Tom Wagg

PhD Student in Astrophysics at the University of Washington

Academic Interests

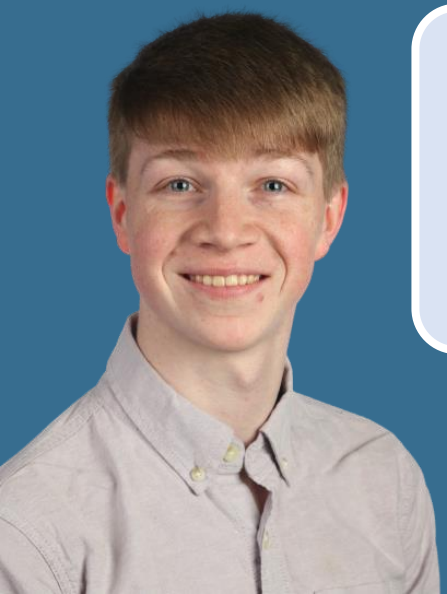
I am broadly interested in constraining binary stellar evolution, particularly with the use of kinematics of stars and compact objects. I'm also passionate about designing and using open-source software. My work combines these joint interests in developing, and applying, self-consistent population synthesis and galactic dynamics simulations.

Funding, Fellowships and Awards

NASA Astrophysics Theory Program Grant, Science PI 2024-2026
"A Galaxy of Binaries: Evolving Kicked Populations Through Galactic Potentials", $545,000

CCA Pre-Doctoral Fellowship for a self-proposed project at the Flatiron Institute *(Simons Foundation)* 2023
Kavli Summer Fellowship for a project on asteroseismic imprints of mass transfer *(Kavli Foundation)* 2023
Provost Scholar Fellowship ($15k) for outstanding academic achievement *(University of Washington)* 2021
Alex G. Booth Fellowship (~$5k) awarded to recent graduates for a research project *(Harvard University)* 2020
Haase Fellowship (~$5k) awarded for summer research project in Physics *(Harvard University)* 2018

Graduate Research Prize for an exceptional research project *(University of Washington)* 2022
Leo Goldberg Prize for the best astronomy senior thesis *(Harvard University)* 2020
Bloomberg creative science prize for most insightful thesis in natural sciences *(Harvard University)* 2020
Distinction in Teaching awarded for excellence in teaching *(Harvard University)* 2019



Education

University of Washington 2021 – 2025
Ph.D. in Astrophysics, M.S. in Astrophysics (March 2023)

Harvard University
A.B. in Physics and Astrophysics, Secondary in Computer Science 2016 – 2020
Cum laude with Highest Honors in Field

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Publications

Full ADS search results

First-author

1. **Wagg. T,** Renzo, M., et al., *Investigating runaway star categorization using cogsworth* [in prep.]
2. **Wagg. T,** Dalcanton, J., et al. (2024), *Exploring the Impact of Binary Interactions on Type II Supernovae Feedback with cogsworth*, [in prep.]
3. **Wagg. T,** Breivik, K., Renzo, M., Price-Whelan, A. (2024), *cogsworth : a Gala of COSMIC proportions combining binary stellar evolution and galactic dynamics*, [submitted], arXiv link, Documentation
4. **Wagg. T,** Broekgaarden, F. (2024), *Streamlining and standardizing software citations with The Software Citation Station*, [submitted], arXiv link, Software Citation Station
5. **Wagg. T,** Juric, M., Yoachim, P., Kurlander, J., et al. (2024), *Expected Impact of Rubin Observatory LSST on NEO Follow-up*, [in review], arXiv link
6. **Wagg. T,** Johnston, C., et al. (2024), *The Asteroseismic Imprints of Mass Transfer: A case study of a binary mass-gainer in the SPB instability strip*, *A&A, 687, 14*, Interactive plots
7. **Wagg, T.**, Broekgaarden, F.S., de Mink, S.E., et al. (2022), *Gravitational wave sources in our Galactic backyard: Predictions for BHBH, BHNS and NSNS binaries detectable with LISA*, ApJ, 937, 118
8. **Wagg, T.**, Breivik, K., de Mink, S.E. (2022), *LEGWORK: A python package for computing the evolution and detectability of stellar-origin gravitational-wave sources with space-based detectors*, ApJS, 260, 52, JOSS, Package documentation, Applied in 21 papers

