Harold ERBIN

Nationality: French
Birth: 5 October 1989 (France)

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Research interests: **string field theory**, **machine learning/physics/math interface**, **quantum computing**, AI for scientific discovery, numerical simulations, quantum gravity, philosophy of science

Employment

April 2024 – aujourd'hui	Postdoctoral researcher Institut de physique théorique (IPHT), CEA, Paris, France
November 2020 – October 2023	Postdoctoral researcher, Marie Skłodowska-Curie fellow Massachusetts Institute of Technology (MIT), Boston, USA CEA, Paris, France
November 2020 – October 2023	Junior investigator NSF AI Institute for Artificial Intelligence and Fundamental Interactions (IAIFI), Boston, USA
August 2019 – October 2020	Postdoctoral researcher Università degli Studi, Turin, Italy
June 2017 – July 2019	Postdoctoral researcher, Humboldt fellow Ludwig-Maximilians-Universität (LMU), Munich, Germany
June 2016 – May 2017	Postdoctoral researcher, CNRS fellow LPTENS, École Normale Supérieure, Paris, France
January 2016 – June 2016	Postdoctoral researcher Harish-Chandra Research Institute (HRI), Allahabad, India International Centre for Theoretical Sciences (ICTS), Bangalore, India

Education

2020 – 2021	Habilitation à diriger des recherches (diploma allowing to supervise PhD) Title: *A field theory approach to string theory* Committee: N. Berkovits, E. Dudas, E. Huguet, E. Kiritsis, I. Sachs Université Denis Diderot–Paris 7, Paris, France
2012 – 2015	PhD in theoretical physics, "mention très honorable" (highest honours) Title: *Black holes in $N = 2$ supergravity* Advisor: Nick Halmagyi Committee: I. Bena, G. Compère, A. Dabholkar, G. Policastro, H. Samtleben, A. Van Proeyen LPTHE, Université Pierre et Marie Curie–Paris 6, Paris, France
2010 – 2012	MSc in theoretical physics, "mention très bien" (highest honours) École Normale Supérieure, Paris, France Université Denis Diderot–Paris 7, Paris, France

2009 – 2010	**BSc in fundamental physics** Université Denis Diderot–Paris 7, France
2007 – 2009	**Classes préparatoires aux grandes écoles** (equivalent to two years of BSc) Lycée Roosevelt, Reims, France

Research experiences prior to the PhD

January 2012 – February 2012	**Internship** Title: *Critical behaviors of random tensor models in the large N limit* Advisor: Valentin Bonzom Perimeter Institute for Theoretical Physics, Waterloo, Canada
May 2011 – August 2011	**Internship** Title: *Classical supersymmetry and supergravity* Advisors: Jihad Mourad, Francesco Nitti Apc, Université Denis Diderot–Paris 7, France
June 2010	**Internship** Title: *Magnetohydrodynamics, jets and stellar winds* Advisor: Nektarios Vlahakis University of Athens, Greece

Fellowships, grants and awards

Fellowships:

2020	Marie Skłodowska-Curie global fellowship (3 years) Title: *Machine learning for string field theory and string- and F-theory landscapes*
2016	Alexander von Humboldt and Carl Friedrich von Siemens fellowship (2 years)
2016	Postdoctoral mandates (Pdm) fellowship, Ku–Leuven (1 year, declined)
2016	Cnrs fellowship (1 year)
2012	PhD scholarship from the French doctoral school Ed564–Edpif (3 years)

Grants and awards:

2020	**Travel award**, Mdpi Physics
2019	Nica mega-science grant 18-02-40121 (associate member) Russian Foundation for Basic Research PI: Maxim Chernodub, Alexander Molochkov Title: *Phase diagram of dense quark-gluon plasma from first-principles simulations enhanced by machine learning techniques*

Distinctions and relevant experiences

- Infinite Expansion award, MIT (2022)
  "For providing exemplary service on the IAIFI Early Career and Equity Committee and being actively involved in many other IAIFI community building efforts."
- Qualifications:[1]
  - CNU Lecturer: section 29 (France, 2016, 2021)
  - CNU Professor: section 29 (France, 2022)
  - AQU Lector (Catalonia, 2021)
- Organization of seminars:
  - String/gravity theory seminar, CTP, MIT (2021–2022)
  - String field theory international journal club (since 2021)
- Management and community activities (IAIFI):
  - Member of the Outreach Committee (2022)
  - Member of the Early Career & Equity Committee (2021–2022)
  - Admin of the collaborative messaging platform (since 2021)
  - Presentations for the NSF and External Advisory Board visiting committees
  - Presenting at the Cambridge Science Festival (2022)
- Other management and community activities:
  - Administration and setup of tools for the string field theory community
  - Elected member of the administration board (LPTHE, 2014–2015)

