

# Mao Zeng

## Curriculum Vitae

### Contact information

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Address: JCMB 4402, Higgs Centre of Theoretical Physics, School of Physics and Astronomy,  
University of Edinburgh

### Education

**2010 – 2015: Doctor of Philosophy in Physics**, C.N. Yang Institute for Theoretical Physics, Stony Brook University, United States.

PhD Advisor: George Sterman.

Research areas: Quantum chromodynamics, Effective field theories.

**2009-2010: Certificate of Advanced Study in Mathematics (Part III Mathematics)**, Honours pass with distinction, Cambridge University, United Kingdom.

Study area: Mathematical physics.

**2006-2009: Bachelor of Arts**, First-class honours, top 5 of class in all three years, Cambridge University, United Kingdom. Study area: Experimental and theoretical physics.

### Employment

**2021-present:** Royal Society University Research Fellow, Higgs Centre of Theoretical Physics, School of Physics and Astronomy, University of Edinburgh

**2021:** Royal Society University Research Fellow, Department of Physics, University of Oxford, United Kingdom.

**2018-2020:** Postdoctoral Scholar in theoretical particle physics, Department of Physics, ETH Zurich, Switzerland.

**2015-2018:** Postdoctoral Scholar in theoretical particle physics, Department of Physics and Astronomy, University of California at Los Angeles, USA

### Awards and Funding

**2023: Frontiers of Science Award, International Congress of Basic Science, Beijing**, \$25,000 award shared between 7 recipients, for work on the correspondence between scattering amplitudes and binary black hole dynamics

**2021-2025: UK Royal Society University Research Fellowship**, £543,000 of initial funding, later successfully applied for £170,000 of supplemental research expenses

**2018: (Declined) Marie Curie COFUND Fellowship** (for postdoc position at Freiburg University, Germany; declined in favor of a regular postdoc position at ETH Zurich)

**2016: President's Award to Distinguished Doctoral Student**, Stony Brook University.  
(Awarded annually to five doctoral graduates in all fields in the university)

**2006-2010: Cambridge Overseas Scholarship**, Cambridge University, UK  
(Full tuition scholarship for four years of study)

**2007: Percy Pemberton Prize for Distinguished Undergraduate Student**, Trinity College,  
Cambridge University, UK  
(Awarded annually to two first-year undergraduate students in Trinity College)

## Publications

42 publications, cited 3283 times as of 19 Dec, 2023, h index = 29, according to the database INSPIREHEP.net for high-energy physics publications.  
(Links to publications on [INSPIRE](#), [arXiv](#))

**1. Sally Dawson, Ian M. Lewis and Mao Zeng**

Phys. Rev. D 88, 054028 – Published 26 September 2013  
*Threshold Resummed and Approximate Next-to-next-to-leading Order Results for WW Pair Production at the LHC*

**2. George Sterman and Mao Zeng**

JHEP 05 132 (2014) – Published 28 May 2014  
*Quantifying Comparisons of Threshold Resummations*

**3. Patrick Meade, Harikrishnan Ramani and Mao Zeng**

Phys. Rev. D 90, 114006 (2014) – Published 01 December 2014  
*Transverse Momentum Resummation effects in WW measurements*

**4. Sally Dawson, Ian M. Lewis and Mao Zeng**

Phys. Rev. D 90, 093007 (2014) – Published 25 November 2014  
*Effective Field Theory for Higgs Plus Jet Production*

**5. Sally Dawson, Ian M. Lewis and Mao Zeng**

Phys. Rev. D 91, 074012 (2015) – Published 07 April 2015  
*The Usefulness of EFT for Boosted Higgs Production*

**6. Mao Zeng**

JHEP 10 (2015) 189 – Published 28 October 2015  
*Drell-Yan Process with Jet Vetoes: breaking of generalized factorization*

