Alex Lupsasca

Assistant Professor
Website: https://lupsasca.com
E-mail: alexandru.v.lupsasca@vanderbilt.edu
Cell: +1 (617) 386-3739

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 Ehrsam
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 Unversity 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 Paugnat (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 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.* **[273 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) **[183 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) **[176 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
Accepted for publication in *Physical Review D*. 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. Paugnat, 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]

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. Gravely, 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
Chapter in *Recent Progress on Gravity Tests*, 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]

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