

## Timothy G. Raben, Ph.D.

Computational geneticist, theoretical physicist, data scientist. Areas of interest include: bioinformatics, uncertainty quantification, complex trait prediction, methods development, machine learning, AI, algorithms, -omics integration, health care ethics, quantum computing, information theory, cryptography, non-perturbative physics, QCD, conformal field theory, lattice physics, diversity in science, and community service.

**skills** **Programming languages:** Python, (La)Tex, Mathematica, Bash, SLURM, Julia, SQL, C++, Pythia, Fortran, and R. **Methods:** machine learning, penalized regression, neural networks, statistical inference, principal component analysis, association testing, Bayesian and frequentist statistics, linear analysis, Monte Carlo, finite elements, gradient descent, Mellin/Laplace/Fourier analysis. **Subject expertise:** bioinformatics, particle physics, big data computation, high performance computing, error analysis, uncertainty quantification, cloud computing, Amazon web services (AWS), population genetics, polygenic scores (PGS), QCD, string theory, conformal field theory, Regge physics, lattice field theory, and information theory.

**tailored expertise** Extensive 12+ years of experience developing methods, processes, algorithms, and tools using Python, R, MATLAB, SQL, and related programs. This work involves integrating programs, data, reviews, proposals, and technology to gather and extract meaning from large and complex data sets. (Co-)author of at least 10 different grants which included long range planning, developing strategies to meet objectives, and coordination between key participants. Primary author, writer, contributor, and validation of code (languages above) for methods development; data visualizations; interactive plots, graphs, and charts; public documents; and research resources. Research and work utilizes open source materials, private data centers, large-scale and complex data sets, high performance computing, workload managers, and private health care data. Special experience with genomic, phenotypic, and multi-omic data sets.

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**research specialist** Michigan State University **summer 2023 – present**

**professional history**

- Conduct original research in computational genetics and theoretical physics. Responsibilities included designing projects, performing theoretical calculations, writing code, writing/editing manuscripts, keeping abreast of literature, applying for new data sets, managing group data, aiding in grant writing: developed novel code for All of Us biobank analysis, 1 first author genetics publication, 1 first author genetics manuscript under review, 1 other genetics publications under review, 1 physics publication published, and 1 R01 grant in preparation as collaborator.
- Developed and maintained computational pipelines using Python, PLINK, SLURM, cloud computing, bash, R, and SQL. Pipelines utilize remote high performance computing, job management/schedulers, and cloud computing.
- Manage external collaboration with researchers at Academia Sinica (Taiwan), Taiwan Precision Medicine Initiative (TPMI), Taiwan Biobank, and University of California at San Francisco: lead development of polygenic score methods to be applied in new biobanks: 1 manuscript under review and 1 manuscript in preparation.
- Attend external meetings and present original research: American Society of Human Genetics annual meeting 2023, 2024 and future meetings.

**research associate** Michigan State University **fall 2018 – summer 2023**

- Conducted original research in computational genetics and theoretical physics. Responsibilities included designing projects, performing theoretical calculations, writing code, writing/editing manuscripts, keeping abreast of literature, applying for new data sets, managing group data. Results: first or second author of 8 genetics publications; 10 physics publications, (re)gained access to UK Biobank, TOPMed, and All of Us; co-developed several internal hpcc and analysis pipelines.
- Managed external collaboration with researchers at Academia Sinica (Taiwan), Taiwan Precision Medicine Initiative (TPMI), Taiwan Biobank, and University of California at San Francisco: lead development of first creation of height polygenic score in Taiwanese population.
- Developed and maintained computational pipelines using Python, PLINK, SLURM, Julia, and bash. Pipelines utilize remote high performance computing, job management/schedulers, and involved shared development and implementation.
- Trained 2 new postdocs and aided in training of graduate students from other research groups.
- PI of 3 grant applications and collaborator, and primary author, of 2 R01 grant applications.

