

# Charlotte Ward

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## Education

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| Ph.D., Astronomy, University of Maryland at College Park  | 2022 |
| Thesis: <i>Tracing the formation and merger-driven growth of massive black holes with the Zwicky Transient Facility</i> |      |
| M.Sc., Astronomy, University of Maryland at College Park  | 2019 |
| B.Sc. (Adv) (Hons), Physics & Mathematics, University of Sydney   | 2016 |
| Thesis: <i>Machine learning techniques for discovery of Fast Radio Bursts with the Parkes Radio Telescope</i>           |      |

## Professional Employment and Internships

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|---|---------------|
| Assistant Professor, The Pennsylvania State University  | Starting 2025 |
| Postdoctoral Research Associate, Princeton University   | 2022 – 2025   |
| HEP Center for Computational Excellence Graduate Summer Internship, Lawrence Berkeley National Laboratory | 2019          |
| School of Physics Laboratory Tutor, University of Sydney  | 2017          |
| Summer Scholar, Centre for Astronomy and Space Science, CSIRO   | 2014, 2015    |
| Nanjing Research Exchange Visiting Scholar, Nanjing University  | 2015          |
| Faculty of Science Information Officer, University of Sydney  | 2014 – 2015   |
| Undergraduate research student, Quantum Control Laboratory, University of Sydney                          | 2015          |
| Undergraduate research student, Institute of Medical Physics, University of Sydney                        | 2014          |

## Research interests

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Multi-resolution image modeling techniques for joint-survey analysis of ground and space-based surveys; multi-wavelength analysis of astrophysical transients; dwarf galaxy AGN; changing-look AGN; tidal disruption events; strongly lensed QSOs and SNe; SMBH binaries; machine learning for transient classification and light curve prediction; large-scale pipelines for wide-field time-domain surveys.

## Grants and Observing Proposals

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| <b>PI:</b> <i>A Scarlet2 framework for characterizing transients and their host galaxies</i><br>(LSST Discovery Alliance LINCC Frameworks Incubator Program, \$22.5K awarded)         | 2025 |
| <b>PI:</b> <i>Exploring the physical origin of compact millimeter emission in radio-quiet AGN with Swift</i><br><i>X-ray monitoring</i> (Swift, \$8K awarded)                         | 2025 |
| <b>PI:</b> <i>Unveiling disk formation and evolution in rebrightening tidal disruption events</i> (WIYN)  | 2025 |
| <b>PI:</b> <i>Understanding variable radio emission in changing-look AGN</i> (VLA)  | 2025 |
| <b>PI:</b> <i>Joint modeling of imaging data from LSST and complementary surveys to maximize early transient science</i> (LSST Discovery Alliance Small Grant Proposal, \$8K awarded) | 2024 |

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| <b>PI:</b> <i>Understanding young radio jets in changing-look AGN with ATCA (ATCA)</i>   | 2024        |
| <b>PI:</b> <i>Understanding episodic SMBH accretion triggering with changing-look AGN (Magellan)</i>                                   | 2023        |
| <b>PI:</b> <i>Investigating 10 Candidates for Gravitational Wave Recoil from an SMBH merger (Keck, NASA allocation, \$15K awarded)</i> | 2023        |
| <b>PI:</b> <i>Confirming the presence of AGN for the variability-selected IMBH candidates from ZTF and WISE (Magellan)</i>             | 2023        |
| <b>CoI:</b> Various HST, Chandra, VLA and ATCA proposals   | 2023 - 2025 |

## Research Advising

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### Graduate students

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| <i>Kendall Sippy (1st year):</i> Multi-resolution analysis of Rubin/LS4, MBH population studies  | 2025 – |
| <i>Miranda Zak (2nd year):</i> Millimeter/X-ray studies of radio-quiet AGN, changing-look AGN    | 2024 – |
| <i>Chloe Klare (4th year):</i> Young radio jets in AGN, anomaly detection in time-domain surveys | 2024 – |