**7. Sally Dawson, Ye Li, Prerit Jaiswal, Harikrishnan Ramani, and Mao Zeng**

Phys. Rev. D 94, 114014 – Published 15 December 2016  
*Resummation of jet veto logarithms at partial  $N^3\text{LL}+\text{NNLO}$  for WW production at the LHC*

**8. Mao Zeng**

JHEP 06 (2017) 121 – Published 22 June 2017  
*Differential equations on unitarity cut surfaces*

**9. S. Abreu, F. Febres Cordero, H. Ita, M. Jaquier, B. Page, M. Zeng**

Phys. Rev. Lett. 119, 142001 – Published 05 October 2017  
*Two-Loop Four-Gluon Amplitudes with the Numerical Unitarity Method*

- 10. Zvi Bern, Michael Enciso, Julio Parra-Martinez, Mao Zeng**  
 JHEP 05 (2017) 137 – Published 25 May 2017  
*Manifesting enhanced cancellations in supergravity: integrands versus integral*
- 11. Zvi Bern, John Joseph M. Carrasco, Wei-Ming Chen, Henrik Johansson, Radu Roiban, Mao Zeng**  
 Phys. Rev. D 96, 126012 – Published 20 June 2018  
*Five-Loop Four-Point Integrand of  $N=8$  Supergravity as a Generalized Double Copy*
- 12. Zvi Bern, Michael Enciso, Harald Ita, Mao Zeng**  
 Phys. Rev. D 96, 096017 – Published 21 November 2017  
*Dual conformal symmetry, integration-by-parts reduction, differential equations and the nonplanar sector*
- 13. Samuel Abreu, Fernando Febres Cordero, Harald Ita, Ben Page, Mao Zeng**  
 Phys. Rev. D 97, 116014 – Published 20 June 2018  
*Planar two-loop five-gluon amplitudes from numerical unitarity*
- 14. Samuel Abreu, Fernando Febres Cordero, Harald Ita, Ben Page, Mao Zeng**  
 Part of Proceedings, 53rd Rencontres de Moriond on QCD and High Energy Interactions (Moriond QCD 2018)  
*Computing Planar Five-Gluon Amplitudes with Numerical Unitarity*
- 15. Zvi Bern, John Joseph Carrasco, Wei-Ming Chen, Alex Edison, Henrik Johansson, Julio Parra-Martinez, Radu Roiban, Mao Zeng**  
 (Editor's suggestion) Phys. Rev. D. 98, 086021 – Published 19 Oct 2018  
*Ultraviolet properties of  $N=8$  supergravity at five loops*
- 16. Zvi Bern, Michael Enciso, Chia-Hsien Shen, Mao Zeng**  
 Phys. Rev. Lett. 121, 121603 – Published 21 Sep 2018  
*Dual conformal structure beyond the planar limit*
- 17. Ben Page, Samuel Abreu, Fernando Febres Cordero, Harald Ita, Matthieu Jaquier, Mao Zeng**  
 Proceedings of Science, RADCOR2017 012 – Published 02 Jul 2018  
*First two-loop amplitudes with the numerical unitarity method*
- 18. Zvi Bern, Michael Enciso, Harald Ita, Mao Zeng**  
 Proceedings of Science, LL2018 084 – Published 02 Oct 2018  
*Two-loop  $D$ -dimensional unitarity and dual conformal symmetry*
- 19. Samuel Abreu, Fernando Febres Cordero, Harald Ita, Ben Page, Mao Zeng**  
 Proceedings of Science, LL 2018 016 – Published 02 Oct 2018  
*Five-point two-loop amplitudes from numerical unitarity*
- 20. Samuel Abreu, Ben Page, Mao Zeng**  
 JHEP 1901 (2019) 006 – published 02 Jan 2019  
*Differential equations from unitarity cuts: nonplanar hexa-box integrals*
- 21. Samuel Abreu, Lance Dixon, Enrico Herrmann, Ben Page, Mao Zeng**  
 Phys. Rev. Lett. 122, 121603 – published 29 Mar 2019  
*The two-loop five-point amplitude in  $N=4$  super-Yang-Mills theory*