Invited referee:

- Journals: Advances in Theoretical and Mathematical Physics, Annals of Physics, Classical and Quantum Gravity, European Physical Journal (EPJC, EPJ Plus), General Relativity and Gravitation, International Journal of Modern Physics A, Journal of High Energy Physics, Nuclear Physics B, Physical Review (PRD, PRL), Physics Letter B, Progress of Theoretical and Experimental Physics, Scipost, Theoretical and Mathematical Physics
- Knowledge databases: Mathematical Reviews (AMS), zbMath
- Publishers: Springer (Lecture notes in physics)
- Workshops in AI conferences: ICLM (AI4Science), ICLR (DGM4HSD), NeurIps (AI4Science, ML4Ph, GenBio)

Thesis committees:

2023 − 2024
        Diane Segalla (CEA-LSCE): Monitoring committee, non-expert member

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[1]Examination, allows applications to positions at universities.

Supervising experiences

Thesis:

November 2018 – April 2020   Hrólfur Ásmundsson (Lmu, master)

Projects:

January 2022 – March 2024   Atakan Hilmi Fırat (Mit, PhD)
January 2021 – August 2021   Riccardo Finotello (Cea-List, junior postdoc)
January 2021 – August 2021   Robin Schneider (Uppsala University, PhD)
December 2020 – August 2022   Maxime Médevielle (Liverpool University, PhD)
January 2020 – December 2020   Riccardo Finotello (Università di Torino, PhD)
January 2016 – September 2017   Corinne de Lacroix (Lptens, PhD)

Internships:

May 2021 – June 2021   Antoine Petitjean (Ens Lyon, master)

Teaching experiences

Teaching at universities:

2022   Mentoring (50 hours): *Quantum mechanics I* (BSc)
                Mit, Usa

2017 – 2019   Lecturer (60 hours / year): *String field theory* (MSc, PhD)
                Elite Master Program "Theoretical and mathematical physics"
                Lmu, Munich, Germany

2012 – 2015   Teaching assistant (64 hours / year)
                Université Paris 6, France

                – *Numerical methods and scientific computation* (1st year MSc):
                  tutorials (2012–2015), lectures (2013–2015)
                – *Classical mechanics II* (1st year BSc): tutorials (2012–2013)
                – *Optics and thermodynamics for biology* (2nd year BSc): tutorials
                  (2013–2014)

2010 – 2012   Teaching assistant (64 hours / year)
                Université Paris 7, France

Teaching at doctoral schools and institutes:

2019   *Introduction to 2d CFT:* tutorials, 4 hours (lecturer: Sylvain Ribault)
         "Yrisw 2019: A modern primer for 2D CFT", Esi, Vienna

2019   *Introduction to string field theory:* lectures, 3 hours
         Itp, Utrecht (2019)

2017   *Introduction to string field theory:* lectures, 6 hours
         Lptens and Lpthe, Paris (2017)

Other teachings:

October 2010 – September 2011   Teaching assistant in sciences (half-time, 800 hours / year)
                                 Lycée Jean Macé, Vitry-sur-Seine, France

Conferences: invited talks and organization

- Machine learning (8)
  "String data", Cambridge University (2022)
  "Data across disciplines workshop", Johannesburg University (2022)
  "String data", Witwatersrand and Cape Town Universities (2021)
  "String data", CERN, Geneva (2020)
  "Mathematical physics days", Koç University, Istanbul (2020)
  "Strings, geometry, and data science", Simons Center, Stony Brook (2020)
  "Machine learning landscape", ICTP, Trieste (2018)
  "Artificial intelligence and theoretical physics", LIST, CEA Saclay (2018)

- String theory (7)
  "Workshop on Matrix Models and String Field Theory", Benasque (2024 – invited)
  "Combinatorics and Arithmetic for Physics", IHES, Paris (2023)
  "Workshop on fundamental aspects of string theory", ICTP-SAIFR, São Paulo (2020)
  "String field theory and string perturbation theory", GGI, Florence (2019)
  "Quantum gravity in Paris", IHP, Paris (2019)
  "Geometry and strings", Ringberg (2018)
  "New frontiers in string theory", YITP, Kyoto (2018)

- 2d gravity and supergravity (5)
  "Conformal anomalies 2024", IDP (2024 – invited)
  "String field theory and string phenomenology", HRI, Allahabad (2018)
  "Strings, cosmology, and gravity student conference", IHP, Paris (2017)
  "2nd French-Russian conference: Physics and random geometry", IHP, Paris (2016)
  "Théorie des cordes en France", Université Paris 6 (2015)

