

# Alex Lupsasca

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Assistant Professor  
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Department of Physics & Astronomy  
and Department of Mathematics  
Vanderbilt University  
Nashville, Tennessee

## RESEARCH INTERESTS

Black hole imaging, electromagnetic observations, and (very-long-baseline) radio interferometry  
General relativity, gravitational lensing, photon rings, and black hole ringdown  
Plasma magnetospheres, force-free electrodynamics, and electromagnetic spin-energy extraction  
Relativistic astrophysics of compact objects: black holes, neutron stars, and pulsars  
Extremal black holes: theoretical properties, emergent symmetries, and observational signatures

## PROFESSIONAL EXPERIENCE

Project Scientist for the **Black Hole Explorer (BHEX)** space mission (2024–)  
Assistant Professor of Physics & Mathematics, Vanderbilt University (2022–)  
Associate Research Scholar, Princeton Gravity Initiative (2020–2022)  
Junior Fellow, Harvard Society of Fellows (2017–2020)

## EDUCATION

Ph.D., Physics, Harvard University [advisor: Andrew Strominger] (2017)  
Thesis: **The Maximally Rotating Black Hole as a Critical Point in Astronomy**  
A.M., Physics, Harvard University (2012)  
A.B., Physics & Mathematics, Harvard College (2011)

## GOVERNMENT FUNDING

National Science Foundation (**NSF**), Division of Physics (PHY)  
**CAREER** award of \$414,762 (**grant number 2340457**) in Gravity Theory (2023–2028)  
Currently supporting Vanderbilt University postdoctoral researcher **Roman Berens**  
  
National Science Foundation (**NSF**), Division of Astronomical Sciences (AST)  
Award of \$287,554 (**grant number 2307888**) in Stellar Astronomy & Astrophysics (2023–2026)  
Currently supporting Vanderbilt University graduate student **Trevor Gravely**

## PRIVATE FUNDING

Initial funding for development of BHEX from Fred Ehram  
Raised \$350,000 in seed funding for BHEX at Vanderbilt University (2024)  
  
Research funding from Will and Kacie Snellings  
Raised \$300,000 in private funding to hire a postdoctoral researcher at Princeton University in 2021  
Used to support **Alejandro Cárdenas-Avendaño** (about to start as faculty at Wake Forest University)  
  
Research funding from the Jacob Goldfield Foundation  
Raised \$300,000 in private funding to hire a postdoctoral researcher at Harvard University in 2018  
Used to support **Shahar Hadar** (now faculty at the University of Haifa, Israel)

## PRIZES & FELLOWSHIPS

**Young Scientist Prize in General Relativity and Gravitation** from the International Union of Pure and Applied Physics and **International Society on General Relativity and Gravitation**, 2024  
**New Horizons in Physics Prize** from the **Breakthrough Prize Foundation**, 2024  
**Junior Fellowship** from the **Harvard Society of Fellows**, 2017–2020  
Joshua S. Friedman Graduate Student Dissertation Fellowship (Harvard University), 2015–2016  
Donald and Cathleen Pfister Prize (Harvard College), 2011  
Awarded to a graduating senior for excellent achievement in the natural sciences

# TEACHING & ADVISING

Courses taught as faculty at Vanderbilt University:

- Physics 1020 (undergraduate): Physics For Future Leaders, Fall 2024
- Physics 8021 (graduate): Advanced Electrodynamics, Fall 2023
- Physics 8160 (graduate): General Theory of Relativity, Spring 2023 & Spring 2024
- Physics 3600 (undergraduate): Seminar in Presenting Physics Research, Fall 2022

Resident Tutor in Kirkland House (Harvard University), 2012-2018

Academic advisor for 5-7 sophomores every year

Star Family Prize Nominee for Excellence in Advising, 2013 & 2015

Derek Bok Center Certificate of Distinction in Teaching, Fall 2012 & Fall 2013

# MENTORSHIP & SUPERVISION

## Postdoctoral researchers

[Roman Berens](#), Vanderbilt University (2023–)

[Alejandro Cárdenas-Avendaño](#), Princeton University (2021–2023)

About to join the faculty at Wake Forest University

[Shahar Hadar](#), Harvard University (2018–2020)

Now faculty at the University of Haifa, Israel

## Graduate students

[Trevor Gravely](#), Vanderbilt University (2022–)

Co-supervised at the University of California, Santa Barbara: [Joseph Farah](#) (2024–)

Co-supervised at Princeton University: [He Jia](#) (2023–), Hengrui Zhu (2021–2022)

