Joshua Pughe-Sanford

PhD Candidate, Center for Non-Linear Dynamics

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Education

2017-Present	**Georgia Institute of Technology**, Atlanta, GA Ph.D. in Physics (Expected, Summer 2023) M.S. in Mathematics (Expected, Summer 2023) GPA: 3.9
2015-2017	**Emory University**, Decatur, GA B.S. in Physics with Highest Honors (Summa Cum Laude) Minor in Mathematics GPA: 3.9
2013-2015	**Oxford College**, Decatur, GA A.A. with Honors GPA: 3.9

Honors and Awards

2022	Herbert P. Haley Fellowship, Georgia Institute of Technology	$4,000
2022	Emelio Fellowship Nominee, Georgia Institute of Technology	
2022	Travel Grant, Georgia Institute of Technology	$1,000
2017-2021	Presidential Fellow, Georgia Institute of Technology	$20,000
2017-Present	Phi Beta Kappa, Honors Society	
2016	Travel Grant, Princeton University	$1,500
2016-Present	Sigma Phi Sigma, Physics Honors Society	
2015-Graduation	Dean's List, Emory University	
2013-Present	Phi Eta Sigma, National Honors Society	
2013-2015	Honors List, Oxford College	

Publications

P1. **J. L. Pughe-Sanford** and R. O. Grigoriev, "Point vortices predict extended vortex interactions in two-dimensional turbulence," *(in preparation)*

P2. **J. L. Pughe-Sanford**, S. Quinn, L. L. Balabanski, and R. O. Grigoriev, "Inferring turbulent averages through regression," *(in preparation)*

P3. **J. L. Pughe-Sanford**, C. J. Crowley, W. Toler, R. O. Grigoriev, and M. F. Schatz, "Observing a Dynamical Skeleton of Turbulence in Taylor-Couette Flow Experiments," *Phil. Trans. A (accepted)*

P4. **J L. Pughe-Sanford**, C. J. Crowley, , W. Toler, M. C. Krygier, R. O. Grigoriev, and M. F. Schatz, "Turbulence tracks recurrent solutions," *Proceedings of the National Academy of Sciences*, vol. 119, no. 34, p. e2120665119, 2022

P5. M. C. Krygier, **J. L. Pughe-Sanford**, and R. O. Grigoriev, "Exact coherent structures and shadowing in turbulent Taylor–Couette flow," *Journal of Fluid Mechanics*, vol. 923, p. A7, 2021

P6. S. Boettcher and **J. L. Pughe-Sanford**, "Renormalization of Discrete-Time Quantum Walks with non-Grover Coins," *Journal of Statistical Mechanics: Theory and Experiment*, vol. 2018, p. 033103, 2017

P7. **J. L. Pughe-Sanford**, "Properties of Quantum Walks within Various One Dimensional Media," *Honors Thesis*, 2017

Conference Talks

C1. **J. L. Pughe-Sanford** and R. O. Grigoriev, "Vortex Interactions: a Low-Dimensional Approach to the Inverse Cascade." APS DFD Indianapolis, 2022 (recorded)

C2. W. Toler, C. J. Crowley, **J. L. Pughe-Sanford**, R. O. Grigoriev, and M. F. Schatz, "Simultaneous shadowing of multiple Exact Coherent Structures in experimental Taylor-Couette flow." APS DFD Indianapolis, 2022

C3. **J. L. Pughe-Sanford**, M. C. Krygier, and R. O. Grigoriev, "Can We Connect a Dynamical Description and a Statistical Description of Turbulence?." APS DFD Phoenix, 2021

C4. C. J. Crowley, **J. L. Pughe-Sanford**, W. Toler, R. O. Grigoriev, and M. F. Schatz, "Time evolution of turbulent Taylor-Couette flow is robustly captured by Exact Coherent Structures." APS DFD Phoenix, 2021

C5. W. Toler, C. J. Crowley, **J. L. Pughe-Sanford**, R. O. Grigoriev, and M. F. Schatz, "Transition to turbulence in experimental small-aspect Taylor-Couette flow." APS DFD Phoenix, 2021

C6. **J. L. Pughe-Sanford** and R. O. Grigoriev, "Dynamics and statistics of weakly turbulent Taylor-Couette flow in terms of exact coherent structures." APS DFD Chicago, 2020

C7. W. Toler, C. J. Crowley, **J. L. Pughe-Sanford**, K. Sands, M. F. Schatz, and R. O. Grigoriev, "Experimental tests of dynamical and statistical relevance of exact coherent structures in turbulent small-aspect-ratio Taylor-Couette flow." APS DFD Chicago, 2020

C8. C. J. Crowley, W. Toler, **J. L. Pughe-Sanford**, K. Sands, R. O. Grigoriev, and M. F. Schatz, "Identifying turbulent shadowing of 3D Exact Coherent Structures from measurements of 2D-2C velocity measurements in small-aspect-ratio Taylor-Couette flow." APS DFD Chicago, 2020

