Oliver Long

Research experience

Postdoctoral Researcher, Max Planck Institute for Gravitational Physics   Nov 2022 –

- Used numerical data to perform a resummation of weak-field expansions of the scattering angle due to a point-particle source to extend their validity into the strong-field regime [3].
- Extended the Spectral Einstein Code (SpEC) to be capable of producing the most accurate simulations of hyperbolic binary black hole encounters to date [7, 2], some of which have been made publically available [8]
- Produced the first numerical relativity simulations of highly asymmetric mass-ratio hyperbolic binary black hole encounters (mass ratio 1:10) and performed the first measurements of disparate scattering angles due to asymmetric gravitational wave emission [2].
- Used numerical relativity scattering simulations to extract high-order self-force coefficients and cross-validate post-Minkowskian calculations and effective-one-body models [1, 2].

Postdoctoral Research Fellow, University of Southampton   Jun 2022 – Oct 2022

- Used numerical data to extract high-order weak-field expansions of the scattering angle due to a point-particle source [4].

Ph.D. Student, University of Southampton   Sep 2018 – Apr 2022

- Developed and implemented a numerical method for calculating perturbations due to a point-particle source in black hole perturbation theory [5, 13].
- Performed the first-ever calculation of the post-geodesic correction to the scattering angle of a point-particle in a black hole spacetime [5].
- Derived analytic formulae for scattering geodesics in a black hole spacetime [13] and implemented them in the KerrGeodesics package of the Black Hole Perturbation Toolkit.

Education

Ph.D. in Mathematical Sciences, University of Southampton   Sep 2018 – Apr 2022

- Thesis title: Self-force in hyperbolic black hole encounters.
- Advisor: Prof. Leor Barack

MPhys in Physics, The University of Manchester   Sep 2014 – Jun 2018

- Project title: Constraints on the neutrino sector using current and future cosmological data.
- Advisor: Dr Eleonora Di Valentino

Prizes and funding awards

Seal of Excellence, European Commission Horizon Europe.   2025

- Project proposal: Gravitational Waves from Hyperbolic Encounters (GWHypE).
- Recognised as a highly rated proposal for the Marie Skłodowska-Curie Actions Postdoctoral Fellowships.

Doctoral Prize Fellowship, Engineering and Physical Sciences Research Council.   2022

- Funding for the Postdoctoral Research Fellow position at the University of Southampton.
- Grant number: EP/T517859/1

Best Student Talk Runner Up, 25th Capra Meeting on Radiation Reaction in GR.   Jun 2022

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Featured publications

[1] **O. Long**, H. P. Pfeiffer, L. E. Kidder, and M. A. Scheel, "Black-hole scattering with numerical relativity: Self-force extraction and post-Minkowskian validation," *Phys. Rev. D*, vol. 112, no. 12, p. 124 038, 2025. DOI: 10.1103/bdsb-sp9c. arXiv: 2511.10196.

[2] **O. Long**, H. P. Pfeiffer, A. Buonanno, G. U. Jakobsen, G. Mogull, A. Ramos-Buades, H. R. Rüter, L. E. Kidder, and M. A. Scheel, "Highly accurate simulations of asymmetric black-hole scattering and cross validation of effective-one-body models," *Phys. Rev. D*, vol. 112, no. 12, p. 124 039, 2025. DOI: 10.1103/p6fx-7798. arXiv: 2507.08071.

[3] **O. Long**, C. Whittall, and L. Barack, "Black hole scattering near the transition to plunge: Self-force and resummation of post-Minkowskian theory," *Phys. Rev. D*, vol. 110, no. 4, p. 044 039, Aug. 2024. DOI: 10.1103/PhysRevD.110.044039. arXiv: 2406.08363.