### Undergraduate students

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| <i>Sufia Birmingham (Princeton astro):</i>   |           |
| 2 x Undergraduate Summer Research Program, Junior Thesis → AAS Chambliss award         |           |
| 1 submitted first-author publication, 3 co-authored publications                       | 2022-2025 |
| <i>Hy Truong (Princeton astro):</i> Junior Thesis, Senior Thesis → publication in prep | 2023-2025 |
| <i>Veena Krishnaraj (Princeton astro):</i> Junior Thesis → publication in prep         | 2025 –    |
| <i>Anavi Uppal (Yale astro) → PhD student and NSF fellow at UCSC:</i>                  |           |
| 1 accepted publication, AAS Chambliss award  | 2023      |
| <i>Sophie Chen (Princeton engineering):</i> Senior Thesis                              | 2023      |
| <i>Abigail García-Pérez (GRAD-MAP student → PhD student University of Turin):</i>      |           |
| Winter Workshop project → 1 co-authored publication                                    | 2019      |
| <i>Immaculate Oyoo (GRAD-MAP student):</i>   |           |
| Winter Workshop project → 1 co-authored publication                                    | 2019      |

### Thesis committee membership

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| Kyle Neumann (Penn State): ML techniques for X-ray/gamma-ray source classification | 2025 – |
| Matt Sampson (Princeton): Latent ODEs for transient light curve prediction         | 2025 – |

## Professional Service and Leadership

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| <i>Discussion Panelist</i> , Hubble Space Telescope Cycle 32 Review & Cycle 33 Review | 2024, 2025     |
| <i>Discussion Panelist</i> , NSF Division of Astronomical Sciences                    | 2025           |
| <i>External proposal referee</i> , Hubble Space Telescope DDT proposal                | 2025           |
| <i>Referee for MNRAS, ApJ, Nature Astronomy</i>                                       | 2022 - ongoing |
| <i>Invited Speaker</i> , VLASS Epoch 4 Review Panel                                   | 2024           |

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| <i>Member, Rubin/Euclid Derived Data Products WG</i>                                      | 2024 - 2025 |
| <i>Member, VLASS Survey Science WG</i>  | 2024 - 2025 |
| <i>Astrocoffee (arXiv journal club) host, Princeton University</i>                        | 2023 - 2025 |
| <i>External proposal referee, CanTAC Gemini</i>   | 2022        |
| <i>Co-coordinator of the Department of Astronomy Journal Club, University of Maryland</i> | 2019-2021   |

## Teaching: Classroom and Workshops

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| <i>Lecturer, Undergraduate Summer Research Program, Princeton University</i>                 | 2024, 2025 |
| <i>Instructor, GROWTH time-domain astronomy school, San Diego State University</i>           | 2020       |
| <i>Teaching Assistant, 'Special Problems in Astronomy: Big Data', University of Maryland</i> | 2018       |
| <i>GRAD-MAP Python Bootcamp developer, University of Maryland</i>                            | 2018       |
| <i>Instructor, 3rd year computational physics lab, University of Sydney</i>                  | 2017       |
| <i>Instructor, 2nd year experimental physics lab, University of Sydney</i>                   | 2017       |
| <i>Grok Learning interactive programming course developer, University of Sydney</i>          | 2017       |

## EDI and Public Outreach

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| <i>Peyton Observatory Public Observing: volunteer/ lead observer/co-coordinator, Princeton U.</i>   | 2022 - 2025 |
| <i>EDI seminar series coordinator, Princeton University</i>   | 2023 - 2025 |
| <i>Astronomy on Tap Trenton Chapter: co-coordinator/speaker, Princeton University</i>   | 2023 - 2024 |
| <i>Postdoc - Grad Student Mentoring Program mentor, Princeton University</i>  | 2023 - 2025 |
| <i>Solar Eclipse Festival: co-coordinator, Princeton University</i>   | 2024        |
| <i>'Science Under the Stars' speaker, New Jersey State Museum &amp; Planetarium</i>   | 2024        |
| <i>Co-lead of GRAD-MAP (Graduate Resources Advancing Diversity in Maryland Astronomy and Physics) program, University of Maryland</i>                     | 2020-2021   |
| <i>Astronomy outreach volunteer for UMD observatory, UMD Open House, Public Library STEM events, and Community College visits, University of Maryland</i> | 2018-2021   |
| <i>Pulse@Parkes High School Outreach Program volunteer, CSIRO</i>   | 2014-2015   |