- 22. Zvi Bern, Clifford Cheung, Radu Roiban, Chia-Hsien Shen, Mikhail P. Solon, Mao Zeng**  
Phys. Rev. Lett. 122, 201603 – published 24 May 2019  
*Scattering Amplitudes and the Conservative Hamiltonian for Binary Systems at Third Post-Minkowskian Order*
- 23. Samuel Abreu, Lance Dixon, Enrico Herrmann, Ben Page, Mao Zeng**  
JHEP 1903 (2019) 123 – Published 21 March 2019  
*The two-loop five-point amplitude in  $N=8$  supergravity*
- 24. Zvi Bern, Clifford Cheung, Radu Roiban, Chia-Hsien Shen, Mikhail P. Solon, Mao Zeng**  
JHEP 10 (2019) 206 – Published 21 October 2019  
*Black Hole Binary Dynamics from the Double Copy and Effective Theory*
- 25. Zvi Bern, Andres Luna, Radu Roiban, Chia-Hsien Shen, Mao Zeng**  
arXiv:2005.03071 – Submitted 06 May 2020  
*Spinning Black Hole Binary Dynamics, Scattering Amplitudes and Effective Field Theory*
- 26. Julio Parra-Martinez, Michael Ruf, Mao Zeng**  
JHEP 11 (2020) 023 – Submitted 09 November 2020  
*Extremal black hole scattering at  $O(G^3)$ : graviton dominance, eikonal exponentiation, and differential equations*
- 27. Samuel Abreu, Harald Ita, Francesco Moriello, Ben Page, Wladimir Tschernow, Mao Zeng**  
JHEP 11 (2020) 117 – Published 23 Nov 2020  
*Two-Loop Integrals for Planar Five-Point One-Mass Processes*
- 28. Charalampos Anastasiou, Rayan Haindl, George Sterman, Zhou Yang, Mao Zeng**  
JHEP 04 (2021) 222 – Published 22 Apr 2021  
*Locally finite two-loop amplitudes for off-shell multi-photon production in electron-positron annihilation*
- 29. Zvi Bern, Julio Parra-Martinez, Radu Roiban, Michael S. Ruf, Chia-Hsien Shen, Mikhail P. Solon, Mao Zeng**  
(Editor's suggestion) Phys.Rev.Lett. 126, 171601 – Published 26 Apr 2021  
*Scattering Amplitudes and Conservative Binary Dynamics at  $O(G^4)$*
- 30. Enrico Herrmann, Julio Parra-Martinez, Michael S. Ruf, Mao Zeng**  
Phys.Rev.Lett. 126, 201602 – Published 17 May 2021  
*Gravitational Bremsstrahlung from Reverse Unitarity*
- 31. Enrico Herrmann, Julio Parra-Martinez, Michael S. Ruf, Mao Zeng**  
JHEP 10 (2021) 148 – Published 18 Oct 2021  
*Radiative Classical Gravitational Observables at  $O(G^3)$  from Scattering Amplitudes*
- 32. Co-authored with R. Alves Batista, M.A. Amin, G. Barenboim, N. Bartolo, D. Baumann, et al.**  
arXiv:2110.10074 – Submitted 19 Oct 2021  
*EuCAPT White Paper: Opportunities and Challenges for Theoretical Astroparticle Physics in the Next Decade*