[4] L. Barack, Z. Bern, E. Herrmann, **O. Long**, J. Parra-Martinez, R. Roiban, M. S. Ruf, C.-H. Shen, M. P. Solon, F. Teng, and M. Zeng, "Comparison of post-Minkowskian and self-force expansions: Scattering in a scalar charge toy model," *Phys. Rev. D*, vol. 108, no. 2, p. 024 025, Jul. 2023, **Co-lead author** (follows HEP alphabetical author list convention). DOI: 10.1103/PhysRevD.108.024025. arXiv: 2304.09200.

[5] L. Barack and **O. Long**, "Self-force correction to the deflection angle in black-hole scattering: A scalar charge toy model," *Phys. Rev. D*, vol. 106, no. 10, p. 104 031, Nov. 2022, **Co-lead author**. DOI: 10.1103/PhysRevD.106.104031. arXiv: 2209.03740.

Other publications

[6] C. Whittall, L. Barack, and **O. Long**, "Frequency-domain self-force calculations using Gegenbauer reconstruction," *Phys. Rev. D*, vol. 112, no. 12, p. 124 045, 2025. DOI: 10.1103/9qsl-pr63. arXiv: 2509.19439.

[7] I. B. Mendes, N. L. Vu, **O. Long**, H. P. Pfeiffer, and R. Owen, "Parameter control for binary black hole initial data," *Phys. Rev. D*, vol. 112, no. 12, p. 124 049, 2025. DOI: 10.1103/zh31-bbtm. arXiv: 2509.07291.

[8] M. A. Scheel *et al.*, "The SXS Collaboration's third catalog of binary black hole simulations," *Classical and Quantum Gravity*, vol. 42, no. 19, p. 195 017, Oct. 2025. DOI: 10.1088/1361-6382/adfd34. arXiv: 2505.13378.

[9] A. Abac *et al.*, "The Science of the Einstein Telescope," Mar. 2025. arXiv: 2503.12263.

[10] L. J. G. Da Silva, R. Panosso Macedo, J. E. Thompson, J. A. V. Kroon, L. Durkan, and **O. Long**, "Hyperboloidal discontinuous time-symmetric numerical algorithm with higher order jumps for gravitational self-force computations in the time domain," Jun. 2023. arXiv: 2306.13153.

[11] N. Afshordi *et al.*, "Waveform modelling for the Laser Interferometer Space Antenna," *Living Rev. Rel.*, vol. 28, no. 1, p. 9, Oct. 2025. DOI: 10.1007/s41114-025-00056-1. arXiv: 2311.01300.

[12] M. Boschini *et al.*, "Extending black-hole remnant surrogate models to extreme mass ratios," *Phys. Rev. D*, vol. 108, no. 8, p. 084 015, Oct. 2023. DOI: 10.1103/PhysRevD.108.084015. arXiv: 2307.03435.

[13] **O. Long** and L. Barack, "Time-domain metric reconstruction for hyperbolic scattering," *Phys. Rev. D*, vol. 104, no. 2, p. 024 014, Jul. 2021. DOI: 10.1103/PhysRevD.104.024014. arXiv: 2105.05630.

Invited seminars (total: 3)

- WQFT Seminar, Humboldt University of Berlin, "Black hole scattering in the strong-field regime: Merging post-Minkowskian theory with numerical methods", 25th November 2024.

- Gravity Seminar, University of Southampton, "Black hole scattering in the strong-field regime: Merging post-Minkowskian theory with numerical methods", 7th November 2024.

- Séminaire Amplitudes et Gravitation sur l'Yvette, Institut des Hautes Études Scientifiques, "Black hole scattering in the strong-field regime: Merging post-Minkowskian theory with numerical methods", 16th October 2024.

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Invited talks (total: 9)

- GWSky kick-off meeting, Max Planck Institute for Gravitational Physics, "NR, PM, PN, GSF comparisons and transferring information from one method to another", 9th December 2025 (joint with Raj Patil).

- 2nd Annual Workshop on Self-Force and Amplitudes, University of Southampton, "Applications of numerical self-force scattering simulations", 10th September 2025.

- EOB@Work25, Istituto Nazionale di Fisica Nucleare, "Highly accurate simulations of asymmetric black-hole scattering and cross validation of effective-one-body models", 4th September 2025.