**research associate** University of Kansas **fall 2016 – fall 2018**

- Conducted original research in high energy particle physics. Responsibilities included designing projects, performing theoretical calculations, writing code, writing/editing manuscripts, keeping abreast of literature. Results: 6 manuscripts, co-wrote 3 grant applications as a collaborator, and developed computational pipelines.
- Attended and presented original research at 9 conferences in North America and Europe. 3 of the conferences also entailed being on the organizing committee and session organizer.
- Primary supervisor of 1 theory graduate student and aided in the supervision of 5 graduate students and 1 undergraduate student.

**research associate** Brown University **spring 2016 – fall 2016**

- Finished a project in theoretical physics resulting in the publication of 1 manuscript in lattice field theory and attending an interdisciplinary Gordon conference.

**visiting assistant professor** Brown University **winter 2016 – spring 2016**

- Designed and teach an original course for undergraduate and graduate students in quantum information. Primary sources used were “Quantum Processes Systems, and Information” by Schumacher and “Quantum Computation and Quantum Information” by Nielsen and Chuang.
- Lectured, developed homework sets, mentored students, held office hours, designed exams, oversaw student projects.
- Continued original research in theoretical particle physics.

**graduate research assistant** Brown University **fall 2014 – winter 2016**

- Conducted original research in theoretical particle physics. Responsibilities included designing projects, performing theoretical calculations, writing code, writing/editing manuscripts, keeping abreast of literature. Results: 4 manuscripts, managed several journal clubs, developed computational pipelines.
- Attended and presented original research at 12 conferences/workshops in North America, South America, and Europe.
- Co-lead mentor programs for physics graduate students and graduate teaching assistants.

professional  
history  
cont'd

- Designed a 30 hour intensive course, from the ground up, about quantum mechanics for high school students. Course involved lectures, group work, demonstrations, homework, readings, presentations, and in class problems.
- Mentored  $\sim 30$  students about applying to colleges, college life, and careers in science.
- Lectured at associated middle school summer program.

professional  
history  
cont'd

NSF GK-12 fellow Brown University fall 2012 – fall 2014

- Designed and teach experiment-based 4th grade and special education science classes at Vartan Gregorian elementary school in Providence Rhode Island. Included  $\sim 10$  hours/week of in class work and  $\sim 10$  hours/week preparation
- Other  $\sim 50\%$  of the time was dedicated to conducting original research in theoretical particle physics. Design projects, perform theoretical calculations, write code, write/edit manuscripts, keep abreast of literature: managed several journal clubs, developed computational pipelines.
- Attended 5 workshops and conferences in Asia and the USA.

education

degree	institute	year	subject	advisor
Ph.D.	Brown University	2016	physics	Chung-I Tan
Sc.M.	Brown University	2012	physics	
B.S.	University of Michigan	2009	physics Hon. Math	Leopoldo Pando-Zayas

Full list can be found at my Google Scholar page.

genetics

selected  
authorship

- *Efficient blockLASSO for Polygenic Scores with Applications to All of Us and UK Biobank.* **Timothy G. Raben**, Louis Lello, Erik Widen, & Stephen D.H. Hsu. *under review*
- *Biobank-scale methods and projections for sparse polygenic prediction from machine learning.* **Timothy G. Raben**, Louis Lello, Erik Widen, & Stephen D.H. Hsu. Scientific Reports vol 13, 11662 (2023)
- *Sibling variation in polygenic traits and DNA recombination mapping with UK Biobank and IVF family data.* Louis Lello, Maximus Hsu, Erik Widen & **Timothy G. Raben**. Scientific Reports vol 13, 376 (2023)
- *Polygenic Health Index, General Health, and Pleiotropy: Sibling Analysis and Disease Risk Reduction.* Erik Widen, Louis Lello, **Timothy G. Raben**, Laurent C. A. M. Tellier & Stephen D. H. Hsu. Scientific Reports vol 12, 18173 (2022)
- *From Genotype to Phenotype: Polygenic Prediction of Complex Human Traits.* **Timothy G. Raben**, Louis Lello, Erik Widen, & Stephen D.H. Hsu. In: Ahmadi, N., Bartholomé, J. (eds) Genomic Prediction of Complex Traits. Methods in Molecular Biology, vol 2467. Humana, New York, NY
- *Machine Learning Prediction of Biomarkers from SNPs and of Disease Risk from Biomarkers in the UK Biobank.* Erik Widen, **Timothy G. Raben**, Louis Lello, & Stephen D.H. Hsu. Genes vol 12, 7 (2021)
- *Sibling validation of polygenic risk scores and complex trait prediction.* Louis Lello, **Timothy G. Raben** & Stephen D. H. Hsu. Scientific Reports vol 10, 13190 (2020)
- *Genetic architecture of complex traits and disease risk predictors.* Soke Yuen Yong, **Timothy G. Raben**, Louis Lello & Stephen D. H. Hsu. Scientific Reports vol 10, 12055 (2020)
- *Genomic Prediction of 16 Complex Disease Risks Including Heart Attack, Diabetes, Breast and Prostate Cancer* Louis Lello, **Timothy G. Raben**, Soke Yuen Yong, Laurent C. A. M. Tellier & Stephen D. H. Hsu. Scientific Reports vol 9, 15286 (2019)

