

Colin J. Burke, PhD

Personal

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Research Interests

Supermassive black hole formation, seeding, growth
Variability and scaling relations of active galactic nuclei

Education

Ph.D. Astronomy, University of Illinois Urbana-Champaign August 2023
Thesis: *Optical variability of intermediate-mass black holes as a probe of black hole accretion and growth*

B.S. Physics, Purdue University – West Lafayette May 2018
Minor in Astronomy
Certificate of learning beyond the classroom

Research & Professional Experience

NSF AAPF Postdoctoral Fellow August 2023 –
Department of Astronomy, Yale University
· Advisor: Priyamvada Natarajan

Graduate Research Assistant May 2018 – July 2023
Department of Astronomy, University of Illinois Urbana-Champaign
· Advisor: Xin Liu

R&D Intern, Space and Missile Systems June 2018 – August 2018
Engility Corporation (currently SAIC) June 2017 – August 2017

Undergraduate Research Assistant February 2014 – May 2018
Department of Physics and Astronomy, Purdue University
· Advisor: John R. Peterson

Grants & Awards

NSF Astronomy and Astrophysics Postdoctoral Fellowship & Simonyi-NSF Scholarship <i>National Science Foundation (\$330,000)</i>	2023 – 2026
Lewis E. Snyder Memorial Award <i>Department of Astronomy, University of Illinois Urbana-Champaign (\$1,000)</i>	Fall 2022
Mr. and Mrs. Hsiang-pai and Wen-hua Chu Department of Astronomy Excellence in Research Graduate Student Award <i>Department of Astronomy, University of Illinois Urbana-Champaign (\$1,000)</i>	2022
Center for AstroPhysical Surveys (CAPS) Graduate Fellowship <i>National Center for Supercomputing Applications (\$30,000 renewed x 3)</i>	2019 – 2022
Teacher Ranked as Excellent <i>University of Illinois Urbana-Champaign</i>	Spring 2019
Richard W. King Award <i>Department of Physics & Astronomy, Purdue University</i>	2017

Publications

First-Author Publications

- **Burke, C. J.**, Natarajan, P. 2025, Nature Astronomy Perspectives (submitted), *Variability as the new discovery channel for Intermediate-Mass Black Holes in the Time Domain Era*
- **Burke, C. J.**, Natarajan, P., Baldassare, V. F., & Geha, M. 2024, *ApJ*, **978**, **77**, *Multi-wavelength constraints on the local black hole occupation fraction*
- **Burke, C. J.**, Liu, Y., Ward, C. A., et al. 2024, *ApJ*, **971**, **140**, *DAVOS: Dwarf Active Galactic Nuclei from Variability for the Origins of Seeds: Properties of Variability-selected Active Galactic Nuclei in the COSMOS Field and Expectations for the Rubin Observatory*
- **Burke, C. J.**, Liu, X., & Shen, Y. 2024, *MNRAS*, **527**, **5356**, *Gemini near-infrared spectroscopy of high-redshift Fermi blazars: jetted black holes in the early universe were overly massive*
- **Burke, C. J.** 2023, *MNRAS*, **523**, **5535**, *The variational slope of quasar light curves is not a distance indicator*
- **Burke, C. J.**, Liu, X., Shen, Y., et al. 2022, *MNRAS*, **516**, **2736-2756**, *Dwarf AGNs from Optical Variability for the Origins of Seeds (DAVOS): insights from the dark energy survey deep fields*
- **Burke, C. J.**, Shen, Y., Liu, X., et al. 2022, *MNRAS*, **518**, **1880-1904**, *Dwarf AGNs from Variability for the Origins of Seeds (DAVOS): Intermediate-mass black hole demographics from optical synoptic surveys*
- **Burke, C. J.**, Shen, Y., Blaes, O., et al. 2021, *Science*, **373**, **789-792**, *A characteristic optical variability time scale in astrophysical accretion disks*
- **Burke, C. J.**, Liu, X., Chen, Y.-C., Shen, Y., & Guo, H. 2021, *MNRAS*, **504**, **543-550**, *On the AGN nature of broad balmer emission in four low-redshift metal-poor galaxies*
- **Burke, C. J.**, Shen, Y., Chen, Y.-C., et al. 2020, *ApJ*, **899**, **136**, *Optical Variability of the Dwarf AGN NGC 4395 from the Transiting Exoplanet Survey Satellite*

- **Burke, C. J.**, Baldassare, V. F., Liu, X., et al. 2020, *ApJ*, **894**, L5, *The Curious Case of PHL 293B: A Long-lived Transient in a Metal-poor Blue Compact Dwarf Galaxy*
- **Burke, C. J.**, Aleo, P. D., Chen, Y.-C., et al. 2019, *MNRAS*, **490**, 3952-3965, *Deblending and classifying astronomical sources with Mask R-CNN deep learning*
- **Burke, C. J.**, Peterson, J. R., Egami, E., et al. 2019, *Journal of Astronomical Telescopes, Instruments, and Systems*, **5**, 038002, *PhoSim-NIRCam: photon-by-photon image simulations of the James Webb Space Telescope's near-infrared camera*