- Mathematical Methods for the General Relativistic Two-body Problem, National University of Singapore, "Putting the hype in hyperbolic black hole scattering", 14th August 2025.

- Fundamental Physics Meets Waveforms With LISA, Max Planck Institute for Gravitational Physics, "Modelling of unbound binary black hole encounters", 6th September 2024.

- Gravitational Self-Force and Scattering Amplitudes Workshop, The Higgs Centre for Theoretical Physics, "Comparing numeric and analytic methods for black hole scattering in unequal mass systems", 20th March 2024.

- Gravitational Waves meet Amplitudes in the Southern Hemisphere, International Center for Theoretical Physics South American Institute for Fundamental Research, "Self-force meets post-Minkowskian in the scattering regime", 24th August 2023.

- Infinity on a Gridshell, Niels Bohr Institute, "Hyperbolic self-force calculations within a hyperboloidal framework", 10th July 2023.

- QCD meets Gravity 2022, Universität Zürich, "Extraction of high-order post-Minkowskian results from scattering self-force calculations", 13th December 2022.

Contributed talks (total: 14)

- New Frontiers of Numerical Relativity, Universitat de les Illes Balears, "Highly accurate simulations of asymmetric black-hole scattering and cross validation of effective-one-body models", 22nd July 2025.

- 24th International Conference on General Relativity and Gravitation and 16th Edoardo Amaldi Conference on Gravitational Waves, Glasgow, "Highly accurate simulations of asymmetric black-hole scattering and cross validation of effective-one-body models", 15th July 2025.

- "Hyperbolic Binary Black Hole encounters with the Spectral Einstein Code", NR Community Call, 2nd December 2024.

- Simulating Extreme Spacetimes with SpEC and SpECTRE, The Institute for Computational and Experimental Research in Mathematics, Brown University, "Hyperbolic Binary Black Hole encounters with SpEC", 7th August 2024.

- 27th Capra Meeting on Radiation Reaction in General Relativity, National University of Singapore, "Double the hype: Hyperboloidal framework for self-force in hyperbolic black hole encounters", 17th June 2024.

- 26th Capra Meeting on Radiation Reaction in General Relativity, Niels Bohr Institute, "Comparison of post-Minkowskian and self-force expansions: Scattering in a scalar charge toy model", 4th July 2023.

- LISA Symposium XIV, "Self-force in hyperbolic black hole encounters", 25th – 29th July 2022. 🔗

- 23rd International Conference on General Relativity and Gravitation, Chinese Academy of Science via Zoom, "Self-force in hyperbolic black hole encounters", 5th July 2022. 🔗

- 25th Capra Meeting on Radiation Reaction in General Relativity, University College Dublin, "Self-force in hyperbolic black hole encounters", 22nd June 2022. 🔗

- BritGrav22, University of Glasgow via Zoom, "Self-force in hyperbolic binary-black-hole encounters", 4th April 2022. 🔗

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- 24th Capra Meeting on Radiation Reaction in General Relativity, Perimeter Institute via Zoom, "Time-domain metric reconstruction for hyperbolic scattering", 10th June 2021. 🔗

- BritGrav21, University College Dublin via Zoom, "Towards a self-force calculation of the scatter angle in hyperbolic encounters", 13th April 2021. 🔗

- LISA Symposium XIII, "Towards a self-force calculation of the scatter angle in hyperbolic encounters", 1st – 3rd October 2020. 🔗

- 23rd Capra Meeting on Radiation Reaction in General Relativity, University of Texas at Austin via Zoom, "Towards a self-force calculation of the scatter angle in hyperbolic encounters", 24th June 2020. 🔗

Posters (total: 1)

- 3rd meeting of the GWVerse COST action, Institute for Fundamental Physics of the Universe, International School for Advanced Studies, "Time-domain metric reconstruction using the Hertz potential", 13th – 16th January 2020.

