Lorenz Zwick

Research Fellow at the Niels Bohr International Academy
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Curriculum Vitae

Scientific Interests

I am interested in several areas of astrophysics related to **black holes**: The formation and growth of **quasars**, approximation schemes for **analytical gravitional waveforms** and the importance of **environmental effects** for future gravitational wave detectors. I am also interested in the possibility of detecting gravitational waves and dark matter with **Doppler ranging** missions in the Solar system.

Education

Ph.D in theoretical astrophysics. September 2019 - September 2023
At the CTAC, University of Zürich.
Under the supervision of Prof. Lucio Mayer.

Masters Degree in physics. September 2017 - June 2019
At the Eidgenössische Technische Hochschule Zürich.

Bachelor Degree in physics. September 2014 - June 2017
At the Eidgenössische Technische Hochschule Zürich.

Languages and IT Skills

Fluent in Italian, English and German.
Intermediate level (B1 - B2) in French.
Beginner level (A2) in Danish.

Fluent in Python and Mathematica.
Experience in coding **direct integrators for N-body systems** with post-Newtonian dynamics and **Bayesian parameter estimation pipelines** for gravitational waves.

Employment History

Postdoctoral fellowship in theoretical astrophysics. October 2023 - Ongoing
At the Niels Bohr Institute, Copenhagen.
In the theoretical astrophysics group.

Ph.D position in theoretical astrophysics. 2019 - 2023
At the University of Zürich.
Under the supervision of Lucio Mayer (*lmayer@physik.uzh.ch*).

Teaching assistant in mathematics and physics. 2015 - 2019
At the Eidgenössische Technische Hochschule Zürich.

Private tutor for high-school students in mathematics. 2015 - 2018
For Zürcher Nachhilfe (*www.zuercher-nachhilfe.ch*).

Mountain Guide Assistant in Finale Ligure, Italy. 2013 - 2014
For Luigi Gagliardi (*gigio.gagliardi@gmail.com*).

Teaching, Supervision & Outreach

Private tutor for several Gymnasium students, at Zürcher Nachhilfe.
Teaching assistant at ETH in various mathematics and physics courses.

Supervision and support to Ph.D students at the Niels Bohr Institute, resulting in several shared publications.
Teaching assistant at UZH in theoretical Astrophysics and Cosmology, as part of my Ph.D duties.

Supervisor for the semester thesis of ETH student **Jeremy Layan**, on the topic of Post Newtonian expansions.
Supervisor for the semester thesis of ETH student **Marcus Haberland**, on the topic of exoplanets and gravitational waves. Accepted for Ph.D programme in Potsdam, Germany.

Actor and presenter at the "Three black holes walk into a bar" outreach event, in the Kosmos Klub, Zürich.

Interviewee in the hour long youtube video "Practically FREE Primordial Gravitational Waves Detector" by Fraser Cain, with over 35'000 views and overwhelmingly positive feedback.

Proposals, Workshops, Memberships

Member of the LISA Consortium.

Chapter Coordinator and Author for the LISA astrophysics working group white paper "Astrophysics with the Laser Interferometer Space Antenna".
Chapter Coordinator and Author for the upcoming TianQin astrophysics white paper.

Contributor to LISA's astrophysics "red book".

Co-Lead author of the accepted proposal "Future Missions to Uranus and Neptune: Prospects for Non-Planetary Science". ISSI, International Teams in Space and Earth Sciences.

Organiser of the workshop on "New Ideas on the origin of Black Hole Mergers". August 2024
At the Niels Bohr Institute.

Participant in the workshop on "scientific computing with Python". August 2022
At the University of Zürich, Zürich.
Participant in the workshop on "black hole dynamics". June 2022
At the Niels Bohr institute, Copenhagen.
Participant in the BINARY22 programme. May 2022
At the Kavli Institute for Theoretical Physics, Santa Barbara CA.
Participant in the workshop on "gravitational wave astronomy". August 2021
At the Niels Bohr institute, Copenhagen.

