

(+44) 7794 474903

b.percival@liverpool.ac.uk

11 Glade Park Court,

Ullet Road, Liverpool L8 3SJ

<https://benjaminpercival.github.io/>

[cultivatingthegrapevine](https://benjaminpercival.github.io/cultivatingthegrapevine)

# BENJAMIN PERCIVAL

## EDUCATION

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10/2017–  
07/2022 **Doctorate in Philosophy (Theoretical Physics)**  
*University of Liverpool, specialising in String Phenomenology*

10/2012–  
07/2016 **MSc Natural Sciences (Maths and Physics)**  
*Durham University*

## WORK EXPERIENCE

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09/2017– **Postdoctoral, Honorary and PhD Researcher in String theory**  
**Present** *University of Liverpool, Department of Mathematical Sciences*

### Research achievements:

Applications of computational methods to the classification of string theory models

- ★ **Generating and handling large data sets** defining input parameters of string models
- ★ Programming large constraint systems in **Python** and **Mathematica** to find desirable models
- ★ Use of **High Performance Computing** to efficiently enumerate solutions– **parallelisation, cloud computing** (AWS and Google Cloud) and **JIT compilation** with Numba in Python.
- ★ Spearheaded a cross-disciplinary **collaboration with AI researchers** at University of Liverpool.
- ★ Implementation of **Autoencoder Neural Network** to reconstruct input data of string models [1]
- ★ Application of advanced **SAT and SMT algorithms** to solve constraint systems to achieve several order of magnitude speed-ups to solution-finding compared to standard techniques [2]
- ★ Implementing **Quantum Computing** techniques– **quantum annealing** and quantum circuits– to solve constraints systems with several order of magnitude efficiency increase
- ★ **Data analysis** with **Pandas** on large solution space of models
- ★ **Data visualisation** in Python and Mathematica for physical properties of string models
- ★ Interpreted results of analysis and related them to open problems in fundamental physics.
- ★ **Developed open-source Python package** for string theory model building [3].
- ★ Work resulted in **11 publications in top scientific journals** overall [2,4,5,6,7,8,9,10,11,12,13]

Analysis of particle physics constraints on string theory models

- ★ Published multiple papers tackling **mysteries in fundamental physics**, including supersymmetry breaking [11,12], moduli stabilisation [13] and the cosmological constant problem [10,11]
- ★ Developed programs to perform **numerical analysis of complex, modular integrals** in Mathematica and Python [2,3,5,10,11,12]
- ★ Solved systems of **differential constraints using analytic and numerical techniques** for physical properties from string models [3,10,11,12]
- ★ Analysed vast parameter space of string model potential energy and tested for stable points using **numerical analysis and calculus methods from dynamical systems** [11,12]

## Teaching roles:

- ★ **Lecturer for 'Probability and Statistics II'** undergraduate course with over 350 students.
- ★ **Lecturer for 'Mathematical IT Skills'** instructing students on programming in **Matlab and Maple**, running **simulations and mathematical models** of financial markets and physical systems.
- ★ Obtained FLTHE Stage 2 **Teaching Qualification**.
- ★ **Lectured course to PhD students** at University of Liverpool on String Model Building [14].
- ★ **Brilliant Club Scholars Program Tutor** designing and delivering course to KS3 and KS5 secondary school students on particle physics.
- ★ Tutor for BUSSTEP PhD Summer School 2023.

## Wider academic contributions:

- ★ Delivered >10 **presentations** to research groups and at conferences and won speaker prize at Young Theorists Forum 2020.
- ★ **Plenary talk** at international 'String Phenomenology 2022' conference [15].
- ★ Attended research visits and delivered talks to Osaka Met. University and IPMU, Kavli Institute theoretical physics groups.

### 09/2016 - **Science Tutor**

09/2017 *Kaplan International College, London Bridge*

- ★ Lectured and developed course material for foundation courses in maths and science.
- ★ Delivered on academic targets and student satisfaction within Science and Engineering team.
- ★ Recruitment, interviewing, observations and onboarding of new staff.

### 05/2015 - **Summer Student Researcher**

09/2015 *CERN*

- ★ Contributed to CERN's research consortium in accelerator beam dynamics, analysing **mathematical models of proton beam extraction** from the PS ring at CERN.
- ★ Ran **simulations of nonlinear dynamical systems** in Mathematica and worked closely with experimentalists to refine model and tune parameters.

## COMPUTER SKILLS

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- ★ Python, Mathematica, Matlab, Neural Networks, SAT/SMT Solvers, Quantum Computing, High Performance Computing

## PUBLICATIONS

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- [1] A. E. Faraggi, G. Harries, B. Percival and J. Rizos (2020), *Towards machine learning in the classification of  $Z_2 \times Z_2$  orbifold compactifications*, J. Phys. Conf. Series 1586 vol. 1.
- [2] A. E. Faraggi, B. Percival, S. Schewe and D. Wojtczak (2021), Physics Letters B. 816. 136187.
- [3] 'Free Fermioniser' Python package: <https://github.com/BenjaminPercival/FreeFermioniser>
- [4] A. E. Faraggi, G. Harries, B. Percival and J. Rizos (2020), Nucl. Phys. B 953 (2020) 114969.
- [5] A. E. Faraggi, V. G. Matyas and B. Percival (2020), Eur. Phys. Jour. C 80 (2020) 4.
- [6] A. E. Faraggi, V.G. Matyas and B. Percival (2020), Nucl. Phys. B 0550-3213 (2020) 115231.
- [7] A. E. Faraggi, V. G. Matyas and B. Percival (2020), IJMP A Vol. 36, No. 24, 2150174 (2021).
- [8] A. E. Faraggi, V.G. Matyas and B. Percival (2020), Phys. Rev. D 104 046002.
- [9] A. E. Faraggi, V.G. Matyas and B. Percival (2020), Physics Letters B 814:136080,
- [10] A. E. Faraggi, V.G. Matyas and B. Percival (2022), Phys. Rev. D 106, 026011.
- [11] A. R. Diaz Avalos, A. E. Faraggi, V.G. Matyas and B. Percival (2023), Phys. Rev. D 108 086007.
- [12] A. R. Diaz Avalos, A. E. Faraggi, V.G. Matyas and B. Percival (2023), Eur. Phys. J. C **83**, 926.
- [13] A. E. Faraggi, S. Groot Nibbelink and B. Percival (2023), Phys. Rev. D LG19547DR
- [14] Lectures on String Model Building [https://youtu.be/SC7MCjOwPyk?si=qFlo6y28VX\\_8i4fd](https://youtu.be/SC7MCjOwPyk?si=qFlo6y28VX_8i4fd)
- [15] Plenary Talk String Pheno. 2022 <https://youtu.be/EoY2QH3pm8?si=plXEW9r6QnWMNONv>