C9. **J. L. Pughe-Sanford** and R. O. Grigoriev, "Heteroclinic Connections as Predictors of Extreme Events in Weakly Turbulent Flow." APS DFD Seattle, 2019 (recorded)

C10. **J. L. Pughe-Sanford**, "Numerical Methods for Determining the Walk Dimension of Quantum Walks." Emory University SIRE Symposium, 2017

Teaching Experience

Georgia Institute of Technology

Assisted in Teaching Graduate Level Courses (not as TA) *2019, 2022*
- PHYS 7224, Non-Linear Dynamics
- PHYS 8823, Math Methods

Head Teaching Assistant *2018-2019*
- Managed a team of TAs and lead them in how to communicate each weeks material to students
- Helped design an online forum where students could post questions and get answers from their peers and myself in real time.

Teaching Assistant *2017-2018*
- Taught Undergraduate Physics I Lab
- Earned 4.9/5.0 on my student teacher evaluations

Service

Georgia Institute of Technology

Physics Allies for Wellness (PAW) *2022*

- A founding member of an association that provides space to address social injustices in the physics department, and university at large, in a manner that prioritizes the safety and anonymity of all involved

Graduate Association of Physics (GAP) *2017-2018*

- Led and coordinated Physics Forum, where each week a graduate student would present their work to their departmental peers

Research Experience

Georgia Institute of Technology, with R. Grigoriev *2018-Present*

I currently work in the Center for Non-linear science, studying methods of simplifying high-dimensional, non-linear systems through understanding their non-ergodic, invariant manifolds.

- Utilized adjoint based optimization to predict when a system will exhibit extreme behavior
- Developed a novel method for approximating a systems statistical behavior from minimal recurrent data
- Developed a robust and low-dimensional method for determining when turbulence is well approximated by a recurrent solution to Naiver-Stokes, in systems with arbitrarily many continuous symmetries
- Created a fast numerical scheme for determining the minimal distance between vectors in systems with arbitrarily many continuous symmetries

Emory University, with S. Boettcher *2016-2018*

I studied the rate at which classical and quantum probability densities traverse various self-similar graphs. Notably, these investigations provided insight into how unitary dynamics allow graphs to be traversed ballistically, whereas classical dynamics do not.

- Studied the asymptotic rate of expansion of quantum systems over self-similar graphs using the renormalization group
- Developed a code suite for simulating and analyzing one-dimensional persistent-classical and quantum walks

Princeton University, with F. Calaprice *2014-2018*

The majority of my time at Princeton was spent with the SABRE collaboration, where we searched for the weakly-interacting, massive dark matter candidate particles (known as WIMPs).

- Helped design and construct the SABRE scintillating-crystal detector.
- Helped design and commission the Sabre insertion system. Design specifications required it to be airtight, chemically resistant, and precisely-controlled.
- Managed relations with numerous internal and external collaborators, acquiring custom parts for the collaboration as well as moderating interpersonal conflicts.

I also briefly worked with the Borexino collaboration, which focuses mostly on Neutrinos. Polonium is a large source of error for both SABRE and Borexino, as it creates a “erroneous” signals, similar to those of interest, as it decays.

- Designed and constructed an automated, non-invasive, wireless, liquid level monitoring system for Princeton’s polonium distillation system.

- Determined the efficiency of Borexino's distillation columns at the National Underground Laboratory at Gran Sasso, Italy.
- Designed and built an enclosure that maximizes the yield of polonium depositions onto silver foils.

Oxford College, with R. Conceicao *2014-2015*

At Oxford College I had my first foray into mathematics, which spurred me to continue studying math to this day (albeit now in a much more applied way).

- Studied the Collatz Conjecture and its polynomial corollary.
- Derived a formula for predicting the total stopping time of all monic polynomials with coefficients in a ring of modulo n.

Work Experience

B-Line Logic, Atlanta, GA *2014-2016*

I was a Core Developer with B-Line Logic, a business that developed efficient tools for distilling Big Data into a small set of optimal actions plans that an employee could choose from and act on, color-coded by optimality.

- Created a predictive-analytics engine for supply chain management.
- Developed system architecture for a distributed event correlation system.
- Managed relations with clients such as Delta Airlines and Cardinal Health.

Interests and Skills

Language (Native)	English
Language (Conversational)	Spanish, Italian, German
Coding (Languages)	Java, MATLAB, Python, Assembly, C++
Coding (Skills)	Machine Learning, big data, PDE simulation, objective function optimization, high-dimensional datasets, data visualization, pattern recognition
Robotics	Built a miniature self balancing, Segway-like robot piloted by an Arduino. Built a robotic hand that tracks the motion of a user-worn glove
Game Design	Created a 3D, single-player game with AI-controlled enemies