Co-supervised at the Observatoire de Paris: Hadrien Pagnat (2021–2022, now at UCLA)

Co-supervised at Harvard University: [Delilah Gates](#) (2018–2021, now at Harvard BHI),

[Mina Himwich](#) (2019–2020, now at Princeton PCTS) and [Yichen Shi](#) (2017–2019)

## Undergraduate students

[Lennox Keeble](#), Princeton University (2024–)

# SERVICE

Referee for:

*Classical and Quantum Gravity* (CQG), *Journal of Cosmology and Astroparticle Physics* (JCAP), *Journal of High Energy Physics* (JHEP), *Physics Letters B* (PLB), *Physical Review D* (PRD), *Physical Review Letters* (PRL), *Physical Review X* (PRX), *The Astrophysical Journal* (ApJ), *European Physical Journal C* (EPJC), *General Relativity and Gravitation* (GRG)

Organizer for the [Photon Ring Science Workshop](#) at Vanderbilt University, February 2024

# SELECTED SOFTWARE

[BlackHoleVision](#) (led by T. Gravely): an [interactive iOS app](#) that simulates black hole lensing

[Metric-Reconstruction](#) (led by R. Berens): linearized metric perturbations of a Kerr black hole

[AART](#) (led by A. Cárdenas-Avendaño): an Adaptive Analytical Ray Tracing code for accretion disks

# INVITED TALKS

University of Memphis, **Physics Department Colloquium**, April 2025

Princeton Center for Theoretical Science, *Black Hole Mimickers Workshop*, March 2025

New York University, *Astrophysics and Relativity Seminar*, February 2025

Los Alamos National Laboratory, **Astrophysics Distinguished Seminar**, February 2025

University of California, Berkeley, **Astronomy Department Colloquium**, January 2025

Las Cumbres Observatory, *Astronomy Seminar*, January 2025

Erwin Schrödinger Institute, *Lensing and Wave Optics in Strong Gravity Workshop*, December 2024

New York University, *Astrophysics and Relativity Seminar*, November 2024

University of Illinois Urbana-Champaign, *Astrophysics, Relativity, & Cosmology Seminar*, October 2024

Troy University, *Troy University Center for Relativity and Cosmology Seminar*, September 2024

Vanderbilt University, **Mathematics Department Colloquium**, August 2024

Joint Israeli Seminar Series on Gravitational Physics, July 2024  
National Astronomical Observatory of Japan, *Black Hole Explorer Japan Workshop*, June 2024  
Simons Collaboration on Extreme Electrodynamics of Compact Sources, *BH seminar*, March 2024  
Southern Denmark University, *CP3-Origins Seminar*, March 2024  
Johns Hopkins University, **Physics Department Colloquium**, January 2024  
American Physical Society, Southeastern Section, *Invited Talk*, November 2023  
NASA Goddard, *Infrared Science and Technology Integration Group Webinar*, November 2023  
Astronomy on Tap, Nashville, October 2023  
University of California, Santa Cruz, *Astronomy Group Talk*, October 2023  
University of California, Santa Cruz, **Physics Department Colloquium**, October 2023  
Institut de Physique Théorique, CEA Saclay, *Conference on Black-Hole Microstructure V*, June 2023  
Harvard Black Hole Initiative, *Instrument Design Lab for Space VLBI*, May 2023  
Institute for Advanced Study, *IAS Astrophysics Coffee Talk*, May 2023  
CERN, *Theory Seminar*, March 2023  
Dartmouth College, **Physics Department Colloquium**, February 2023  
Carnegie Mellon University, **Physics Department Colloquium**, November 2022  
Stanford Institute for Theoretical Physics, *It from Qubit Seminar*, October 2022  
Stanford University, **Physics Department Colloquium**, October 2022  
Harvard Black Hole Initiative & CMSA, *Conference on Flat Holography*, June 2022  
McGill University, *High-Energy Theory Group Meeting*, May 2022  
Harvard Black Hole Initiative, *2022 Annual Conference*, May 2022  
Harvard University, *High-Energy Physics Seminar*, March 2022  
University of Amsterdam, *String Theory Seminar*, March 2022  
University of Cambridge, *DAMTP GR Seminar*, March 2022  
University of Mississippi, **Physics Department Colloquium**, November 2021  
Aveiro University, *Gravity and Gravitational Dynamics Seminar*, October 2021  
Albert Einstein Institute (MPI Potsdam), *Astrophysics and Relativity Seminar*, October 2021  
Harvard Black Hole Initiative, *Monday Foundations Seminar*, September 2021  
Harvard CMSA, *General Relativity Seminar*, September 2021  
Sixteenth Marcel Grossman Meeting, *‘Radio Astronomy in Space’ Session*, July 2021  
University of Arizona, **Physics Department Colloquium**, April 2021  
Latin American Webinar on Physics, April 2021  
Vanderbilt University, *Gravity, Waves and Fluids Initiative Seminar*, April 2021  
Princeton University, *High-Energy Theory Seminar*, February 2021  
Next-Generation Event Horizon Telescope, *ngEHT Inaugural Science Meeting*, February 2021  
Harvard Black Hole Initiative, *2020 Annual Conference*, December 2020  
University of Bremen, *Space Science @ Drop Tower Seminar*, October 2020  
Harvard Black Hole Initiative, *Colloquium*, September 2020  
Princeton University, *Gravity Initiative Seminar*, September 2020  
University of California, Davis, *Fields, Strings, Gravity Seminar*, February 2020  
Harvard CMSA, *General Relativity Seminar*, February 2020  
Institute for Advanced Study, *IAS Astrophysics Seminar*, October 2019  
Brown University, *High-Energy Theory Seminar*, September 2018  
Harvard Black Hole Initiative, *2018 Annual Conference*, May 2018  
McGill University, *High-Energy Theory Seminar*, January 2018  
Harvard CMSA, *Mathematical Relativity Workshop*, May 2016  
Université Libre de Bruxelles, *Theoretical Physics Seminar*, May 2016  
Université Pierre et Marie Curie, Paris VI, *LPTHE Seminar*, January 2016  
McGill University, *High-Energy Theory Seminar*, November 2015  
Perimeter Institute, *Strong Gravity Seminar*, October 2015