## Honors, Awards and Press Coverage

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| <i>Equity Prize for Outreach, Department of Astrophysical Sciences, Princeton U.</i>           | 2024      |
| <i>Martin and Beate Block Winter Award, Aspen Center for Physics</i>                           | 2023      |
| <i>ZTF IMBH paper featured in Astrobites</i>   | 2023      |
| <i>ZTF Recoiling AGN paper featured in New Scientist</i>                                       | 2021      |
| <i>Graduate Student Summer Research Fellowship, University of Maryland at College Park</i>     | 2020      |
| <i>Graduate School Dean's Fellowship for Astronomy, University of Maryland at College Park</i> | 2017      |
| <i>Physics Foundation Scholarship No III, University of Sydney</i>                             | 2016      |
| <i>School of Physics Honours Scholarship, University of Sydney</i>                             | 2016      |
| <i>Faculty of Science Merit Scholarship, University of Sydney</i>                              | 2013-2015 |
| <i>School of Physics Smith Prize in Experimental Physics, University of Sydney</i>             | 2013      |

## Selected Colloquia, Seminars and Conference Talks

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| <i>Invited Seminar</i> , Berkeley Theoretical Astrophysics Center                             | 2025      |
| <i>Contributed Talk</i> , Data-Driven Discovery in the Rubin Era, SLAC                        | 2025      |
| <i>Contributed Talk</i> , Transients in Space, STScI  | 2025      |
| <i>Contributed Talk</i> , Aspen Winter Conference: The Era of Binary SMBHs                    | 2025      |
| <i>Contributed Talk</i> , AAS Winter Meeting  | 2025      |
| <i>Internal Talk</i> , Bahcall Lunch, Princeton U./IAS  | 2025      |
| <i>Invited Talk</i> , HEACOSS-2024 conference   | 2024      |
| <i>Invited Talk</i> , SIFA Morning Tea, University of Sydney School of Physics                | 2024      |
| <i>Invited Seminar</i> , Naval Research Laboratory Remote Sensing Division                    | 2024      |
| <i>Contributed Talk</i> , Rubin Community Workshop  | 2024      |
| <i>Contributed Talk</i> , Tidal Disruption Events and Nuclear Transients conference           | 2024      |
| <i>Contributed Talk</i> , BASS2024 Team Meeting   | 2024      |
| <i>Internal Talk</i> , Thursday Lunch Talks, Princeton U.                                     | 2024      |
| <i>Invited Colloquium</i> , The Pennsylvania State University, Department of Astronomy        | 2023      |
| <i>Contributed Talk</i> , IMBHs: The Dawn of a Revolutionary Era conference                   | 2023      |
| <i>Invited Seminar</i> , ASKAP Variable And Slow Transients (VAST) team meeting               | 2023      |
| <i>Contributed Talk</i> , Aspen Winter Conference: eXtreme Black Holes                        | 2023      |
| <i>Invited Colloquium</i> , Lawrence Berkeley National Laboratory, Computer Sciences Division | 2022      |
| <i>Invited Seminar</i> , Stanford KIPAC Tea Talk  | 2022      |
| <i>Invited Colloquium</i> , Lawrence Berkeley National Laboratory, Physics Division           | 2022      |
| <i>Invited Colloquium</i> , Australia Telescope National Facility, CSIRO                      | 2022      |
| <i>Invited Seminar</i> , Nanograv Meeting   | 2022      |
| <i>Contributed Talk</i> , IMBHS: New Science from Stellar Evolution to Cosmology conference   | 2022      |
| <i>Contributed Talk</i> , Aspen Winter Conference: Dynamical Formation of GW Sources          | 2022      |
| <i>Invited Seminar</i> , Johns Hopkins University AGN Journal Club                            | 2021      |
| <i>Invited Seminar</i> , NASA Goddard AGN Seminar Series                                      | 2021      |
| <i>Contributed Talks</i> , ZTF Team Meetings in Stockholm, Tel Aviv, and Pasadena             | 2018-2019 |

## Selected Peer-Reviewed and Submitted Publications

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**39 total, 25 with significant contributions**, h-index=23, 4703 total citations.

\*: graduate student †: undergraduate student

**Ward, C.**, Koss, M. et al. ‘BASS LII: Clues from Twin Peaks — Investigating AGN accretion disks at low Eddington ratios using hard X-ray selected double-peaked emitters’, submitted to ApJ, arXiv: 2507.05380.