Co-author

9. Merritt, J., (9 co-authors, incl. **Wagg, T.**), *Implications of modern mass-loss rates for massive stars*, [in prep.]
   Contribution: I participated in discussions deciding which mass-loss prescriptions to use and how to implement them in COMPAS.
10. Suissa, G., **Wagg, T.** et al., *Improved estimates of the planetary radius valley using constraints from multi-transiting transiting systems*, [in prep.]
    Contribution: I advised the first-author on the project and created the setup for fitting multi-transiting systems based on Kepler and TESS data.
11. Wainer, T., Davenport, J., Tovar, G., Feinstein, A., **Wagg, T.**, 2024, *Searching for Stellar Activity Cycles using Flares: The Short and Long Timescale Activity Variations of TIC-272272592*, *[accepted]*, *arXiv*
    Contribution: I created a pipeline for processing TESS observations of stars to characterize their flare activity and the completeness of observations.
12. Stegmann, J., Vigna-Gomez, A., Rantala, A., **Wagg, T**., et al., 2024, *Close Encounters of Wide Binaries Induced by the Galactic Tide: Implications for Stellar Mergers and Gravitational-Wave Sources*, *ApJL, 972, 2*
    Contribution: I helped design the initial conditions of the simulations and to derive the detection rates.
13. Vigna-Gomez, A. (**Wagg, T.** 5th of 10 co-authors), 2024, *Constraints on Neutrino Natal Kicks from Black-Hole Binary VFTS 243*, PRL, 132, 19
    Contribution: I performed simulations that investigated how the galactic orbit of VFTS 243 would vary for different neutrino natal kicks.

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Publications

Full ADS search results

Co-author (continued)

14. Wainer, T., Zasowski, G., Pepper, J., **Wagg, T.**, et al., 2023, *Catalog of Integrated-light Star Cluster Light Curves in TESS*, AJ, 166, 3
Contribution: I co-wrote the analysis pipeline for this paper with the first-author, which we then generalized and published as the python package ELK.

15. Broekgaarden, F.S., et al. (incl. **Wagg, T.**), 2022, *Impact of Massive Binary Star and Cosmic Evolution on Gravitational Wave Observations II: Double Compact Object Rates and Properties*, MNRAS, 516, 4
Contribution: I participated in discussions interpreting the properties of detectable systems.

16. van Son, L.A.C (**Wagg, T.** 5th of 9 co-authors), *2022, The redshift evolution of the binary black hole merger rate: a weighty matter*, ApJ, 931, 1
Contribution: I tested the robustness of our predictions by repeating the simulations for a series of binary physics variations.

17. Team COMPAS (incl. **Wagg, T.**), 2022, *Rapid stellar and binary population synthesis with COMPAS*, ApJS, 258, 2 & JOSS
Contribution: I implemented the mass-loss rates for the code and wrote Section 3.5. I also created Figures 5, 6, 7, and 8.

18. Hellier, C., et al. (incl. **Wagg, T.**), 2017, *WASP-South transiting exoplanets: WASP-130b, WASP-131b, WASP-132b, WASP-139b, WASP-140b, WASP-141b and WASP-142b*, MNRAS, 465, 3
Contribution: I discovered WASP-142b and estimated the parameters of the system.

19. Maxted, P., et al. (incl. **Wagg, T.**), 2016, Five transiting hot Jupiters discovered using WASP-South, Euler, and TRAPPIST: WASP-119 b, WASP-124 b, WASP-126 b, WASP-129 b, and WASP-133 b, A&A, 591, A55
Contribution: Performed MCMC fits to the planetary systems and created Figures 2-6.

Software Development

Primary author

`cogsworth`, *A Python package for performing self-consistent population synthesis and galactic dynamics*, GitHub, released 2024

`LEGWORK`, *A Python package for calculating gravitational-wave strains, performing binary orbital evolution and computing SNRs for space-based gravitational-wave detectors*, GitHub, JOSS, released 2022

Developer/Contributor

`COSMIC`, *A rapid binary population synthesis suite with a special purpose of generating realistic compact binary populations*, GitHub, contributed since 2023

`COMPAS`, *Compact Object Mergers: Population Astrophysics & Statistics – a rapid population synthesis code*, GitHub, JOSS, contributed since 2020

`Gala`, A *Python package for Galactic and gravitational dynamics*, GitHub, contributed since 2023