Discussion moderator:

- "Machine learning techniques in lattice QCD", MITP (2021)

Committees:

- "At the interface of physics, mathematics, and artificial intelligence", Pollica (organization committee, May 2023)
  Funding obtained: full support for speaker local expenses (Pollica Physics Center, call 2023)

- "String field theory 2022", Prague (scientific committee, September 2022)

- "SFT@Cloud 2021", online (organization committee, September 2021)

- "First French-German meeting in physics, mathematics and artificial intelligence theory", Paris (organization committee, November 2019)
  Funding obtained: Artificial Intelligence Procope Event grant, INRIA & French Embassy in Berlin

Invited talks at institutions

- String (field) theory (17)
  3× CTP, MIT, Cambridge (2022); CTP, MIT, Cambridge (2021); 2× LAPTH, Annecy (2020); IDP, Tours (2019); IHP, Paris (2019); HRI, Allahabad (2019); LMU, Munich (2019); ITP, Utrecht (2019); SINP, Kolkata (2019); AEI, Potsdam (2018); ICTP, Trieste (2018); LMU, Munich (2018); IPHT, CEA Saclay (2017); LMU, Munich (2016)

- Machine learning (23)
SLAC, Stanford (2023); Ferdowsi University of Mashhad (2023); Università di Torino (2023); Lapth, Annecy (2022); Amsterdam University (2022); Imb, Dijon (2022); Northeastern University, Cambridge (2022); New Hampshire University, Durham (2022); Tensor journal club (2022); Imb, Dijon (2022); Idp, Tours (2022); Cea-List, Saclay (2022); Itp, Heidelberg (2021); Iit Madras (2021); Liverpool University (2021); Lpthe, Université Paris 6 (2020); Milan (2020); Ceico, Prague (2020); Università di Torino (2019); Sinp, Kolkata (2019); Iacs, Kolkata (2019); Idp, Tours (2018); Lmu, Munich (2018); Hri, Allahabad (2018)

- 2d gravity (6)
Simons Center, Stony Brook (2019); Lmu, Munich (2017); Icts, Bangalore (2016); Ulb, Brussels (2015); Lpthe, Université Paris 6 (2015); Lpthe, Lptens, Paris (2015)

- Black holes and supergravity (10)
Virtual Institute of Astroparticle Physics (2016); Hri, Allahabad (2016); Lmu, Munich (2015); Università Milano–Bicocca (2015); Aei, Potsdam (2015); Itp, Utrecht (2014); Università di Torino (2014); Ulb, Brussels (2014); Università degli Studi di Milano (2014); Lpthe, Université Paris 6 (2014)

Computer science

- Machine learning, numerical and symbolic libraries
(including Keras, jax/flax/optax, scikit-learn, pandas, numpy, sympy, Blas/Lapack)
- Programming languages: Python, Bash, Php, C, Fortran
- System administration and software development
- Web design: Html/Css, Django, Bootstrap, Javascript, Wordpress
- Experiences
  - Certificate: Full Stack Software Developer (Ibm, Coursera, earned 09/2023)
  - Contest: Codingame programming contest (01/2013, rank 12/349)
  - Contribution to open source projects: SymPy

Misc

- Languages:
  - French (native)
  - English (fluent)
  - German (advanced, B2–C1)[2]
  - Italian (advanced)
  - Hindi (notions)
  - Esperanto (notions)

- First aid training (Psc1, France)

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[2]June–July 2017: intensive course at Goethe Institute (level B2.3 reached).

Publications

Book and thesis:

1. H. Erbin. "String field theory – A Modern Introduction". Lectures Notes in Physics 980, Springer (2021). ISBN: 978-3030653200. 420 pages. harolderbin.com/science-books

2. H. Erbin. "A Field Theory Approach to String Theory". Habilitation thesis. Université Denis Diderot – Paris VII (2021). 110 pages. hal: `tel-03341545`.

3. H. Erbin. "Black Holes in $N = 2$ Supergravity". PhD thesis. Université Pierre et Marie Curie – Paris VI (2015). 237 pages. hal: `tel-01269849`.

Published:

1. H. Erbin, A. Hilmi Fırat. "Characterizing 4-string contact interaction using machine learning". Journal of High Energy Physics 2024:04 (Apr. 2024). 38 pages.

2. C. de Lacroix, H. Erbin, V. Lahoche. "Gravitational action for a massive Majorana fermion in 2d quantum gravity". Journal of High Energy Physics 2024:01 (Jan. 2024). 40 pages. arXiv: `2308.08342`.