TOP 3  
HIGHEST-IMPACT  
PUBLICATIONS

- ★ 1) **Universal Interferometric Signatures of a Black Hole’s Photon Ring**  
M. D. Johnson, A. Lupsasca (**co-first authors**) *et al.* [305 citations]  
*Science Advances* **6**, no. 12, eaaz1310 (2020), [arXiv:1907.04329](#) [astro-ph.IM]
- ★ 2) **Lensing by Kerr Black Holes**  
S. E. Gralla and A. Lupsasca (**alphabetized author list**) [210 citations]  
*Physical Review D* **101**, no. 4, 044031 (2020), [arXiv:1910.12873](#) [gr-qc]
- ★ 3) **The Shape of the Black Hole Photon Ring: A Precise Test of Strong-Field Gravity**  
S. E. Gralla, A. Lupsasca, and D. P. Marrone (**alphabetized author list**) [200 citations]  
*Physical Review D* **102**, no. 12, 124004 (2020), [arXiv:2008.03879](#) [gr-qc]

PUBLICATIONS  
(FIRST-AUTHOR  
SYSTEM)

**The Black Hole Explorer: using the photon ring to visualize black hole spacetime**  
P. Galison, M. D. Johnson, A. Lupsasca, T. Gravely, and R. Berens  
*Proceedings of SPIE* **13902**, 130926R (2024), [arXiv:2406.11671](#) [gr-qc]

**The Black Hole Explorer: photon ring science, detection, and shape measurement**  
A. Lupsasca (**first author**) *et al.*  
*Proceedings of SPIE* **13902**, 130926Q (2024), [arXiv:2406.09498](#) [gr-qc]

**The Black Hole Explorer: motivation and vision**  
M. D. Johnson *et al.*  
*Proceedings of SPIE* **13902**, 130922D (2024), [arXiv:2406.12917](#) [astro-ph.IM]

**Photon Ring Interferometric Signatures Beyond The Universal Regime**  
H. Jia, E. Quataert, A. Lupsasca, and G. N. Wong  
*Physical Review D* **110**, no. 8, 083044 (2024), [arXiv:2405.08804](#) [astro-ph.HE]

**Black Hole Polarimetry I: A Signature of Electromagnetic Energy Extraction**  
A. Chael, A. Lupsasca, G. N. Wong, and E. Quataert  
*The Astrophysical Journal* **958**, no. 1, 65 (2023), [arXiv:2307.06372](#) [astro-ph.HE]

**Images and photon ring signatures of thick disks around black holes**  
F. H. Vincent, S. E. Gralla, A. Lupsasca, and M. Wielgus  
*Astronomy & Astrophysics* **667**, A170 (2022), [arXiv:2206.12066](#) [astro-ph.HE]