**physics** (authors listed alphabetically)

selected authorship cont'd	<ul style="list-style-type: none"> <li>• <i>The Operator Product Expansion for Radial Lattice Quantization of 3D <math>\phi^4</math> Theory</i> V Ayyar, RC Brower, GT Fleming, AME Glück, EK Owen, TG Raben, C-I Tan, Physical Review D 109 (11), 114518 (2024)</li> <li>• <i>First computation of Mueller Tang processes using a full NLL BFKL approach.</i> Dimitri Colferai, Federico Deganutti, Timothy G. Raben &amp; Christophe Royon. Journal of High Energy Physics vol 2023, 91 (2023)</li> <li>• <i>Embedding Space Approach to Lorentzian CFT Amplitudes and Causal Spherical Functions.</i> Pulkit Agarwal, Richard C. Brower, Timothy G. Raben, &amp; Chung-I Tan. arxiv:2302.06469 (2023)</li> <li>• <i>Radial lattice quantization of 3D <math>\phi^4</math> field theory.</i> Richard C. Brower, George T. Fleming, Andrew D. Gasbarro, Dean Howarth, Timothy G. Raben, Chung-I Tan, &amp; Evan S. Weinberg. Physical Review D vol 104, 094502 (2021)</li> <li>• <i>Odderon Exchange from Elastic Scattering Differences between <math>pp</math> and <math>p^-p</math> Data at 1.96 TeV and from <math>pp</math> Forward Scattering Measurements</i> V.M. Abazov et al. Physical Review Letters vol 127, 062003 (2021)</li> <li>• <i>Minkowski conformal blocks and the Regge limit for Sachdev-Ye-Kitaev-like models.</i> Timothy G. Raben &amp; Chung-I Tan. Physical Review D vol 98, 086009 (2018)</li> <li>• <i>Lattice <math>\phi^4</math> field theory on Riemann manifolds: Numerical tests for the 2D Ising CFT on <math>\mathbb{S}^2</math>.</i> Richard C. Brower, Michael Cheng, Evan S. Weinberg, George T. Fleming, Andrew D. Gasbarro, Timothy G. Raben, &amp; Chung-I Tan. Physical Review D 98, 014502 (2018)</li> <li>• <i>Inclusive production through AdS/CFT.</i> Richard Nally, Timothy Raben &amp; Chung-I Tan. Journal of High Energy Physics vol 2017, 75 (2017)</li> <li>• <i>Lattice Dirac fermions on a simplicial Riemannian manifold.</i> Richard C. Brower, Evan S. Weinberg, George T. Fleming, Andrew D. Gasbarro, Timothy G. Raben, &amp; Chung-I Tan. Physical Review D vol 95, 114510 (2017)</li> <li>• <i>Strong coupling expansion for the conformal Pomeron/Odderon trajectories.</i> Richard C. Brower, Miguel S. Costa, Marko Djurić, Timothy Raben &amp; Chung-I Tan. Journal of High Energy Physics vol 2015, 104 (2015)</li> </ul>
grants	<hr/> <p>Submitted 3 N.I.H. K-25 grants. Co-author of 3 submitted NIH R01 grants. Co-author on two D.O.E. grants (one successfully awarded \$400k), two N.S.F. grants, a D.O.D. grant, and a N.A.S.A. grant. Previous recipient of an NSF GK-12 fellowship for 2 years of graduate school funding and stipend.</p>
service and committees	<p><b>current:</b> American Society of Human Genetics (ASHG) Special Interest Group committee. American Physics Society - Inclusion, Diversity, and Equity Alliance (APS-IDEA) network. MSU dept. of physics and astronomy diversity, equity, and inclusion committee. <b>previous:</b> MSU faculty advisory committee (FAC). Brown Univ. dept. of physics curriculum committee, physics mentor program coordinator, and physics TA training coordinator.</p> <p><b>Peer reviewer:</b> Nature Communications, Annals of Human Biology.</p> <hr/>
selected conference presentations and organization	<ul style="list-style-type: none"> <li>• ASHG Annual Meeting 2024 Denver CO, USA, Nov 2024</li> <li>• Southern California Symposium on Polygenic Risk Scores September 2024</li> <li>• ASHG Annual Meeting 2023 Washington DC, USA, Nov 2023</li> <li>• Academia Sinica, Taipei, Taiwan, July 2023</li> <li>• "Taiwan Precision Health Symposium", Taipei, Taiwan, July 2023</li> <li>• ASHG Annual Meeting 2022 Los Angeles, CA, USA, Oct 2022</li> <li>• "Diffraction &amp; Low-x 2018" (organizing committee &amp; session organizer) Reggio Calabria, Italy Aug 2018</li> <li>• "15th Workshop on Non-perturbative QCD" (session organizer) Paris, France, June 2018</li> </ul>

