Philipp Hähnel

email: phahnel@hsph.harvard.edu
homepage: phylyc.github.io

CV PHILIPP HÄHNEL

I have a passion for researching, understanding, and applying machine learning techniques at the cutting edge of technology and for the benefit of humanity.

RESEARCH INTERESTS

Artificial General Intelligence, Reinforcement Learning, Deep Learning, Symmetries and Invariance, Genetic Algorithms, Multi-Agent Systems

Computational Genomics, Positive Selection

EDUCATION

Doctor of Philosophy, Mathematics, Trinity College Dublin, Mar 2014 – Mar 2018
Doctoral thesis: *Higher spin theories in twistor space*
Advisor: Prof. T. McLoughlin Reviewer: Prof. Ruth Britto, Prof. Lionel Mason
Synopsis: Using the twistor formalism, I formulated an action principle for a conformal higher spin theory. The action poses as generating functional to compute scattering amplitudes for this theory, which had been a difficult problem since its conception.

Master of Science in Physics, Humboldt University of Berlin, Apr 2011 – Jun 2014, result A
Master thesis: *The one-loop effective action of N=4 SYM-type theories*
Advisor: Dr. C. Sieg Reviewer: Prof. M. Staudacher, Dr. H. Dorn
Synopsis: I developed a *Mathematica* program to automate the computation of the first-order renormalization constants of many Lagrangian theories. The program computes the divergent part of the first-order quantum corrections to the effective action using the background field method and dimensional regularization.

Bachelor of Science in Physics, Humboldt University of Berlin, Oct 2007 – Mar 2011, result A-
Bachelor thesis: *Minimal surfaces in anti-de Sitter spaces*
Advisor: Dr. H. Dorn Reviewer: Dr. H. Dorn, Prof. J. Plefka
Synopsis: I studied conformal transformations of minimal surfaces in AdS space that correspond to gluon scattering amplitudes via the AdS/CFT correspondence.

WORK EXPERIENCE

Research Fellow at the Dana-Farber Cancer Institute, Harvard T.H. Chan School of Public Health, and **Affiliate** at the Broad Institute: (Jan 2019 – present)
Developing tools for studying differential positive selection in cancer, using Bayesian inference and generative modeling

Fellow at the Institute for Pure and Applied Mathematics, UCLA: (Sep – Dec 2018)
Science at Extreme Scales: Where Big Data Meets Large-Scale Computing
Leading a study group focusing on exploring and exploiting symmetries and invariants in algorithm design and data analysis; participating in study groups on interpretability, scalability, and model development of machine learning algorithms

Research Scientist Intern at I.B.M., Dublin: (May Sep 2018)
Deep learning for pollution modelling and forecasting: using traffic and weather data, to replace an expensive PDE-based model with a scalable ML model by imposing consistency constraints across the boundaries of a mesh that decomposes a large domain

Teaching Assistant at the School of Mathematics, Trinity College Dublin: (Sep 2014 Dec 2017)
Differential Geometry, General Relativity, Quantum Mechanics, Advanced Calculus, Classical Field Theory & Classical Electrodynamics

Teaching Assistant at the Dept. of Physics, Humboldt University of Berlin: (Oct 2011 Sep 13)
Quantum Field Theory I & II, Linear Algebra and Analytical Geometry I & II

Seminar Coordinator at the Dept. of Physics, Technical University of Berlin: (2006 2012)
Seminar series for secondary school students on: Introduction to General Relativity, Physics of the Sun, the EPR-Paradox, Anomalies in the Solar System, Gravitational Lenses, Physics of Stars, Recent Cosmology, Introduction to Quantum Physics, and Black Holes

Student Assistant at the Neurorobotics Research Laboratory, HU Berlin (Oct 2010 Sep 2011)
Software engineering: 2D physics simulator for the exploration of autonomous robot designs

Student Intern at Fraunhofer Institute for Open Communication Systems, Berlin (Aug 2007)
Data analysis: classifying neural signaling data using k-fold cross-validation

Student Intern at the German Aerospace Center (DLR), Berlin (Aug 2005)
Image analysis: calculating atmospheric height of dust clouds on Mars

PROGRAMMING EXPERIENCE (SEE ALSO: github.com/phylyc)