Other events attended (total: 11)

- In Pursuit of Gravitational Waves: Solving the Two-Body Problem in General Relativity, Max Planck Institute for Gravitational Physics (Albert Einstein Institute), 20th – 22nd October 2025.

- Black Hole Perturbation Toolkit Workshop (via Zoom), The Institute for Computational and Experimental Research in Mathematics, Brown University, 25th – 27th July 2022.

- From Scattering Amplitudes to Gravitational-Wave Predictions for Compact Binaries, Universität Zürich & ETH Zürich, 4th – 15th July 2022.

- Advances and Challenges in Computational Relativity Workshop (Online), The Institute for Computational and Experimental Research in Mathematics, Brown University, 14th – 18th September 2020.

- Black Hole Perturbation Toolkit Workshop (Online), Astronomical Institute of the Academy of Sciences of the Czech Republic, 25th – 27th May 2020.

- Kavli RISE Summer School on Gravitational Waves, University of Cambridge, 23rd – 27th September 2019.

- 22nd International Conference on General Relativity and Gravitation and 13th Edoardo Amaldi Conference on Gravitational Waves, Palau de congressos de Valencia, 8th – 12th July 2019.

- 22nd Capra Meeting on Radiation Reaction in General Relativity, Centro Brasileiro de Pesquisas Físicas, 17th – 21st June 2019.

- LISA Waveform Working Group Meeting, Max Planck Institute for Gravitational Physics (Albert Einstein Institute), 13th – 15th May 2019.

- BritGrav19, Durham University, 15th – 16th April 2019.

- Black Hole Perturbation Toolkit Workshop, University College Dublin, 19th – 21st March 2019.

Mentorship and supervision

Francisco Grippa   Nov 2025 –

- Visiting PhD student from Salerno University, co-supervised with Harald Pfeiffer.

- Project: Initial data for hyperbolic black hole encounters using the Extended Conformal Thin Sandwich (XCTS) approach.

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Other community service

- Member of the Simulating eXtreme Spacetimes (SXS) Social Media Team. Aug 2024 –
- Member of the Capra community's Equality, Diversity and Inclusion (EDI) Team. Jun 2024 –
- Reviewer for *Physical Review Letters* and *Physical Review D*. Mar 2023 –
- Discussion chair for "Scattering – What? Why? How?", Fundamental Physics Meets Waveforms With LISA, Max Planck Institute for Gravitational Physics, 6th September 2024.
- Discussion chair for "Self-force meets Amplitudes", 26th Capra Meeting on Radiation Reaction in General Relativity, Niels Bohr Institute, 4th July 2023.

Research collaborations

Simulating eXtreme Spacetimes (SXS) collaboration Nov 2022 –

- Contributor to the Spectral Einstein Code (SpEC).
- Member of the SXS Social Media Team.

The Black Hole Perturbation Toolkit Mar 2019 –

- Contributor to the KerrGeodesics package.

Laser Interferometer Space Antenna (LISA) Consortium Oct 2018 –

- Member of the Waveform Working Group and LISA Early Career Scientists (LECS).
- Member of the "Verified 1PA Dissipative Data" project team.

LIGO Scientific Collaboration (LSC) Apr 2023 – Nov 2023

- Member of the Waveform Working Group.

Computing experience

- Extensive experience with high-performance computing (HPC) on clusters.
- Extensive experience with running and troubleshooting binary black hole simulations with SpEC.

Advanced: C/C++, Python, Mathematica, Git, Linux, MacOS, LaTeX.

Intermediate: Bash, OpenMP, Slurm, Paraview, Windows.

Some experience: Perl, Cython, OpenMPI.

Teaching experience

Postgraduate Student Demonstrator, University of Southampton Sep 2018 – Jan 2022

- Numerical Methods in Python: Run workshops based on problem sheets and coursework.
- Maths for Physicists: Run classes demonstrating mathematical techniques and coursework marking.
- Maths for Engineers: Run drop-in workshops, marking of exams, and exam writing.