

Patrick T. Komiske III

Curriculum Vitae

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Patrick Komiske
MIT Center for Theoretical Physics
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Education

Massachusetts Institute of Technology

Fall 2016 - Present

Ph.D. Candidate in the Center for Theoretical Physics
Advisor: [Jesse Thaler](#)
Degree expected June 2021

Harvard University

Fall 2012 - Spring 2016

A.M., Physics
A.B., *summa cum laude*, Physics (highest honors) and Mathematics
Secondary field in computer science

Research in Theoretical Particle Physics

- Collider physics phenomenology, machine learning, quantum chromodynamics
- Algorithm/software development for collider tools and strategies
- Analyses of public and archival collider data

Honors

- *Summa cum laude*, Harvard College, *May 2016*
- Highest honors, Harvard Physics Department, *May 2016*
- John Harvard Scholarship, *2014-2015*
- Derek C. Bok Award for Distinction in Teaching, *2014*
- University Physics Competition Silver Medal, *2014*
- Harvard College Scholarship, *2013-2014*
- National AP Scholar, *2011*

Mentorship

- Nishat Protyasha, MIT UROP, *Fall 2020 - Present*
- Shira Jackson, MIT Summer Research Program, *Summer 2020 - Present*
- Serhii Kryhin, MIT UROP, *Spring 2020 - Present*
- Nilai Sarda, MIT M.Eng., *Spring 2020*
- Radha Mastandrea, MIT UROP, *Spring 2019*
- Preksha Naik, MIT M.Eng., *Spring 2019*
- Simon Thor, RSI, *Summer 2018*
- Maximilian Henderson, International Research Opportunities Programme, *Summer 2018*
- Edward Hirst, International Research Opportunities Programme, *Summer 2018*
- Rahim Leung, International Research Opportunities Programme, *Summer 2017*

Papers

Publications

- [12] Patrick T. Komiske, Eric M. Metodiev, and Jesse Thaler, *The Hidden Geometry of Particle Collisions*, *JHEP* **07** (2020) 006 [[2004.04159](#)].
- [11] Anders Andreassen, Patrick T. Komiske, Eric M. Metodiev, Benjamin Nachman, and Jesse Thaler, *OmniFold: A Method to Simultaneously Unfold All Observables*, *Phys. Rev. Lett.* **124** (2020) 182001 [[1911.09107](#)].
- [10] Patrick T. Komiske, Eric M. Metodiev, and Jesse Thaler, *Cutting Multiparticle Correlators Down to Size*, *Phys. Rev. D* **101** (2020) 036019 [[1911.04491](#)].
- [9] Patrick T. Komiske, Radha Mastandrea, Eric M. Metodiev, Preksha Naik, and Jesse Thaler, *Exploring the Space of Jets with CMS Open Data*, *Phys. Rev. D* **101** (2020) 034009 [[1908.08542](#)].
- [8] Gregor Kasieczka and Tilman Plehn, eds., et al., *The Machine Learning Landscape of Top Taggers*, *SciPost Phys.* **7** (2019) 014 [[1902.09914](#)].
- [7] Patrick T. Komiske, Eric M. Metodiev, and Jesse Thaler, *Metric Space of Collider Events*, *Phys. Rev. Lett.* **123** (2019) 041801 [[1902.02346](#)].
- [6] Patrick T. Komiske, Eric M. Metodiev, and Jesse Thaler, *Energy Flow Networks: Deep Sets for Particle Jets*, *JHEP* **01** (2019) 121 [[1810.05165](#)].
- [5] Patrick T. Komiske, Eric M. Metodiev, and Jesse Thaler, *An operational definition of quark and gluon jets*, *JHEP* **11** (2018) 059 [[1809.01140](#)].
- [4] Patrick T. Komiske, Eric M. Metodiev, Benjamin Nachman, and Matthew D. Schwartz, *Learning to classify from impure samples with high-dimensional data*, *Phys. Rev. D* **98** (2018) 011502 [[1801.10158](#)].
- [3] Patrick T. Komiske, Eric M. Metodiev, and Jesse Thaler, *Energy flow polynomials: A complete linear basis for jet substructure*, *JHEP* **04** (2018) 013 [[1712.07124](#)].

