Patrick T. Komiske III

Curriculum Vitae
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Patrick Komiske
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Education

Massachusetts Institute of Technology *Fall 2016 - Present*
Ph.D., Center for Theoretical Physics
NSF AI Institute for Artificial Intelligence and Fundamental Interactions
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

[13] Gregor Kasieczka, Benjamin Nachman, and David Shih, eds., et al., *The LHC Olympics 2020: A Community Challenge for Anomaly Detection in High Energy Physics*, 2101.08320.

[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 Moult, 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

- "OmniFold: Simultaneously Unfolding All Observables with Deep Learning," CMS Machine Learning Forum, *virtual, Feb. 2021*.
- "OmniFold: Improved Unfolding with Deep Learning," LHC Electroweak/Jets Working Group Seminar, *virtual, Feb. 2021*.
- "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 Sievenpiper 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