Selected and Recent Talks

Talk: Environmental effects on gravitational waves. December 2023
RESCEU workshop on black hole dynamics, Tokyo.
Talk: Imprints of accretion discs physics on gravitational waves. January 2023
Getting ready to descend the slippery slope of multimessenger black hole data, Sexten.
Talk: Direct collapse of exceptionally heavy black holes in the merger-driven scenario. October 2022
Young astronomers and galactic nuclei, San Sebastian.
Talk: Ice Giant Missions as Gravitational Wave Detectors. October 2021
LISA community Call (Virtual).
Talk: Multiband Gravitational waves from gas embedded sources. September 2021
Young astronomers and galactic nuclei, Kopenhagen.
Talk: Improved Gravitational Radiation Timescales. March 2020
The XIIth LISA Symposium, Nijmegen.

Invited talk: 2-D imaging with gravitational waves? September 2024
Università Insubria, Como.
Invited talk: Traces of accretion disc physics in gravitational waves. October 2022
Donostia International Physics Centre, San Sebastian.
Invited Talk: Traces of accretion disc physics in gravitational waves. May 2022
Kavli institute for theoretical physics, Santa Barbara CA.
Invited talk: The handbook of the gravitational wave astronomer. January 2022
GWNext conference, Beijing (Virtual).

Publication List

26. *Gravitational Wave Phase Shifts in Eccentric Black Hole Mergers as a Probe of Dynamical Formation Environments*
Kai Hendriks, **Lorenz Zwick** and Johan Samsing.
ArXiv 2403.05625 August 2024

25. *The Evolution of Accreting Population III Stars at 10^{-6} - 10^{3} $M_{\odot}$ yr^{-1}*
Devesh Nandal, **Lorenz Zwick**, Daniel J. Whalen, Lucio Mayer, Sylvia Ekström, Georges Meynet.
ArXiv 2407.06994 July 2024

24. *Imprints of massive black hole binaries on neighbouring deci-Hz gravitational-wave sources*
Jakob Stegmann*, **Lorenz Zwick***, Sander M. Vermeulen, Fabio Antonini, Lucio Mayer.
NATASTRON-24010097B July 2024

23. *Bridging the micro-Hz gravitational wave gap via Doppler tracking with the Uranus Orbiter and Probe Mission: Massive black hole binaries, early universe signals and ultra-light dark matter*
Lorenz Zwick, Deniz Soyuer, Daniel J. D'Orazio, David O'Neill, Andrea Derdzinski, Prasenjit Saha, Diego Blas, Alexander C. Jenkins, Luke Zoltan Kelley.
ArXiv 2406.02306 June 2024

22. *Detecting environmental effects in gravitational waves from binaries perturbed by periodic forces*
Lorenz Zwick, Christopher Tiede, Alessandro A. Trani, Andrea Derdzinski, Zoltan Haiman, Daniel J. D'Orazio, Johan Samsing.
ArXiv 2405.05698 May 2024

21. *Close Encounters of Wide Binaries Induced by the Galactic Tide: Implications for Stellar Mergers and Gravitational-Wave Sources*
Jakob Stegmann, Alejandro Vigna-Gómez, Antti Rantala, Tom Wagg, **Lorenz Zwick**, Mathieu Renzo, Lieke A. C. van Son, Selma E. de Mink, Simon D. M. White
ArXiv 2405.02912 May 2024

20. *Gravitational Wave Memory Imprints on the CMB from Populations of Massive Black Hole Mergers*
Lorenz Zwick, David O'Neill, Kai Hendriks, Philip Kirkeberg and Miravet-Tenés
ArXiv 2404.06927 April 2024

19. *Gravitational Wave Phase Shifts in Eccentric Black Hole Mergers as a Probe of Dynamical Formation Environments*
Johan Samsing, Kai Hendriks, **Lorenz Zwick**, Daniel J. D'Orazio and Bin Liu.
ArXiv 2403.05625 March 2024

18. *Black Holes in the Era of Gravitational-Wave Astronomy*
Several Authors, including **Lorenz Zwick**.
Elsevier May 2024

17. *Disk-induced Binary Precession: Implications for Dynamics and Multimessenger Observations of Black Hole Binaries*
Christopher Tiede, Daniel J. D'Orazio **Lorenz Zwick** and Paul C. Duffel.
Monthly Notices of the Royal Astronomical Society, Volume 526, Issue 2 December 2023

16. *LISA Definition Study Report*
Several Authors, including **Lorenz Zwick**
ESA February 2024

15. *Relativistic binary-disc dynamics and the timing of OJ-287's flares*
Lorenz Zwick and Lucio Mayer.
Monthly Notices of the Royal Astronomical Society, Volume 526, Issue 2 December 2023