3. H. Erbin, M. Médevielle. "Closed string theory without level-matching at the free level". Journal of High Energy Physics 2023:03 (Mar. 2023). 33 pages. arXiv: `2209.05585`.

4. H. Erbin, V. Lahoche, D. Ousmane Samary. "Nonperturbative Renormalization for the Neural Network-QFT Correspondence". Machine Learning: Science and Technology 3:1 (Jan. 2022). 62 pages. arXiv: `2108.01403`.

5. H. Erbin, A. Hilmi Fırat, B. Zwiebach. "Initial Value Problem in String-inspired Nonlocal Field Theory". Journal of High Energy Physics 2022:01 (Jan. 2022). 49 pages. arXiv: `2111.03672`.

6. A. Bilal, C. de Lacroix, H. Erbin. "Effective Gravitational Action for 2d Massive Fermions". Journal of High Energy Physics 2021:11 (Nov. 2021). 32 pages. arXiv: `2109.03637`.

7. H. Erbin, R. Finotello, R. Schneider, M. Tamaazousti. "Deep Multi-task Mining Calabi-Yau Four-folds". Machine Learning: Science and Technology 3:1 (Nov. 2021). 15 pages. arXiv: `2108.02221`.

8. H. Erbin, R. Finotello. "Machine Learning for Complete Intersection Calabi-Yau Manifolds: A Methodological Study". Physical Review D 103:12 (June 2021). 59 pages. arXiv: `2007.15706`.

9. H. Erbin, V. Lahoche, M. Tamaazousti. "Constructive Expansion for Quartic Vector Field Theories. I. Low Dimensions". Journal of Mathematical Physics 62:4 (Mar. 2021). 49 pages. arXiv: `1904.05933`.

10. H. Erbin, R. Finotello. "Inception Neural Network for Complete Intersection Calabi-Yau 3-folds". Machine Learning: Science and Technology 2:2 (Jan. 2021). 8 pages. arXiv: `2007.13379`.

11. H. Erbin, C. Maccaferri, M. Schnabl, J. Vošmera. "Classical Algebraic Structures in String Theory Effective Actions". Journal of High Energy Physics 2020:11 (Nov. 2020). 85 pages. arXiv: 2006.16270.

12. H. Erbin, S. Krippendorf. "GANs for Generating EFT Models". Physics Letters B 810 (Sep. 2020). 6 pages. arXiv: 1809.02612.

13. M. N. Chernodub, H. Erbin, V. A. Goy, A. V. Molochkov. "Topological Defects and Confinement with Machine Learning: The Case of Monopoles in Compact Electrodynamics". Physical Review D 102:5 (Sep. 2020). 15 pages. arXiv: 2006.09113.

14. M. N. Chernodub, H. Erbin, I. V. Grishmanovskii, V. A. Goy, A. V. Molochkov. "Casimir Effect with Machine Learning". Physical Review Research 2:3 (Sep. 2020). 7 pages. arXiv: 1911.07571.

15. T. Bautista, H. Erbin, M. Kudrna. "BRST Cohomology of Timelike Liouville Theory". Journal of High Energy Physics 2020:05 (May 2020). 29 pages. arXiv: 2002.01722.

16. H. Erbin, C. Maccaferri, J. Vošmera. "Localization of Effective Actions in Heterotic String Field Theory". Journal of High Energy Physics 2020:02 (Feb. 2020). 48 pages. arXiv: 1912.05463.

17. C. de Lacroix, H. Erbin. "A Short Note on Dynamics and Degrees of Freedom in $2d$ Classical Gravity". General Relativity and Gravitation 52:9 (Jan. 2020). 13 pages. arXiv: 1612.04097.

18. S. Dartois, H. Erbin, S. Mondal. "Conformality of $1/N$ Corrections in SYK-like Models". Physical Review D 100:12 (Dec. 2019). 31 pages. arXiv: 1706.00412.

19. T. Bautista, A. Dabholkar, H. Erbin. "Quantum Gravity from Timelike Liouville theory". Journal of High Energy Physics 2019:10 (Oct. 2019). 43 pages. arXiv: 1905.12689.

20. H. Erbin, J. Maldacena, D. Skliros. "Two-Point String Amplitudes". Journal of High Energy Physics 2019:7 (Jul. 2019). 7 pages. arXiv: 1906.06051.

21. C. de Lacroix, H. Erbin, A. Sen. "Analyticity and Crossing Symmetry of Superstring Loop Amplitudes". Journal of High Energy Physics 2019:5 (May 2019). 28 pages. arXiv: 1810.07197.