**Photon ring test of the Kerr hypothesis**  
H. Pagnat, A. Lupsasca, F. H. Vincent, and M. Wielgus  
*Astronomy & Astrophysics* **669**, A11 (2022), [arXiv:2206.02781](#) [astro-ph.HE]

- ★ **Universal Interferometric Signatures of a Black Hole’s Photon Ring**  
M. D. Johnson, A. Lupsasca (**co-first authors**) *et al.*  
*Science Advances* **6**, no. 12, eaaz1310 (2020), [arXiv:1907.04329](#) [astro-ph.IM]

**Polarization Whorls from M87\* at the Event Horizon Telescope**  
A. Lupsasca (**first author**), D. Kapec, Y. Shi, D. E. Gates, and A. Strominger  
*Proceedings of the Royal Society A* **476**, no. 2237, 20190618 (2020), [arXiv:1809.09092](#) [hep-th]

PUBLICATIONS  
(ALPHABETIZED  
AUTHOR LIST)

**Explanation for the absence of secondary peaks in black hole light curve autocorrelations**  
A. Cárdenas-Avendaño, C. Gammie, and A. Lupsasca  
*Physical Review Letters* **133**, no. 13, 131402 (2024), [arXiv:2406.04176](#) [astro-ph.HE]

**Assessing the impact of instrument noise and astrophysical fluctuations on measurements of the first black hole photon ring**  
A. Cárdenas-Avendaño, L. Keeble, and A. Lupsasca  
*Physical Review D* **109**, no. 12, 124052 (2024), [arXiv:2404.01083](#) [gr-qc]

**Gravitational Waves on Kerr Black Holes I:  
Reconstruction of Linearized Metric Perturbations**

R. Berens, T. Gravelly, and A. Lupsasca

*Classical and Quantum Gravity* **41**, no. 19, 195004 (2024), [arXiv:2403.20311 \[gr-qc\]](#)

**A Beginner's Guide to Black Hole Imaging and Associated Tests of General Relativity**

A. Lupsasca, D. R. Mayerson, B. Ripperda, and S. Staelens

*Recent Progress on Gravity Tests* (Chapter 6), Springer, Singapore (2024), [arXiv:2402.01290 \[gr-qc\]](#)

**Black hole bulk-cone singularities**

M. Dodelson, C. Iossa, R. Karlsson, A. Lupsasca, and A. Zhiboedov

*Journal of High Energy Physics* **2024**, 46 (2024), [arXiv:2310.15236 \[hep-th\]](#)

**Prediction for the interferometric shape of the first black hole photon ring**

A. Cárdenas-Avendaño and A. Lupsasca

*Physical Review D* **108**, no. 4, 064043 (2023), [arXiv:2305.12956 \[gr-qc\]](#)

**Adaptive Analytical Ray Tracing of Black Hole Photon Rings**

A. Cárdenas-Avendaño, A. Lupsasca, and H. Zhu

*Physical Review D* **107**, no. 4, 043030 (2023), [arXiv:2211.07469 \[gr-qc\]](#)

**Photon Rings Around Warped Black Holes**

D. Kapec, A. Lupsasca, and A. Strominger

*Classical and Quantum Gravity* **40**, no. 9, 095006 (2023), [arXiv:2211.01674 \[gr-qc\]](#)

**Holography of the Photon Ring**

S. Hadar, D. Kapec, A. Lupsasca, and A. Strominger

*Classical and Quantum Gravity* **39**, no. 21, 215001 (2022), [arXiv:2205.05064 \[gr-qc\]](#)

**Observing the Inner Shadow of a Black Hole: A Direct View of the Event Horizon**

A. Chael, M. D. Johnson, and A. Lupsasca

*The Astrophysical Journal* **918**, no. 1, 6 (2021), [arXiv:2106.00683 \[astro-ph.HE\]](#)

**Extreme Black Hole Anabasis**

S. Hadar, A. Lupsasca, and A. Porfyriadis

*Journal of High Energy Physics* **2021**, 223 (2021), [arXiv:2012.06562 \[hep-th\]](#)

**Photon Emission from Circular Equatorial Kerr Orbiters**

D. E. A. Gates, S. Hadar, and A. Lupsasca

*Physical Review D* **103**, no. 4, 044050 (2021), [arXiv:2010.07330 \[gr-qc\]](#)

**Photon Ring Autocorrelations**

S. Hadar, M. D. Johnson, A. Lupsasca, and G. N. Wong

*Physical Review D* **103**, no. 10, 104038 (2021), [arXiv:2010.03683 \[gr-qc\]](#)