**Ward, C.**, Melchior, P., Sampson, M.\* et al. ‘Disentangling transients and their host galaxies with Scarlet2: A framework to forward model multi-epoch imaging’, **2025**, Astronomy and Computing, 51, 100930.

- Ward, C.**, Gezari, S., Nugent, P et al. ‘Panic at the ISCO: time-varying double-peaked broad lines from evolving accretion disks are common amongst optically variable AGN’, **2024**, The Astrophysical Journal, 961, 172.
- Ward, C.**, Gezari, S., Nugent, P et al. ‘Variability-selected intermediate mass black hole candidates in dwarf galaxies from ZTF and WISE’, **2022**, The Astrophysical Journal, 936, 104.
- Ward, C.**, Gezari, S., Frederick, S. et al. ‘AGNs on the Move: A Search for Off-nuclear AGNs from Recoiling Supermassive Black Holes and Ongoing Galaxy Mergers with the Zwicky Transient Facility’, **2021**, The Astrophysical Journal, 913, 102.
- Birmingham, S.<sup>†</sup>, **Ward, C.** et al. ‘The birth of young radio jets in changing-look AGN: a population study’, submitted to ApJ, arXiv: 2507.01355.
- Yao, Y., Chornock, R., **Ward, C.** et al. ‘A Massive Black Hole 0.8 kpc from the Host Nucleus Revealed by the Offset Tidal Disruption Event AT2024tvd’, **2025**, ApJL, 985, L48.
- Onoue, M. et al., (author 7 of 35), ‘A Post-Starburst Pathway to Forming Massive Galaxies and Their Black Holes at  $z > 6$ ’, **2025**, in press Nature Astronomy, arXiv: 2409.07113.
- Liu, Y.<sup>†</sup>, Burke, C. et al. (author 7 of 7), ‘Dwarf Active Galactic Nuclei from Variability for the Origins of Seeds (DAVOS): Properties of Variability-Selected AGNs in the Dark Energy Survey Deep Fields’, **2025**, submitted to ApJ, arXiv: 2503.06372.
- Sampson, M.\* , Melchior, P., **Ward, C.**, Birmingham, S.<sup>†</sup> ‘Score matching diffusion models as data-driven priors for improved multi-band source separation’, **2024**, Astronomy and Computing, Volume 49, id.100875, doi:10.1016/j.ascom.2024.100875.
- Uppal, A.<sup>†</sup>, **Ward C.**, et al. ‘Astrometric Jitter as a Detection Diagnostic for Recoiling and Slingshot Supermassive Black Hole Candidates’, **2024**, ApJ, 975, 286.
- Ridley, E.\* , Nicholl, M., **Ward, C.** et al. ‘AT2017bcc: time-varying double-peaked emission lines following the sudden ignition of a dormant galactic nucleus’, **2024**, MNRAS, 531, 1905.
- Burke, C., Liu, Y.<sup>†</sup>, **Ward, C.** et al. ‘Dwarf AGNs from Variability for the Origins of Seeds (DAVOS): Properties of Variability-Selected AGNs in the COSMOS Field and Expectations for Rubin Observatory’, **2024**, ApJ, 971, 140.
- Liang, Y.\* , Melchior, P., et al. (author 7 of 7) ‘Outlier Detection in the DESI Bright Galaxy Survey’, **2023**, ApJL, 956, L6.
- Liang, Y.\* , Melchior, P. et al. (author 5 of 5), ‘Autoencoding Galaxy Spectra II: Redshift Invariance and Outlier Detection’, **2023**, ApJ, 166, 75.
- Hammerstein, E.\* , Gezari, S. et al. (author 7 of 9), ‘Integral Field Spectroscopy of 13 Tidal Disruption Event Hosts from the ZTF Survey’, **2023**, ApJ, 957, 86.
- Arcodia, R. et al (author 17 of 19), ‘O Corona, where art thou? eROSITA’s view of UV-optical-IR variability-selected massive black holes in low-mass galaxies’, **2023**, A&A, 681, A97.

Brightman, M., **Ward, C.** et al. 'A Luminous X-Ray Transient in SDSS J143359.16+400636.0: A Likely Tidal Disruption Event', **2021**, The Astrophysical Journal, 909, 102.