14. *Direct formation of massive black holes via dynamical collapse in metal-enriched merging galaxies at $z \sim 10$: fully cosmological simulations*
Lucio Mayer, Pedro R. Capelo, **Lorenz Zwick** and Tiziana di Matteo.
The Astrophysical Journal, Volume 961, Number 1. April 2023

13. *Prospects for localising Planet 9 with a future Uranus mission*
Jozef Bucko, Deniz Soyuer and **Lorenz Zwick**.
Monthly Notices of the Royal Astronomical Society, Volume 524, Issue 1. September 2023

12. *Priorities in gravitational waveform modelling for future space-borne detectors: vacuum accuracy or environment?*
Lorenz Zwick, Pedro R. Capelo and Lucio Mayer.
Monthly Notices of the Royal Astronomical Society, Volume 521, Issue 3. May 2023

11. *Direct collapse of exceptionally heavy black holes in the merger-driven scenario.*
Lorenz Zwick, Lucio Mayer, Lionel Haemmerlè and Ralf S Klessen.
Monthly Notices of the Royal Astronomical Society, Volume 518, Issue 2. January 2023

10. *Prospects for a Local Detection of Dark Matter With Future Missions to Uranus and Neptune.*
Lorenz Zwick, Deniz Soyuer and Jozef Bucko.
Astronomy and Astrophysics, Volume 664. July 2022

9. *The imprint of gas on gravitational waves from LISA intermediate-mass black hole binaries.*
Mudit Garg, Andrea Derdzinski, **Lorenz Zwick**, Pedro R. Capelo and Lucio Mayer.
Monthly Notices of the Royal Astronomical Society, Volume 517, Issue 1. November 2022

8. *Dirty Waveforms: multiband harmonic content of gas-embedded gravitational wave sources.*
Lorenz Zwick, Andrea Derdzinski, Mudit Garg, Pedro R. Capelo and Lucio Mayer.
Monthly Notices of the Royal Astronomical Society, Volume 511, Issue 4. April 2022

7. *Astrophysics with the Laser Interferometer Space Antenna*
Several Authors, including **Lorenz Zwick** as a coordinator for Ch. 3.
Accepted in LRR [arXiv:220306016A]. March 2022

6. *Revised event rates for extreme and extremely large mass-ratio inspirals.*
Veronica Vazquez-Acevez, **Lorenz Zwick**, Elisa Bortolas, Pedro R. Capelo, Pau Amaro-Seoane, Lucio Mayer and Xian Chen.
Monthly Notices of the Royal Astronomical Society, Volume 510, Issue 2. February 2022

5. *On the maximum accretion rate of supermassive stars.*
Lionel Haemmerlé, Ralf S. Klessen, Lucio Mayer and **Lorenz Zwick**.
Astronomy and Astrophysics Volume 652. August 2021

4. *Improved Gravitational Radiation Timescales II: Spin-orbit contributions and environmental perturbations.*
Lorenz Zwick, Pedro R. Capelo, Elisa Bortolas,Veronica Vazquez-Acevez, Lucio Mayer and Pau Amaro-Seoane.
Monthly Notices of the Royal Astronomical Society, Volume 506, Issue 1. June 2021

3. *Searching for gravitational waves via Doppler tracking by future missions to Uranus and Neptune.*
Deniz Soyuer, **Lorenz Zwick**, Daniel J. D'Orazio and Prasenjit Saha.
Monthly Notices of the Royal Astronomical Society: Letters, Volume 503, Issue 1. May 2021

2. *Towards a polarization prediction for LISA via intensity interferometry.*
Sandra Baumgartner, Mauro bernardini, Josè Roberto Canivete Cuissa, Hugues de Laroussilhe, Alison M. W. Mitchell, Benno A. Neuenschwander, Prasenjit Saha, Timothèe Schaeffer, Deniz Soyuer and **Lorenz Zwick**.
Monthly Notices of the Royal Astronomical Society, Volume 498, Issue 3. November 2020

1. *Improved Gravitational Radiation Timescales: significance for LISA and LIGO-Virgo sources.*
Lorenz Zwick, Pedro R. Capelo, Elisa Bortolas, Lucio Mayer and Pau Amaro-Seoane.
Monthly Notices of the Royal Astronomical Society, Volume 495, Issue 2. June 2020