Contributing-Author Publications

* indicates student advised by Burke

- Liu, Y.*, Burke, C. J., Miura, D.*, et al. 2025, *arXiv e-prints*, arXiv:2503.06372 (accepted), *Dwarf Active Galactic Nuclei from Variability for the Origins of Seeds (DAVOS): Properties of Variability-Selected AGNs in the Dark Energy Survey Deep Fields*
- Merz, G., Liu, X., Schmidt, S., et al. 2025, *The Open Journal of Astrophysics*, **8**, 40, *DeepDISC-photoz: Deep Learning-Based Photometric Redshift Estimation for Rubin LSST*
- Dattathri, S., Natarajan, P., Porras-Valverde, A. J., et al. 2024, *ApJ*, **984**, 122, *The redshift evolution of the $M_{\text{BH}} - M_*$ scaling relation: new insights from cosmological simulations and semi-analytic models*
- Ren, W., Guo, H., Shen, Y., et al. 2024, *ApJ*, **974**, 153, *Prior-informed Active Galactic Nucleus Host Spectral Decomposition Using PyQSOFit*
- Ward, C., Melchior, P., Sampson, M. L., et al. 2024, *Astronomy & Computed submitted*, *Disentangling transients and their host galaxies with Scarlet2: A framework to forward model multi-epoch imaging*
- Zhuang, M.-Y., Yang, Q., Shen, Y., et al. 2024, *ApJS submitted*, *High-quality Extragalactic Legacy-field Monitoring (HELM) with DECam*
- Sokolovsky, K. V., Aydi, E., Malanchev, K., et al. 2023, *ApJ submitted*, *TESS photometry of the nova eruption in V606 Vul: asymmetric photosphere and multiple ejections?*
- Merz, G., Liu, Y., **Burke, C. J.**, et al. 2023, *MNRAS*, **526**, 1122, *Detection, instance segmentation, and classification for astronomical surveys with deep learning (DEEPDISC): DETECTRON2 implementation and demonstration with Hyper Suprime-Cam data*
- Wang, Z. F.*., **Burke, C. J.**, Liu, X., & Shen, Y. 2023, *MNRAS*, **521**, 99, *Dwarf AGNs from variability for the origins of seeds (DAVOS): optical variability of broad-line dwarf AGNs from the zwicky transient facility*
- Stone, Z., Shen, Y., **Burke, C. J.**, et al. 2022, *MNRAS*, **514**, 164-184, *Optical variability of quasars with 20-yr photometric light curves*
- Bellm, E. C., **Burke, C. J.**, Coughlin, M. W., et al. 2022, *ApJS*, **258**, 13, *Give Me a Few Hours: Exploring Short Timescales in Rubin Observatory Cadence Simulations*
- Shen, Y., & **Burke, C. J.** 2021, *ApJ*, **918**, L19, *A Sample Bias in Quasar Variability Studies*
- Palmese, A., Fishbach, M., **Burke, C. J.**, Annis, J., & Liu, X. 2021, *ApJ*, **914**, L34, *Do LIGO/Virgo Black Hole Mergers Produce AGN Flares? The Case of GW190521 and Prospects for Reaching a Confident Association*
- Guo, H., Peng, J., Zhang, K., et al. 2020, *ApJ*, **905**, 52, *High-redshift Extreme Variability Quasars from Sloan Digital Sky Survey Multiepoch Spectroscopy*
- Sánchez, J., Walter, C. W., Awan, H., et al. 2020, *MNRAS*, **497**, 210-228, *The LSST DESC data challenge 1: generation and analysis of synthetic images for next-generation surveys*
- Guo, H., **Burke, C. J.**, Liu, X., et al. 2020, *MNRAS*, **496**, 3636-3647, *Dark Energy Survey identification of a low-mass active galactic nucleus at redshift 0.823 from optical variability*

- Peterson, J. R., Peng, E., **Burke, C. J.**, Sembroski, G., & Cheng, J. 2019, *ApJ*, **873**, 98, *Deformation of Optics for Photon Monte Carlo Simulations*

Non-Refereed Publications & White Papers

- Breivik, K., Connolly, A. J., Ford, K. E. S., et al. 2022, *arXiv e-prints*, arXiv:2208.02781, *From Data to Software to Science with the Rubin Observatory LSST*
- Thomas, D., Kahn, S. M., Bianco, F. B., et al. 2018, *arXiv e-prints*, arXiv:1812.02932, *Unveiling the Rich and Diverse Universe of Subsecond Astrophysics through LSST Star Trails*

Approved Observing Programs

Gemini Observatory 8-meter Telescope

- > 6 nights awarded as PI, 0.5 night DDT awarded as Co-I

Palomar 200-inch (5.1-meter) Hale Telescope

- 5 nights awarded as PI (Yale TAC)