Hammerstein, E. \*, Gezari, S., van Velzen, S. et al. (author of 6 of 20) 'Tidal Disruption Event Hosts Are Green and Centrally Concentrated: Signatures of a Post-merger System', Erica Hammerstein et al. **2021**, ApJL, 908, L20.

van Velzen, S., Hammerstein, E. \*, Gezari, S., et al. (author 6 of 44) 'Seventeen Tidal Disruption Events from the First Half of ZTF Survey Observations: Entering a New Era of Population Studies', **2021**, ApJ, 908, 4.

Frederick, S. et al. (author 8 of 20), 'A Family Tree of Optical Transients from Narrow-Line Seyfert 1 Galaxies', **2021**, ApJ, 920, 56.

Stein, R. et al. (including Ward, C.), 'A tidal disruption event coincident with a high-energy neutrino', **2021**, Nature Astronomy, 5, 510.

Coppejans, D. L. et al. (author 22 of 38), 'A Mildly Relativistic Outflow from the Energetic, Fast-rising Blue Optical Transient CSS161010 in a Dwarf Galaxy', **2020**, ApJL 895, L23.

Andreoni, I. et al. (author 16 of 52), 'GROWTH on S190814bv: Deep Synoptic Limits on the Optical/Near-infrared Counterpart to a Neutron Star-Black Hole Merger', **2020**, ApJ, 890, 131.

van Velzen, S. et al. (author 15 of 41), 'The First Tidal Disruption Flare in ZTF: From Photometric Selection to Multi-wavelength Characterization', **2019**, ApJ, 172, 198.

Mahabal, A. et al. (author 15 of 50), 'Machine Learning for the Zwicky Transient Facility', **2019**, PASP, 131, 997.

Frederick, S. J. et al. (author 15 of 20), 'A New Class of Changing-look LINERs', **2019**, The Astrophysical Journal, 883, 31.

Hung, T. et al. (author 15 of 28), 'Discovery of Highly Blueshifted Broad Balmer and Metastable Helium Absorption Lines in a Tidal Disruption Event', ApJ, **2019**, 879, 119.

Duev, D. et al. (author 11 of 11), 'Real-bogus classification for the Zwicky Transient Facility using deep learning', **2019**, MNRAS, 489, 3582.

van Roestel, J. et al. (author 10 of 12), 'Simultaneous Observations of the Northern TESS Sectors by the Zwicky Transient Facility', **2019**, RNAAS, 3, 9, 136.

Perley, D. et al. (author 63 of 65), 'The fast, luminous ultraviolet transient AT2018cow: extreme supernova, or disruption of a star by an intermediate-mass black hole?', **2019**, The Monthly Notices of the Royal Astronomical Society, 484, 1.

Dobie, D. . et al. (author 28 of 30), 'An ASKAP Search for a Radio Counterpart to the First High-significance Neutron Star—Black Hole Merger LIGO/Virgo S190814bv', **2019**, The Astrophysical Journal, 887, 13.

Nordin, J. et al. (including Ward, C.), ‘Transient processing and analysis using AMPEL: alert management, photometry, and evaluation of light curves’, **2019**, A&A, 631, 147.

Kerr, M. et al. (author 3 of 6), ‘Extreme Scattering Events Towards Two Young Pulsars’, **2018**, MNRAS, 474, 4.

Hobbs, G. et al. (author 9 of 78), ‘A pilot ASKAP survey of radio transient events in the region around the intermittent pulsar PSR J1107- 5907’, **2016**, MNRAS, 456, 4.

Lynch, C. et al. (author 6 of 6), ‘Radio detections of southern ultracool dwarfs’, **2016**, The Monthly Notices of the Royal Astronomical Society, 457, 2.

## **White Papers:**

**Ward, C.**, Nugent P. & Strauss M., ‘After SDSS-V Blue Skies Ideas: Unveiling transients and their host galaxies in the era of time-domain surveys’, internal white paper, **2024**.

Nyland, K. et al. (including **Ward, C.**) ‘VLASS Epoch 4 Science Case’ white paper, **2024**, <https://science.nrao.edu/vlass/library/white-papers>.

## **References**

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