22. H. Erbin, V. Lahoche. "Universality of Tunnelling Particles in Hawking Radiation". Physical Review D 98:10 (Nov. 2018). 12 pages. arXiv: 1708.00661.

23. C. de Lacroix, H. Erbin, E. E. Svanes. "Minisuperspace Computation of the Mabuchi Spectrum". Classical and Quantum Gravity 35:18 (Aug. 2018). 24 pages. arXiv: 1704.05855.

24. J. D. Dorronsoro, H. Erbin, T. Van Riet. "Domain Wall Seeds in CSO-Gauged Supergravity". Journal of High Energy Physics 17:06 (Jun. 2017). 17 pages. arXiv: 1704.06534.

25. C. de Lacroix, H. Erbin, E. E. Svanes. "Mabuchi Spectrum from the Minisuperspace". Physics Letters B 758 (Jul. 2016). 5 pages. arXiv: 1511.06150.

26. H. Erbin. "Deciphering and Generalizing Demianski-Janis-Newman Algorithm". General Relativity and Gravitation 48:5 (May 2016). 20 pages. arXiv: 1411.2909.

27. H. Erbin, N. Halmagyi. "Quarter-BPS Black Holes in AdS$_4$-NUT from $N = 2$ Gauged Supergravity". Journal of High Energy Physics 2015:10 (Oct. 2015). 34 pages. arXiv: 1503.04686.

28. H. Erbin, L. Heurtier. "Five-Dimensional Janis-Newman Algorithm". Classical and Quantum Gravity 32:16 (Aug. 2015). 28 pages. arXiv: 1411.2030.

29. H. Erbin, L. Heurtier. "Supergravity, Complex Parameters and the Janis-Newman Algorithm". Classical and Quantum Gravity 32:16 (Aug. 2015). 18 pages. arXiv: 1501.02188.

30. H. Erbin, N. Halmagyi. "Abelian Hypermultiplet Gaugings and BPS Vacua in $N = 2$ Supergravity". Journal of High Energy Physics 2015:5 (May 2015). 37 pages. arXiv: 1409.6310.

31. H. Erbin. "Janis-Newman Algorithm: Simplifications and Gauge Field Transformation". General Relativity and Gravitation 47:3 (Mar. 2015). 11 pages. arXiv: 1410.2602.

32. V. Bonzom, H. Erbin. "Coupling of Hard Dimers to Dynamical Lattices via Random Tensors". Journal of Statistical Mechanics: Theory and Experiment 2012:9 (Sep. 2012). 12 pages. arXiv: 1204.3798.

Reviews and book chapters:

33. H. Erbin, R. Finotello. "Deep learning complete intersection Calabi-Yau manifolds". In: "Machine-learning in Theoretical Physics & Pure Mathematics" (ed. Yang-Hui He), World Scientific (Jul. 2023). arXiv: 2311.11847.

34. C. de Lacroix, H. Erbin, S. P. Kashyap, A. Sen, M. Verma. "Closed Superstring Field Theory and Its Applications". International Journal of Modern Physics A 32:28n29 (Oct. 2017). 137 pages. arXiv: 1703.06410.

35. H. Erbin. "Janis-Newman Algorithm: Generating Rotating and NUT Charged Black Holes". Universe 3:1 (Mar. 2017). 68 pages. arXiv: 1701.00037.

Proceedings and conference papers:

36. H. Erbin, R. Finotello, M. Tamaazousti. "Machine learning for complete intersection Calabi-Yau manifolds". NeurIps 2022 workshop: Machine Learning and the Physical Sciences workshop (Dec. 2022).

37. H. Erbin, V. Lahoche, D. Ousmane Samary. "Renormalization in the neural network-quantum field theory correspondence". NeurIps 2022 workshop: Machine Learning and the Physical Sciences workshop (Dec. 2022).

38. H. Erbin. "Janis–Newman Algorithm for Supergravity Black Holes". Proceedings: The String Theory Universe, Leuven, September 7-11, 2015. Fortschritte der Physik 64 (Apr. 2016). 2 pages.

Preprints:

39. H. Erbin, S. Majumder. "SL$(2, \mathbb{C})$ quartic vertex for closed string field theory" (Nov. 2023). 20 pages. arXiv: 2311.07367.

40. H. Erbin, R. Finotello, B. W. Kpera, V. Lahoche, D. Ousmane Samary. "Functional renormalization group for signal detection and stochastic ergodicity breaking" (Aug. 2023). 33 pages. arXiv: 2310.07499.

41. H. Erbin, A. Hilmi Fırat. "Open string stub as an auxiliary string field" (Aug. 2023). 39 pages. arXiv: 2308.08587.