg, Bierbaum, Sethna, Cohen – Phys Rev Lett 110 (22) 228701 2013

Scaling theory of continuum dislocation dynamics in three dimensions: Self-organized fractal pattern formation – Chen, Choi, Papanikolaou, Bierbaum, Sethna – Intl Journal Plasticity 46, 94-129 2013

Formation of Massive Black Holes in Dense Star Clusters. II. Initial Mass Function and Primordial Mass Segregation – Goswami, Umbreit, Bierbaum, Rasio – Astrophysical Journal 752 (1), 43 2012

Interests

Ask Me About

Fun physics - cost of a pot hole, physics of bubbles, order of magnitude
Wood & metal working - tables, benches, custom espresso tamps
Generative art - creating simulation-based art using modern physics algorithms
Bicycles - Carbon road, single speed road, single speed mountain bike
Short films / photography - filming, editing, timelapse
Ithaca Generator - community maker space