**Maximum Observable Blueshift from Circular Equatorial Kerr Orbiters**

D. E. A. Gates, S. Hadar, and A. Lupsasca

*Physical Review D* **102**, no. 10, 104041 (2020), [arXiv:2009.03310 \[gr-qc\]](#)

★ **The Shape of the Black Hole Photon Ring: A Precise Test of Strong-Field Gravity**

S. E. Gralla, A. Lupsasca, and D. P. Marrone

*Physical Review D* **102**, no. 12, 124004 (2020), [arXiv:2008.03879 \[gr-qc\]](#)

**On the Observable Shape of Black Hole Photon Rings**

S. E. Gralla and A. Lupsasca

*Physical Review D* **102**, no. 12, 124003 (2020), [arXiv:2007.10336 \[gr-qc\]](#)

### Universal Polarimetric Signatures of the Black Hole Photon Ring

E. Himwich, M. D. Johnson, A. Lupsasca, and A. Strominger

*Physical Review D* **101**, no. 8, 084020 (2020), [arXiv:2001.08750](#) [gr-qc]

### Null Geodesics of the Kerr Exterior

S. E. Gralla and A. Lupsasca

*Physical Review D* **101**, no. 4, 044032 (2020), [arXiv:1910.12881](#) [gr-qc]

### ★ Lensing by Kerr Black Holes

S. E. Gralla and A. Lupsasca

*Physical Review D* **101**, no. 4, 044031 (2020), [arXiv:1910.12873](#) [gr-qc]

### Particle Motion Near High-Spin Black Holes

D. Kapec and A. Lupsasca

*Classical and Quantum Gravity* **37**, no. 1, 015006 (2019), [arXiv:1905.11406](#) [hep-th]

### Critical Emission from a High-Spin Black Hole

A. Lupsasca, A. P. Porfyriadis, and Y. Shi

*Physical Review D* **97**, no. 6, 064017 (2018), [arXiv:1712.10182](#) [gr-qc]

### Observational Signature of High Spin at the Event Horizon Telescope

S. E. Gralla, A. Lupsasca, and A. Strominger

*MNRAS* **475**, no. 3, 3829–3853 (2018), [arXiv:1710.11112](#) [astro-ph.HE]

### Inclined Pulsar Magnetospheres in General Relativity:

#### Polar Caps for the Dipole, Quadrupole and Beyond

S. E. Gralla, A. Lupsasca, and A. Philippov

*The Astrophysical Journal* **851**, no. 2, 137 (2017), [arXiv:1704.05062](#) [astro-ph.HE]

### Force-Free Foliations

G. Compère, S. E. Gralla, and A. Lupsasca

*Physical Review D* **94**, no. 12, 124012 (2016), [arXiv:1606.06727](#) [math-ph]

### Pulsar Magnetospheres: Beyond the Flat Spacetime Dipole

S. E. Gralla, A. Lupsasca, and A. Philippov

*The Astrophysical Journal* **833**, no. 2, 258 (2016), [arXiv:1604.04625](#) [astro-ph.HE]

### Near-horizon Kerr Magnetosphere

S. E. Gralla, A. Lupsasca, and A. Strominger

*Physical Review D* **93**, no. 10, 104041 (2016), [arXiv:1602.01833](#) [hep-th]

### Electromagnetic Jets from Stars and Black Holes

S. E. Gralla, A. Lupsasca, and M. J. Rodriguez

*Physical Review D* **93**, no. 4, 044038 (2016), [arXiv:1504.02113](#) [gr-qc]

### Note on Bunching of Field Lines in Black Hole Magnetospheres

S. E. Gralla, A. Lupsasca, and M. J. Rodriguez

*Physical Review D* **92**, no. 4, 044053 (2015), [arXiv:1504.02112](#) [gr-qc]

### Exact Solutions for Extreme Black Hole Magnetospheres

A. Lupsasca and M. J. Rodriguez

*Journal of High Energy Physics* **2015**, 90 (2015), [arXiv:1412.4124](#) [hep-th]

### Force-Free Electrodynamics around Extreme Kerr Black Holes

A. Lupsasca, M. J. Rodriguez, and A. Strominger

*Journal of High Energy Physics* **2014**, 185 (2014), [arXiv:1406.4133](#) [hep-th]

**Quasinormal Quantization in de Sitter spacetime**

D. L. Jafferis, A. Lupsasca, V. Lysov, G. S. Ng, and A. Strominger

*Journal of High Energy Physics* **2015**, 4 (2015), [arXiv:1305.5523 \[hep-th\]](#)