

Andrew Chael | CV

CONTACT	411A Jadwin Hall Center for Theoretical Science Princeton University Princeton, NJ 08540	<i>Phone:</i> (609) 258-1149 <i>E-mail:</i> achael@princeton.edu <i>Website:</i> blackholesshadow.com <i>GitHub:</i> github.com/achael
RESEARCH INTERESTS	Astrophysical black holes, accretion, relativistic jets, magnetohydrodynamic simulations, computational imaging.	
EDUCATION	Harvard University , Cambridge, MA <i>Ph.D. in Physics, May 2019</i> <i>A.M. in Physics, March 2015</i>	2013 – 2019
	Carleton College , Northfield, MN <i>B.A. in Physics summa cum laude, June 2013</i> <i>Secondary Concentration in Medieval and Renaissance Studies</i>	2009 – 2013
RESEARCH EXPERIENCE	NASA Hubble Fellowship Program Einstein Fellow <i>Princeton Center for Theoretical Science</i> <ul style="list-style-type: none">• Proposal Title: Simulating and Imaging Flaring Black Holes on Horizon Scales	2019 –
	Black Hole Initiative Postdoctoral Fellow <i>Center for Astrophysics / Harvard & Smithsonian</i>	2019
	Graduate Researcher <i>Accretion Theory, Center for Astrophysics / Harvard & Smithsonian</i> <ul style="list-style-type: none">• Adviser: Ramesh Narayan• Work on evolving relativistic thermal and nonthermal particle populations in simulations of black hole accretion.• Maintain and develop KORAL, a massively parallel C code to evolve plasmas in general relativity.	2015 – 2019
	Graduate Researcher <i>VLBI Imaging, Center for Astrophysics / Harvard & Smithsonian</i> <ul style="list-style-type: none">• Advisers: Sheperd Doeleman and Michael Johnson• Work on image reconstruction and polarimetry using Event Horizon Telescope observations of Sagittarius A* and M87.• Wrote and developed ehtim, an open-source python software suite for data analysis and imaging in radio interferometry.	2014 – 2019

- Graduate Researcher** 2015
Cosmology, Harvard University Department of Physics
 • Adviser: Cora Dvorkin
 • Worked on constraining light dark matter scattering with baryons.
- Undergraduate Research Assistant** 2011 – 2012
Pulsar Astronomy, CSIRO Astronomy and Space Science
 • Adviser: Ryan Shannon
 • Worked on statistical analysis of pulsar emission polarization and pulsar timing array observations with the Parkes radio telescope.
- Undergraduate Research Assistant** 2010 – 2013
Pulsar Astronomy, Carleton College
 • Adviser: Joel Weisberg
 • Worked on refining uncertainties on pulsar distances with accurate statistics and precision timing of binary orbit decay from gravitational wave emission.
- TEACHING AND MENTORSHIP EXPERIENCE** **Resident Tutor** 2015 – 2019
Dunster House, Harvard College
 • Serve as a live-in mentor and resident advisor for Harvard undergraduates.
 • Lead BGLTQ mentoring and advising.
- Fellowships Committee Chair** 2017 – 2019
Dunster House, Harvard College
 • Lead fellowships and graduate school advising for ~400 undergraduates.
 • Conduct advising meetings, review applications, and lead mock interviews.
 • Write Harvard College endorsement letters for scholarship applicants.
- Teaching Consultant** 2016 – 2018
Department of Physics, Harvard University
 • Mentored new Physics Teaching Fellows in workshops and review sessions.
- Teaching Fellow** 2015 – 2016
Department of Physics, Harvard University
 • PHYS 125: Widely Applied Physics, Fall 2015. (Prof. John Doyle)
 • PHYS 175: Laser and Modern Optical Physics, Spring 2016. (Prof. Markus Greiner)
 • Designed and ran interactive weekly sections as the sole teaching fellow for two upper-level undergraduate courses.
 • Wrote and graded weekly problem sets, midterms, and final exams.
- Peer Tutor** 2010 – 2013
Carleton College Department of Physics
 • Assisted introductory physics students with group study sessions.
 • Led student telescope observations for astronomy class research projects.