Python [~2 years]	• Scripting, modeling, and prototyping of Bayesian inference models to study mutation signals from genomic data • Data analysis pipelines and ML models for air pollution forecasting • A platform for light-weight multi-player online games, with the purpose of developing machine-learning-based agents to play: arenarium.com
Tensorflow [~1 year]	• Combining multiple, independent deep neural networks by recurrently applying consistency constraints between them
Mathematica [~13 years]	• Master thesis (see below) • Everything that needs mathematical modelling, calculations or visualization (plots and graphs)
Matlab / Scilab [~3 years]	• Data analysis for university courses, and used while working at the NRL and Fraunhofer Institute (see work experience above)
MongoDB [~1 year]	• Managing agent database for the arenarium • Handling storage and access of multiple databases while at I.B.M.
LaTeX [~14 years]	• Publications, hobby projects, almost everything written

COMMUNITY SERVICES

- Reviewer for Journal of Physics A

Honors and Awards

- 2007 2010 Scholarship of the German National Academic Foundation, awarded to top 10% of all students, awards: 960 €/year, mentoring, and access to courses
- 2007 3rd place at national round, Jugend Forscht; awards: 750 €, an internship at the Fraunhofer Institute for Open Communication Systems in Berlin, and membership in the German Physical Society
- 2007 2nd place at the state round, Jugend Forscht, award: 500 €
- 2007 School's best graduation in physics, Heinrich-Hertz Oberschule, Berlin

Funded Grants

- Sep 2015 COST Action MP1210 'The String Theory Universe'
  Travel grant ECOST-STSM-MP1210-010915-063415
  1,000; host: Prof. L. Mason, Mathematical Institute, University of Oxford

Early Scientific Activities

- 2006 2012 Member of work group *Astrometrie* at Wilhelm Foerster Observatory, Berlin
- 2003 2005 Member of the mathematical pupil association *Leonard Euler* at HU Berlin

Invited Talks and Posters

- Lecture series for PhD students on *Gauge field theory* at TCD, Jan Feb 2018
- Over 10 invited talks and posters on my publications since 2014
  - *Scaling up Deep Learning for PDE-based Models*
    seminars: UCLA, Oct 2018
  - *Conformal Higher Spin Theory and Twistor Space Actions*
    seminars: ULB, Brussels, Sep 2017; University of Mons, Sep 2017; Mathematical Society colloquium, Trinity College Dublin, Feb 2017; HU Berlin, Nov 2016; Imperial College London, Oct 2016; HU Berlin, Oct 2016; Albert Einstein Institute, Potsdam-Golm, Jan 2016;
    conferences: Irish Quantum Foundations, Maynooth, May 2016; SCGSC, Imperial College London, Jan 2016;
  - *The one-loop effective action of N=4 SYM-type theories*
    conferences: Quantum groups workshop, DESY Hamburg, Jul 2014 (poster); IGST Hamburg, Jul 2014 (poster); Irish Quantum Foundations, Trinity College Dublin, May 2014
- Participation in over 30 conferences, workshops and summer schools related to my research interests in theoretical physics since 2011

Languages

German: native
English: fluent

Other Interests

Swing & Blues dancing (performances & teaching)
Story writing, world building, role playing

Patent Applications

P. Haehnel, J. Mareček, J. Monteil and F. O'Donncha, patent application on *Deep Learning for PDE-based Models*, serial no. 16/121,315, filed through I.B.M. at the USPTO on Sep 4th, 2018

Bibliography

Peer-reviewed publications:

[1] T. Adamo, **P. Haehnel** and T. McLoughlin, *Conformal higher spin scattering amplitudes from twistor space*, arXiv:1611.06200 [hep-th], JHEP 1704: 021, 2017

[2] **P. Haehnel** and T. McLoughlin, *Conformal higher spin theory and twistor space actions*, arXiv:1604.08209 [hep-th], *J. Phys. A: Math. Theor.* **50** 485401. Selected for Journal of Physics A Highlights of 2017

Non-peer reviewed publications:

[3] **P. Haehnel**, J. Mareček, J. Monteil and F. O'Donncha, *Scaling up Deep Learning for PDE-based Models*, arXiv:1810.09425 [cs.LG], (submitted for publication)

[4] **P. Haehnel**, *Higher spin theories in twistor space*, Trinity College Dublin, School of Mathematics, 2018, http://hdl.handle.net/2262/83839

[5] W. Hasse, E. Birsin and **P. Haehnel**, *On force-field models of the spacecraft flyby anomaly*, arXiv:0903.0109 [gr-qc].