- 33. Zvi Bern, Julio Parra-Martinez, Radu Roiban, Michael S. Ruf, Chia-Hsien Shen, Mao Zeng**  
Phys.Rev.Lett. 128, 161103 – Published 22 April 2022  
*Scattering Amplitudes, the Tail Effect, and Conservative Binary Dynamics at  $O(G^4)$*
- 34. Zvi Bern, Juan Pablo Gatica, Enrico Herrmann, Andres Luna, Mao Zeng**  
JHEP 08 (2022) 131 – Published 10 Aug 2022  
*Scalar QED as a toy model for higher-order effects in classical gravitational scattering*
- 35. Alessandra Buonanno, Mohammed Khalil, Donal O'Connell, Radu Roiban, Mikhail P. Solon, Mao Zeng**  
Contribution to 2022 Snowmass Summer Study, arXiv:2204.05194 – Submitted 11 Apr 2022  
*Snowmass White Paper: Gravitational Waves and Scattering Amplitudes*
- 36. Fernando Febres Cordero, Manfred Kraus, Guanda Lin, Michael Ruf, Mao Zeng**  
Phys.Rev.Lett. 130, 021601 – Published 12 January 2023  
*Conservative Binary Dynamics with a Spinning Black Hole at  $O(G^3)$  from Scattering Amplitudes*
- 37. Michael Ruf, Zvi Bern, Julio Parra-Martinez, Chia-Hsien Shen, Mikhail Solon, Mao Zeng**  
Proceedings of Science, Loops and Legs in Quantum Field Theory (LL2022) – Published 20 October, 2022  
*Scattering amplitudes and conservative dynamics at the fourth post-Minkowskian Order*
- 38. Mao Zeng**  
JHEP 09 (2023) 042 – Published 07 September 2023  
*Feynman Integrals from Positivity Constraints*
- 39. Leor Barack, Zvi Bern, Enrico Herrmann, Oliver Long, Julio Parra-Martinez, Radu Roiban, Michael S. Ruf, Chia-Hsien Shen, Mikhail P. Solon, Fei Teng, Mao Zeng**  
Phys. Rev. D 108, 024025 - Published 12 July 2023  
*Comparison of post-Minkowskian and self-force expansions: Scattering in a scalar charge toy model*
- 40. Kirill Mokrov, Alexander Smirnov, Mao Zeng**  
Numerical Methods and Programming 24(4) 352-367 (2023), Published 19-10-2023  
*Rational Function Simplification for Integration-by-Parts Reduction and Beyond*
- 41. Zvi Bern, Enrico Herrmann, Radu Roiban, Michael S. Ruf, Alexander V. Smirnov, Vladimir A. Smirnov, Mao Zeng**  
arXiv:2305.08981, Submitted 15 May 2023  
*Conservative binary dynamics at order  $O(\alpha^5)$  in electrodynamics*
- 42. Alexander V. Smirnov, Mao Zeng**  
arXiv:2311.0237, Submitted 4 Nov 2023  
*FIRE 6.5: Feynman Integral Reduction with New Simplification Library*
- 43. A.V. Belitsky, A.A. Kokosinskaya, A.V. Smirnov, V.V. Voevodin, Mao Zeng**  
arXiv:2402.07499, Submitted 12 Feb 2024  
*Efficient reduction of Feynman integrals on supercomputers*