- [2] Patrick T. Komiske, Eric M. Metodiev, Benjamin Nachman, and Matthew D. Schwartz, *Pileup Mitigation with Machine Learning (PUMML)*, *JHEP* **12** (2017) 051 [[1707.08600](#)].
- [1] Patrick T. Komiske, Eric M. Metodiev, and Matthew D. Schwartz, *Deep learning in color: towards automated quark/gluon jet discrimination*, *JHEP* **01** (2017) 110 [[1612.01551](#)].

Works in Progress

- Samuel Alipour-fard, Patrick T. Komiske, Eric M. Metodiev, and Jesse Thaler, *Safe Drop Grooming and Pileup Mitigation*, in preparation.
- Patrick T. Komiske, Ian Mout, Jesse Thaler, and HuaXing Zhu, *Analyzing N-Point Energy Correlators with CMS Open Data*, in preparation.
- Patrick T. Komiske, Eric M. Metodiev, Nilai Sarda, and Jesse Thaler, *Factorized Topic Modeling for Particle Physics*, in preparation.
- Patrick T. Komiske, Serhii Kryhin, Eric M. Metodiev, and Jesse Thaler, *Disentangling Quarks and Gluons in CMS Open Data*, work in progress.
- Eric R. Anschuetz, Patrick T. Komiske, and Jesse Thaler, *Quantum Annealing for Sparse Linear Regression: A Case Study in High Energy Physics*, work in progress.
- Anthony Badea, Patrick T. Komiske, Eric M. Metodiev, Benjamin Nachman, Yen-Jie Lee, Jesse Thaler, Austin Baty, and Chris McGinn, *Multi-Differential and Unbinned Measurements of Hadronic Event Shapes in e^+e^- Collisions at $\sqrt{s} = 91$ GeV in ALEPH Open Data*, work in progress.
- Yang-Ting Chien, Patrick T. Komiske, Iain W. Stewart, and Gherardo Vita, *Collinear Drop at NNLL*, work in progress.

Refereeing

- *Physical Review Letters* (PRL)
- *Physical Review D* (PRD)
- Machine Learning and the Physical Sciences Workshop at NeurIPS 2020

Presentations

Plenary Talks

- “OmniFold: Simultaneously Unfolding All Observables,” ML4Jets2020, *NYU*, Jan. 2020.
- “Cutting Multiparticle Correlators Down to Size,” BOOST 2019, *MIT*, Jul. 2019.
- “The Metric Space of Collider Events,” Deep Learning in the Natural Sciences, *U. Hamburg*, Mar. 2019.
- “Point Cloud Strategies for Boosted Objects,” BSM Forum, *CERN*, Feb. 2019.
- “Energy Flow Networks: Deep Sets for Particle Jets,” Machine Learning for Jet Physics, *Fermilab*, Nov. 2018.

- “Point Cloud Strategies for Boosted Tops,” Boosted Objects for New Physics Searches, *Fermilab*, Nov. 2018.
- “Energy Flow and Jet Substructure,” BOOST 2018, *Paris*, Jul. 2018.
- “Energy Flow Polynomials for Jet Substructure,” Jet Workshop, *MIT*, Jan. 2018.
- “Linear Jet Tagging with the Energy Flow Basis,” Machine Learning for Jet Physics, *LBL*, Dec. 2017.
- “Quark/Gluon Discrimination with Jet-Images and Deep Learning,” BOOST 2017, *Buffalo, NY*, Jul. 2017.

Seminars

- “Simultaneously Unfolding All Observables with Deep Learning,” Jefferson Lab Theory Seminar, *virtual*, Jan. 2021.
- “The Hidden Geometry of Particle Collisions,” BSM Pandemic Double Feature, *virtual*, Dec. 2020.
- “The Hidden Geometry of Particle Collisions,” Particle Physics Phenomenology Series, *Genoa (virtual)*, Jun. 2020.
- “The Metric Space of Collider Events,” Particle Physics Seminar, *U. Chicago*, May 2019.
- “Point Cloud Strategies for Boosted Tops,” ML-HEP-LBL Meetup, *LBL*, Apr. 2019.
- “The (Metric) Space of Collider Events,” Elementary Particle Theory Seminar, *U. Maryland*, Mar. 2019.