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Talks

Invited Review Talks

GWANW 2024 - Science with the Laser Interferometer Space Antenna — June 2024

Invited Seminars

Caltech Tea Talk – *Applying cogsworth to constrain binary stellar evolution* — Nov 2024
CIERA Observers Group – *cogsworth: a code combining population synthesis & galactic dynamics* — Oct 2024
Yale Data-science x Astrophysics Seminar - *Stellar-origin GW sources in LISA* — Jan 2024
CCA SPA Group – *The asteroseismic imprints of mass transfer* — Oct 2023
UWB Gravitational Wave Astronomy Group – *Stellar-origin GW sources in LISA* — Jan 2022
LISA Early Career Scientist Software Series – *LEGWORK python package* — Dec 2021
LISA Community Telecon – *Stellar-origin GW sources in LISA* — Nov 2021
SESTAS Seminar at Max Planck Institute, Garching – *Stellar-origin GW sources in LISA* — Nov 2021
TianQin Research Center for Gravitational Physics – *LEGWORK python package* — May 2021
CCA Gravitational Wave Group – *Stellar-origin GW sources in LISA* — Feb 2021

Contributed Talks

LIAC41 - *Combining binary evolution and galactic dynamics to understand runaway stars* — July 2024
GWANW 2024 – *Using LEGWORK to make predictions for LISA* — June 2024
AAS 241 – *NEO Follow-up in the era of LSST* — Jan 2023
LSST@Europe4 – *A hybrid solar system object catalogue* — Oct 2022
14th LISA Symposium – *Stellar-origin gravitational wave source in LISA* — July 2022
EAS 2021 – *Stellar-origin gravitational wave source in LISA* — May 2021
13th LISA Symposium – *Black hole-Neutron Star binaries in LISA* — Sep 2020

Research Advising

Samanvita Singhania, *Carnegie Mellon University* (undergraduate) — 2024-now
Project: Simulating the distribution of offsets of short gamma-ray bursts from their host galaxies
Co-advisor: Brendan O'Connor

Allison Payne, *University of Washington* (undergraduate) — 2023
Project: Improved estimates of the radius valley using constraints from multi-transiting systems
Co-advisor: Eric Agol

Emma Bacarra, Miguel Varanda & Elizabeth Pawelka, *University of Washington* (undergraduates) — 2023
Project: A search for self-lensing BH-star binaries in TESS
Co-advisor: Andy Tzanidakis

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Teaching

ASTR 150E: The Planets, *University of Washington* 2022
Online general education course on various topics related to the solar system and its planets. Led weekly discussions, held office hours and designed final exam with Nicole Kelly

ASTR 150A: The Planets, *University of Washington* 2021
General education course on various topics related to the solar system and its planets. Taught 3 weekly sections, held office hours and designed exam mark scheme with Toby Smith

CS61: Systems Programming and Machine Organization, *Harvard* 2019
Course for computer science majors teaching the fundamentals of systems programming with C with Eddie Kohler. Taught weekly sections & held office hours

CS50: Introduction to Computer Science, *Harvard* 2018
Class introducing computer science to undergraduates through C, Python and JavaScript with David Malan. Taught weekly sections & held office hours

Outreach

eSTEAM: UW Prison Outreach Program 2022–now
Designed, built and continuously maintain website for the eSTEAM prison outreach program

Astronomy on Tap Presenter 2022–now
Presented talks on gravitational waves and NEOs to the general public, ~2 per year

UW Planetarium Presenter 2021–now
Perform weekly planetarium shows for local schools and homeschool groups on the solar system and the Milky Way using WorldWideTelescope in the UW planetarium

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Departmental Leadership

UW *Department Roundup* Talks Founder 2024-now

I created a new monthly talk series to highlight departmental research, aiming to foster collaboration and community. Most attended non-colloquium seminar. Each month I solicit and select talks (1 graduate student, 1 postdoc, 1 faculty per session), balancing subject matter. I host the sessions, introducing each speaker and handling questions.

UW Graduate Student Representative 2022–24

As the elected graduate student representative in the department, I have worked to improve the department community and culture, in particular regarding graduate student activities.

- Organised weekly faculty-grad lunches for graduates to interact with faculty in a casual manner and form stronger intra-departmental connections
- Helped to implement guidelines and safeguards for expectations regarding TA work to address issues of inequity across different classes
- Represented graduate students on assistant professor hiring committee

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