## Talks and Presentations

1. *Parton Luminosity Shapes and Threshold Resummation in SCET and Direct QCD*, XIth Annual Workshop on Soft-Collinear Effective Theory, Technical University of Munich, Mar 26, 2014.
2. *Transverse Momentum Resummation effects in WW measurements*, remote, ATLAS Collaboration Standard Model Plenary Meeting, Aug 14, 2014.
3. *Effective Field Theory for Higgs plus Jet Production*, Seminar at Brookhaven National Laboratory, Sep 26, 2014.
4. *Same title as above*, Phenomenology / Experiment Joint Seminar, Stony Brook University, Sep 29, 2014.
5. *Same title as above*, Seminar at Argonne National Laboratory, Nov 12, 2014.
6. *Transverse Momentum Resummation effects in WW measurements*, PITT-PACC Workshop on QCD and Beyond at Colliders, Pittsburgh University, Nov 14, 2014.
7. *Drell-Yan Process with Jet Vetoes: Breaking of Generalized Factorization*, The 12th International Symposium on Radiative Corrections and LoopFest XIV, UC Los Angeles, Jun 17, 2015.
8. *Jet vetoes and discrete symmetries*, QCD Factorization Workshop, University at Buffalo, Nov 03, 2015.
9. *Same title as above*, Seminar at Harvard University, May 10, 2016.
10. *Same title as above*, Seminar UC San Diego, Jun 14, 2016.
11. *Partial N<sup>3</sup>LL + NNLO resummation for WW production under a jet veto*, LoopFest XV Conference, University at Buffalo, Aug 16, 2016
12. *New integration-by-parts techniques for gravity amplitudes*, QCD Meets Gravity Workshop, UC Los Angeles, Dec 05, 2016.
13. *Towards multi-jet production at NNLO*, Topical Workshop on QCD Structure of Nucleons in the Modern Era, UC Los Angeles, May 06, 2017.
14. *Differential equations and integration by parts from unitarity*, LoopFest XVI Workshop, Argonne National Laboratory, Jun 02, 2017
15. *Unitarity cuts and UV divergences*, Scattering Amplitudes and Beyond Workshop, Kavli Institute for Theoretical Physics, UC Santa Barbara, Jun 29, 2017.
16. *QCD at the LHC using new theoretical tools in scattering amplitudes*, Seminar at Lawrence Berkeley National Laboratory, Sep 20, 2017.
17. *Unitarity cuts and loop amplitudes in QCD and supersymmetric theories*, Seminar at UC Los Angeles, October 03, 2017.
18. *Unitarity cuts beyond loop integrands*, Seminar at SLAC National Accelerator Laboratory, December 01, 2017.
19. *Two-loop D-dimensional unitarity and dual conformal symmetry*, 14th Workshop on Loops and Legs in Quantum Field Theory, St. Goar, Germany, May 04, 2018
20. *Integral reduction and five-loop supergravity*, Workshop on Taming the Complexity of Multiloop Integrals, June 05, 2018

21. *Calculating supergravity divergences at high loop orders*, Amplitudes 2018 International Conference, SLAC National Accelerator Laboratory, June 20, 2018
22. *Five-loop UV properties of  $N=8$  supergravity*, International Workshop on High Precision for Hard Processes, Albert-Ludwigs-Universitat Freiburg, October 03, 2018
23. *The high-multiplicity frontier for two-loop QCD*, Workshop on Amplitudes in the LHC Era, Galileo Galilei Institute for Theoretical Physics, Florence, October 29, 2018
24. *Loop amplitudes from unitarity and ansatz*, Particle Physics Seminar at the Institute for Theoretical Physics, ETH Zurich, February 26, 2019
25. *High-multiplicity Frontier for Amplitudes at the LHC*, Annual Meeting of the Institute of Theoretical Physics, Chinese Academy of Science, Beijing, April 29, 2019
26. *Generalized unitarity and frontiers of perturbative QFT*, Seminar at SLAC National Accelerator Laboratory, August 08, 2019
27. *Generalized unitarity and numerical ansatzes for 2-loop 5-point amplitudes*, LoopFest XVIII Conference, Fermilab, August 13, 2019
28. *Orbital Dynamics from double copy and EFT*, RadCor 2019 – 14th International Symposium on Radiative Corrections, 11 September 2019
29. *Black Hole Binary Dynamics from Scattering Amplitudes*, Seminar at Zurich University, Dec 03, 2019
30. *Towards 4th-Post-Minkowskian Potential*, QCD Meets Gravity Conference, University of California at Los Angeles, Dec 10, 2019
31. *NNLO subtraction for numerical integration of virtual amplitudes*, remote, QCD@LHC-X Conference, CERN, Sep 10, 2020
32. *Factorization and subtraction of singularities of 2-loop amplitudes*, remote, Seminar at Peking University, Oct 13, 2020
33. *Locally finite representation of 2-loop amplitudes*, remote, Seminar at University of Edinburgh, Oct 22, 2020
34. *New results for gravitational binary dynamics from QFT amplitudes*, remote, Seminar at Mathematical Institute, University of Oxford, Jan 26, 2021
35. *New results for gravitational binary dynamics from scattering amplitudes*, remote, Seminar at Nordita, Feb 16, 2021
36. *Third-post-Minkowskian binary dynamics from KMOC formalism*, remote, UCLA / AEI Potsdam joint journal club, Mar 09, 2021
37. *Gravitational physics from scattering amplitudes and collider methods*, remote, Colloquium at University of Oxford, Apr 30, 2021
38. *Integrals for post-Minkowskian classical dynamics*, remote, GGI Workshop on Gravitational Scattering, Inspiral, and Radiation, May 12, 2021
39. *Importing perturbative QCD methods into gravitational wave physics*, remote, Radcor-LoopFest 2021 Conference, Florida State University, May 20, 2021.