Other Talks

- “Probing QCD with Energy Flow Observables,” CEPC Workshop, *Shanghai, China (virtual)*, Oct. 2020.
- “Machine Learning – An Essential Toolkit for Particle Physics,” Snowmass Computational Frontier Workshop, *virtual*, Aug. 2020.
- “Energy Flow for Collider Physics,” (with Eric Metodiev), (B)SM/LHC/QCD/DM CTP Journal Club, *MIT*, Mar. 2020.
- “Energy Flow and Jet Substructure,” Particle Physics Lunch Talk, *Harvard*, Nov. 2018.
- “Analyzing Jet Substructure via Energy Flow,” (B)SM/DM/LHC/QCD/ML CTP Journal Club, *MIT*, Oct. 2018.
- “(Machine) Learning Jet Physics,” CTP Lunch Talk, *MIT*, May 2018.
- “Jet Physics & Modern Machine Learning,” (with Eric Metodiev), Particle Physics Lunch Talk, *Harvard*, Feb. 2018.
- “Quark/Gluon Discrimination with Jet-Images and Deep Learning,” BSM/DM/LHC CTP Journal Club, *MIT*, Sep. 2017.

Teaching Experience

Massachusetts Institute of Technology

- 8.(3)09 – Advanced Classical Mechanics – Teaching Assistant
 - Taught recitation: *Fall 2018, 2019*; Graded: *Fall 2017*
 - Lecturer: Prof. Iain Stewart

Harvard University

- Physics 143a – Quantum Mechanics I – Teaching Fellow
 - Taught section and graded: *Fall 2015*
 - Lecturer: Prof. Matthew Reece
- Physics 16 – Honors Introductory Mechanics and Special Relativity – Teaching Fellow
 - Taught section: *Fall 2014*
 - Lecturer: Prof. Howard Georgi
- Math 1b – Calculus, Series, and Differential Equations – Course Assistant
 - Taught section and worked in math question center: *Fall 2013*

Research/Work Experience

Harvard University

Program for Research in Science and Engineering (PRISE) Fellow, *Summer 2015*

- Computed the normal modes of an exponential block-spring system allowing for the definition of a family of Fourier-like discrete transformations from position space to mode space, worked with Profs. Howard Georgi and Matthew Schwartz
- Explored the quantum-to-classical transition through decoherence to a pointer basis, worked with Prof. Matthew Reece

Jane Street Capital – New York, NY

Winter Trading Intern: *Jan. 2015, 2016*

- Analyzed financial markets
- Wrote bash program to study novel type of options trade
- Participated in mock trading

Northrop Grumman Electronic Systems – Baltimore, MD

Summer Intern: *May-Aug. 2014*

- Superconducting Electronics Group, Quantum Computing Collaboration
- Wrote MATLAB program to improve fidelity of high-speed, precision microwave pulses used for qubit control via calculation of a transfer function and deconvolution methods

Johns Hopkins University Applied Physics Laboratory – Laurel, MD

Summer Intern: *May-Aug. 2012, May-Aug. 2013*

- Asymmetric Operations and Research and Exploratory Development Departments
- Investigated electromagnetic properties of high-impedance Sienviper metamaterial structures for low-profile RF antenna applications, characterized material properties of magnetic nanoparticle polymers
- Catalogued dielectric properties of explosive simulant materials for transportation security purposes

Related Experience

MIT Physics Graduate Student Council

Colloquium representative and lunch organizer: *Spring 2017 - Fall 2018*

- Arranged and hosted PGSC colloquium speaker once a semester
- Organized biweekly lunches with physics department colloquium speaker