Writing Consultant

2010 – 2013

Carleton College Writing Center

- Assisted students with academic writing via one-on-one tutoring.
- Served as designated course writing assistant for three freshman seminars.

FIRST AUTHOR PUBLICATIONS **A Chael**, R Narayan, M Johnson. “Two-temperature, Magnetically Arrested Disc simulations of the supermassive black hole in M87.” *Monthly Notices of the Royal Astronomical Society* 486, p.2873-2895, 2019.
doi:[10.1093/mnras/stz988](https://doi.org/10.1093/mnras/stz988)

A Chael, M Rowan, R Narayan, MD Johnson, L Sironi. “The role of electron heating physics in images and variability of the Galactic Center black hole Sagittarius A*.” *Monthly Notices of the Royal Astronomical Society* 478, p.5209–5229, 2018.
doi:[10.1093/mnras/sty1261](https://doi.org/10.1093/mnras/sty1261)

A Chael, MD Johnson, KL Bouman, L Blackburn, K Akiyama, R Narayan. “Interferometric imaging directly with closure phases and closure amplitudes.” *The Astrophysical Journal* 857, 23, 2018.
doi:[10.3847/1538-4357/aab6a8](https://doi.org/10.3847/1538-4357/aab6a8)

A Chael, R Narayan, A Sadowski. “Evolving non-thermal electrons in simulations of black hole accretion.” *Monthly Notices of the Royal Astronomical Society* 470, p.2367–2386, 2017.
doi:[10.1093/mnras/stx1345](https://doi.org/10.1093/mnras/stx1345)

A Chael, MD Johnson, R Narayan, SS Doeleman, J Wardle, KL Bouman. “High-resolution linear polarimetric imaging for the Event Horizon Telescope.” *The Astrophysical Journal* 829, 11, 2016.
doi:[10.3847/0004-637X/829/1/11](https://doi.org/10.3847/0004-637X/829/1/11)

COLLABORATION PUBLICATIONS The Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope results I: the shadow of the supermassive black hole.” *The Astrophysical Journal Letters* 875, L1, 2019.
doi:[10.3847/2041-8213/ab0ec7](https://doi.org/10.3847/2041-8213/ab0ec7)

The Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope results II: array and instrumentation.” *The Astrophysical Journal Letters* 875, L2, 2019.
doi:[10.3847/2041-8213/ab0c96](https://doi.org/10.3847/2041-8213/ab0c96)

The Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope results III: data processing and calibration.” *The Astrophysical Journal Letters* 875, L3, 2019.
doi:[10.3847/2041-8213/ab0c57](https://doi.org/10.3847/2041-8213/ab0c57)

The Event Horizon Telescope Collaboration et al., "First M87 Event Horizon Telescope results IV: imaging the central supermassive black hole." *The Astrophysical Journal Letters* 875, L4, 2019. **(One of five paper coordinators)**
doi:[10.3847/2041-8213/ab0e85](https://doi.org/10.3847/2041-8213/ab0e85)

The Event Horizon Telescope Collaboration et al., "First M87 Event Horizon Telescope results V: physical origin of the asymmetric ring." *The Astrophysical Journal Letters* 875, L5, 2019.
doi:[10.3847/2041-8213/ab0f43](https://doi.org/10.3847/2041-8213/ab0f43)

The Event Horizon Telescope Collaboration et al., "First M87 Event Horizon Telescope results VI: the shadow and mass of the central black hole." *The Astrophysical Journal Letters* 875, L6, 2019.
doi:[10.3847/2041-8213/ab1141](https://doi.org/10.3847/2041-8213/ab1141)

OTHER PUBLICATIONS

S Issaoun, MD Johnson, L Blackburn, M Moscibrodzka, **A Chael**, H Falcke. "VLBI imaging of black holes via second moment regularization. *Astronomy and Astrophysics* 629, A32, 2019. doi:[10.1051/0004-6361/201936156](https://doi.org/10.1051/0004-6361/201936156)