Brown Univ. dept. of physics Beyer Award: for excellence in scholarship and service (2016). Brown Univ. faculty fellowship: full funding for the final semester of graduate work and appointment as a visiting assistant professor for a semester immediately following graduation (2015-2016). Brown Univ. conference travel award (Aug 2015, Mar 2015, Mar 2014). Brown Univ. international travel award (Aug 2015, Mar 2015, Mar 2014). Brown Univ. Joukowsky summer research travel award (2014). National Science Foundation: GK-12 Fellow (2011-2013). Summer@Brown Archambault Teaching Award second place (2012). Brown Univ. dept. of physics award for excellence as a graduate teaching assistant (2010-2011). Brown Univ. presidential award for excellence in teaching physics dept. nominee (2010-2011). Univ. of Michigan Physics Addison-Wesley Award: Presented to a graduating senior for outstanding contributions to the life of the physics department (2010). Univ. of Michigan university honors (Apr 2007, Dec 2007, Dec 2008)

**awards and fellowships**

Quantum Information— PHYS1970F, Course Designer & Instructor, Brown Univ. (Spring 2016). Course Grader Brown Univ. physics 1600, Computational Physics (2015). Designer & Instructor, Summer@Brown—The Quantum Revolution in Technology: 30 hour summer school course for advanced high school students (2012, 2013, 2014, 2015, 2016). Course Grader, Brown Univ.—Physics 0070, Advanced Analytic Mechanics (2012, 2013, 2014). Course Grader, Brown Univ. physics 2040, Graduate Electricity & Magnetism (2012). 4th grade science teacher at Vartan Gregorian Elementary School in Providence, RI (2011-2012, 2012-2013, 2013-2014). Community & TA Mentor, Brown Univ. dept. of physics (2011-2016). Science teacher at “Brown Summer High School” (2011). Teaching assistant, Brown Univ. physics 0560, Modern Physics (2011). Teaching Assistant, Brown Univ. physics 0470, Electricity & Magnetism (2010). Course Grader, Univ. of Michigan physics 457, Cosmology (2010). Physics tutor, Univ. of Michigan physics (2010).

**teaching**

American Society of Human Genetics (ASHG), European Society of Human Genetics (ESHG), American Physical Society (APS), Sigma Pi Sigma (honor society for physics and astronomy), and Golden Key.

**societies**