40. Particle physics methods for gravitational wave physics, remote, Qingdao Summer School in Particle Physics Theory, Qingdao University, China, Jul 13, 2021
41. *Conservative and radiative binary dynamics from scattering amplitudes*, remote, Amplitudes 2021 International Conference, Michigan State University, 18 Aug, 2021.
42. *Amplitudes, Loops, and Gravity*, Seminar at Queen Mary University of London, remote, 11 Nov, 2021.
43. *Multi-loop scattering amplitudes and gravitational binary dynamics*, Seminar at Kings College London, 26 Jan, 2022.
44. *Multi-loop scattering amplitudes and gravitational binary dynamics*, remote, Colloquium at CERN Department of Theoretical Physics, 02 Mar, 2022
45. Spinning binary black holes & 2-loop scattering amplitudes, remote, Seminar at Institute of Theoretical Physics, Chinese Academy of Science, 30 Jun, 2022
46. *Multi-loop integrals for binary dynamics*, Workshop on From Scattering Amplitudes to Gravitational-Wave Predictions for Compact Binaries, University of Zurich, 14 Jul, 2022
47. *Electrodynamics as toy model for binary gravitational dynamics at higher orders*, remote, Physics in Intense Fields Conference 2022 (PIF22), Plymouth University, 31 Aug, 2022
48. *A new method for evaluating Feynman integrals*, Zurich Phenomenology Workshop, 12 Jan, 2023
49. *Feynman integrals from positivity constraints*, remote, Peking University HEP Seminar, 02 Feb, 2023
50. *Feynman integrals from positivity constraints*, remote, Amplitudes Seminar at Bonn University, 11 May 2023
51. *Feynman integrals from positivity constraints*, LoopFest XXI conference, SLAC National Accelerator Laboratory
52. *Feynman integrals from positivity constraints*, remote, Seminar at the University of Colorado Boulder, Nuclear Theory Group, 07 Sep
53. *Scattering Amplitudes and Gravitational Wave Physics*, remote, Theoretical Particle Physics Seminar at the University of Sussex, 06 Nov

## Teaching

Fall 2010 and Spring 2011: graduate Teaching Assistant for PHY 277 Computation for Physics and Astronomy, Stony Brook University

Summer 2011 and Fall 2011: graduate Teaching Assistant for PHY 124 Physics for the Life Sciences II, Stony Brook University

Spring 2011: graduate Teaching Assistant for PHY 512 Quantum Mechanics II, Stony Brook University

Fall 2018: Teaching Coordinator for Quantum Field Theory I, ETH Zurich (postdoc appointment)



2018-2019: Supervision of master student thesis, ETH Zurich (postdoc appointment)

2022-: Lecturer for Computer Simulations, course for 2nd year undergraduate physics students, Edinburgh University

2021-: Project supervisor of Mphys program at Edinburgh University. Two Mphys students supervised so far.

2022-: PhD student supervision. Two PhD students currently under supervision.

2023:- Supervisor for summer project of exchange undergraduate student from Nankai University, China

2024-: Project supervisor of Msc program at Edinburgh University. Three Msc students supervised so far.

2024:- Project supervisor of Senior Honours Mathematical Physics Program, University of Edinburgh. One current student under supervision.