S Issaoun et al. "The size, shape and scattering of Sagittarius A* at 86 GHz: first VLBI with ALMA." *The Astrophysical Journal* 871, 30, 2019.
doi:[10.3847/1538-4357/aaf732](https://doi.org/10.3847/1538-4357/aaf732)

W Lu, C Dvorkin, **A Chael**. "Probing sub-GeV dark matter-baryon scattering with cosmological observables." *Physical Review D* 97, 103530, 2018.
doi:[10.1103/PhysRevD.97.103530](https://doi.org/10.1103/PhysRevD.97.103530)

KL Bouman, MD Johnson, A Dalca, **A Chael**, F Roelofs, SS Doleman, W Freeman. "Reconstructing video from interferometric measurements of time-varying sources." *IEEE Transactions on Computational Imaging*, 2018.
doi:[10.1109/TCI.2018.2838452](https://doi.org/10.1109/TCI.2018.2838452)

MD Johnson, KL Bouman, L Blackburn, **A Chael**, J Rosen, H Shiokawa, F Roelofs, K Akiyama, V Fish, SS Doleman. "Dynamical imaging with interferometry." *The Astrophysical Journal* 850, 172, 2018.
doi:[10.3847/1538-4357/aa97dd](https://doi.org/10.3847/1538-4357/aa97dd)

A Sadowski, M Wielgus, R Narayan, D Abarca, J McKinney, **A Chael**. "Radiative, two-temperature simulations of low-luminosity black hole accretion flows in general relativity." *Monthly Notices of the Royal Astronomical Society* 466, p. 705–725, 2018.
doi:[10.1093/mnras/stw3116](https://doi.org/10.1093/mnras/stw3116)

K Akiyama, K Kuramochi, S Ikeda, V Fish, F Tazaki, M Honma, SS Doeleman, A Broderick, J Dexter, M Moscibrodzka, KL Bouman, **A Chael**, A Zaizen. "Imaging the Schwarzschild-radius-scale structure of M87 with the Event Horizon Telescope using sparse modeling." *The Astrophysical Journal* 838, 1, 2017.

doi:[10.3847/1538-4357/aa6305](https://doi.org/10.3847/1538-4357/aa6305)

G Ortiz-Leon et al. "The intrinsic shape of Sagittarius A* at 3.5-mm wavelength." *The Astrophysical Journal* 824, 40, 2016.

doi:[10.3847/0004-637X/824/1/40](https://doi.org/10.3847/0004-637X/824/1/40)

V Fish et al. "Persistent asymmetric structure of Sagittarius A* on event horizon scales." *The Astrophysical Journal* 820, 90, 2016.

doi:[10.3847/0004-637X/820/2/90](https://doi.org/10.3847/0004-637X/820/2/90)

MD Johnson et al. "Resolved magnetic field structure and variability near the event horizon of Sagittarius A*." *Science* 350, p. 1242–1245, 2015.

doi:[10.1126/science.aac7087](https://doi.org/10.1126/science.aac7087)

MD Johnson, A Loeb, H Shiokawa, **A Chael**, SS Doeleman. "Measuring the direction and angular velocity of a black hole accretion disk via lagged interferometric covariance." *The Astrophysical Journal* 813, 132, 2015.

doi:[10.1088/0004-637X/813/2/132](https://doi.org/10.1088/0004-637X/813/2/132)

P Verbiest, JM Weisberg, **A Chael**, K Lee, D Lorimer. "On pulsar distance measures and their uncertainties." *The Astrophysical Journal* 775, 39, 2012.

doi:[10.1088/0004-637X/755/1/39](https://doi.org/10.1088/0004-637X/755/1/39)

SELECTED TALKS

"In the shadow of the black hole." *GitHub Satellite 2019*
Invited. Berlin, Germany. May 2019.

"Photographing a black hole with the Event Horizon Telescope." *Carleton College Physics Special Lecture*.
Invited. Northfield, MN. May 2019.

"Simulating and imaging supermassive black hole accretion flows." *Black Hole Initiative Colloquium*.
Invited. Cambridge, MA. May 2019.