Blanco 4-meter Telescope

- 0.5 nights awarded as Co-I, > 5 nights observing experience for DECAT collaboration

WIYN 3.5-meter Telescope

- 6 nights awarded as Co-I (Purdue TAC)

Very Large Array

- ~ 75 hours total awarded as PI

Talks

Invited Talks

- CHASC Seminar, CfA & Statistics, Harvard University (April 2025)
- UMBRELA Seminar, CfA, Harvard University (February 2025)
- **Astronomy Seminar, Texas A&M University (August 2024)**
- Santa Cruz Galaxy Workshop (August 2024)
- Rubin Project and Community Workshop, Science Medley parallel session (August 2023)
- **KICP Seminar, University of Chicago (May 2023)**
- AAS#241, DES special session (January 2023)
- **BHI Colloquium, Harvard University (November 2022)**
- KIPAC Tea Talk, Stanford University (October 2022; remote)
- **MPE Seminar, Max Planck Institute for Extraterrestrial Physics (September 2022)**
- ESO AGN Coffee Series, European Southern Observatory, Garching (September 2022)
- Astronomy Tea Talk, Caltech (May 2022; remote)
- X-ray Binaries Group, University of Southampton (February 2022; remote)
- CosmoPalooza webinar (January 2022)
- LSST AGN Science Collaboration Meeting (July 2021; remote)

- MINERVA Seminar, Paris Observatory (May 2021; remote)
- DES Collaboration Meeting Plenary (May 2020; remote)
- LSST Science Collaboration Meeting: DESC deblending parallel session (May 2019; remote)

Contributed Talks

- *Massive black holes across cosmic time*, Cambridge University (September 2025)
- Rubin Community Workshop, Simonyi-NSF session (July 2025)
- LSST AGN Science Collaboration meeting (July 2025)
- AAS#243 (January 2024)
- Intermediate-mass black holes (December 2023)
- AAS#241, AGN VI session (January 2023)
- *Origin, growth and feedback of black holes in dwarf galaxies*, San Sebastián, Spain (September 2022)
- *Boom! A Workshop on Explosive Transients with LSST*, University of Illinois Urbana-Champaign (July 2022)
- *Intermediate-Mass Black Holes: New Science from Stellar Evolution to Cosmology* workshop, Northwestern University/COFI (May 2022)
- *Illinois Astrofest*, University of Illinois Urbana-Champaign (April 2022)
- AAS#239, AGN variability session (January 2022; canceled due to COVID pandemic)
- Astroinformatics 2021, Caltech (November 2021; remote)
- TESS Science Conference II, Massachusetts Institute of Technology (August 2021; remote)
- *New Faces of Black Holes* workshop, Joint Space-Science Institute (November 2019)

Professional Service

- Referee for major peer-reviewed journals in astronomy, e.g., *Astronomy & Astrophysics*, *The Astrophysical Journal*, *Monthly Notices of the Royal Astronomical Society*, *Astronomy & Computing*.
- Significant open source software contributions: *PhoSim*, *lightkurve*, *PyQSOFit*, *PyZOGY*.
- Subject-matter expert reviewer in a NASA peer review (2025)
- SOC, 2024 Tinsley Workshop - JWST results on galaxies and black holes in the early Universe
- Reviewer, FONDECYT-Chile Astronomy & Astrophysics grants
- Yale telescope TAC for Keck and Palomar (Fall 2023 -)
- Organizing committee of UIUC Astrofest (2021)
- Organizer of UIUC Journal Club seminar series (2021-2022)

Teaching & Outreach

Student Advising & Mentoring

- Tony Zhang (Yale Pathways high school student intern)
- Astronomy Mentorship Program for Upcoming Postdocs (AMP-UP) mentor (2024-2025)
- Diego Miura (Yale STARS undergraduate)
- Carmen Muscolina (Yale senior thesis)
- Yichen Liu (astronomy undergraduate → U. Arizona graduate student)

- Z. Franklin Wang (astronomy undergraduate → TAMU graduate student)
- Yufeng Liu (NCSA SPIN undergraduate)
- Anshul Shah (NCSA SPIN undergraduate → Finance software engineering internship)
- Will Lande (high school student, Illinois State Science Fair project)

Teaching

- Guest lecturer: Introduction to Cosmology (Fall 2024)
- Guest lecturer: AI and Big Data in Astronomy (Fall 2021)
- Teaching Assistant: Stars and Galaxies (Spring 2019; Ranked as excellent teacher)
- Teaching Assistant: Big Bang, Black Holes, and the Universe (Fall 2018)

Broader Outreach

- Speaker for Yale Pathways to Science: Exploring Science and Science Cafe programs
- Secured thousands of dollars in grant money for purchase and distribution of 10,000 solar eclipse glasses to schools and libraries near Purdue's campus in 2017
- Co-taught middle school physics in joint Purdue–Jiangsu Second Normal University service learning trip to Nanjing, China (May 2017)

Media

- Work featured in popular media outlets such as *The London Times*, *space.com*, *Popular Science*, *Science News*.