Harvard-Radcliffe Society of Physics Students

Event coordinator: *Fall 2015 - Spring 2016*

- Helped organize the first Harvard-MIT SPS Research Conference for undergraduates to present their research
- Facilitated movie nights and liquid nitrogen ice cream events, coordinated freshman and pre-frosh outreach

Software Libraries and Datasets

- **EnergyFlow**

- Python package for the EnergyFlow suite of tools including:
 - Computing Energy Flow Polynomials (EFPs)
 - Computing Energy Flow Moments including for efficient EFP computation
 - Implementing Energy/Particle Flow Networks in Keras/Tensorflow
 - Facilitating evaluation of the Energy Mover's Distance
 - Interfaces with public particle physics datasets, including the MOD Jet Dataset
 - Utilities for working with particle kinematics in Python
- Documentation: <https://energyflow.network>
- GitHub: <https://github.com/pkomiske/EnergyFlow>
- PyPI: <https://pypi.org/project/EnergyFlow>
- Binder: <https://mybinder.org/v2/gh/pkomiske/EnergyFlow/master>
- Datasets:
 - Pythia8 Quark and Gluon Jets: <https://doi.org/10.5281/zenodo.3164691>
 - Herwig Quark and Gluon Jets: <https://doi.org/10.5281/zenodo.3066475>
 - Pythia/Herwig + Delphes Jet Datasets for OmniFold Unfolding: <https://doi.org/10.5281/zenodo.3548091>
 - MOD datasets (see below) designed to be accessed via EnergyFlow

- **MOD**

- GitHub: <https://github.com/pkomiske/MOD>
- Datasets:
 - CMS 2011A Jet Primary Dataset in MOD HDF5 Format: <https://doi.org/10.5281/zenodo.3340205>
 - CMS 2011A Simulation Pythia 6 QCD 170-300 in MOD HDF5 Format: <https://zenodo.org/record/3340205>

- CMS 2011A Simulation Pythia 6 QCD 300-470 in MOD HDF5 Format: <https://zenodo.org/record/3341498>
- CMS 2011A Simulation Pythia 6 QCD 470-600 in MOD HDF5 Format: <https://zenodo.org/record/3341419>
- CMS 2011A Simulation Pythia 6 QCD 600-800 in MOD HDF5 Format: <https://zenodo.org/record/3364139>
- CMS 2011A Simulation Pythia 6 QCD 800-1000 in MOD HDF5 Format: <https://zenodo.org/record/3341413>
- CMS 2011A Simulation Pythia 6 QCD 1000-1400 in MOD HDF5 Format: <https://zenodo.org/record/3341502>
- CMS 2011A Simulation Pythia 6 QCD 1400-1800 in MOD HDF5 Format: <https://zenodo.org/record/3341770>
- CMS 2011A Simulation Pythia 6 QCD 1800- in MOD HDF5 Format: <https://zenodo.org/record/3341772>
- **Wasserstein**
 - A Python/C++ library for computing the p-Wasserstein distances, known as the Earth Mover’s Distance for $p = 1$ and the Energy Mover’s Distance in particle physics.
 - Documentation: <https://pkomiske.github.io/Wasserstein>
 - GitHub: <https://github.com/pkomiske/Wasserstein>
 - PyPI: <https://pypi.org/project/Wasserstein>
- **EnergyEnergyCorrelators**
 - A Python/C++ library for computing N -point Energy-Energy Correlators and related high-dimensional structures.
 - GitHub: <https://github.com/pkomiske/EnergyEnergyCorrelators>
 - PyPI: <https://pypi.org/project/eec/>
- **EventGeneration**
 - A C++ library for facilitating particle physics event generation with [Pythia 8](#) and [FastJet 3](#) including matching of the hard-process, parton-level, and hadron-level events.
 - GitHub: <https://github.com/pkomiske/EventGeneration>
- **PUMML**
 - An implementation of the jet-image-based PUMML architecture in Keras.
 - GitHub: <https://github.com/pkomiske/PUMML>
 - Pileup Jet Dataset: <https://doi.org/10.5281/zenodo.2652034>