"Two-temperature, radiative, MAD simulations of the supermassive black hole in M87." *Center for Astrophysics ITC lunch*.
Invited (Keto Prize Talk). Cambridge, MA. May 2019.

"Photographing black holes: first results from the Event Horizon Telescope." *Harvard University, Special Colloquium*.
Cambridge, MA. April 2019.

“What will the EHT see? Electron heating in simulations of Sgr A* and M87.”
Columbia Astronomy Thursday Seminar.
 Invited. New York, NY. November 2018.

“Electron heating and particle acceleration in GRMHD simulations of Sgr A*.”
The Central Arcsecond: Towards Testing GR in the Galactic Center.
 Invited. Ringberg, Germany. November 2018.

“What will the EHT see? Electron heating in simulations of Sgr A* and M87.”
Northwestern CIERA Theory Group Meeting.
 Invited. Evanston, IL. October 2018.

“Electron heating physics in images and variability of Sgr A*.” *15th Marcel Grossman Meeting on General Relativity.*
 Invited. Rome, Italy. July 2018.

“The role of electron heating physics in images and variability of Sgr A*.” *28th New England Regional Quasar and AGN Meeting.*
 New Haven, CT. May 2018.

“Imaging a black hole with the Event Horizon Telescope.” *907th Amateur Telescope Makers of Boston Monthly Meeting.*
 Invited. Cambridge, MA. March 2018.

“Evolving thermal and nonthermal electron distributions in simulations of Sagittarius A*.” *231st Meeting of the American Astronomical Society.*
 Washington, DC. January 2018.

“Evolving thermal and nonthermal electron distributions in accretion simulations.” *13th School of Modern Astrophysics.*
 Moscow, Russia. July 2017.

“Evolving thermal and nonthermal electron distributions in accretion simulations.” *When Brandeis Met Jansky: Astrophysics and Beyond.*
 Waltham, MA. May 2017.

“Imaging techniques for the Event Horizon Telescope.” *3rd Event Horizon Telescope Collaboration Meeting.*
 Invited. Cambridge, MA.

“Evolving non-thermal electron distributions in accretion simulations.” *3rd Event Horizon Telescope Collaboration Meeting.*
 Cambridge, MA. December 2016.

“Imaging black hole magnetic fields with the Event Horizon Telescope.” *M87 Workshop: Towards the 100th Anniversary of the Discovery of Cosmic Jets.*
 Taipei, Taiwan. May 2016.

“Probing Dynamical Activity near the Event Horizon with the EHT.” *2nd Event Horizon Telescope Collaboration Meeting*.
Invited. Waterloo, ON. November 2014.

ACADEMIC
SERVICE

Scientific Organizing Committee, EHT Polarization Workshop, Bonn, Germany. July 2019.

Organizer, 2nd EHT Imaging Workshop, Cambridge, MA. July 2018.

Organizer, 1st EHT Imaging Workshop, Cambridge, MA. November 2017.

Reviewer, Monthly Notices of the Royal Astronomical Society. 2019

Reviewer, Advances in Space Research. 2019

HONORS

Eric Keto Prize in Theoretical Astrophysics, Harvard Astronomy 2019

Harvard University Certificate of Distinction in Teaching 2016

NSF Graduate Research Fellowship Honorable Mention 2014

Phi Beta Kappa, Carleton College 2013

Distinction in Physics and Integrative Exercise, Carleton College 2013

Lawrence McKinley Gould Prize in Natural Science, Carleton College 2013

Catherine Boyd Prize in Medieval Studies, Carleton College 2013

Rhodes Scholarship Finalist 2013

Kolenkow-Reitz Research Fellowship, Carleton College 2012

Patricia Damon Merit Scholarship, Carleton College 2012

Phillip Niles Prize in Medieval Studies, Carleton College 2011

Dean’s List, Carleton College 2010, 2011, 2012

United States Department of Education Presidential Scholar 2009

PROGRAMMING
SKILLS

C, Python, Fortran, *Mathematica*, HTML/CSS

LANGUAGES

French (Proficient), Mandarin Chinese (Intermediate)