Philipp Hähnel

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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

[**AI**]: artificial general intelligence, reinforcement learning, deep learning, symmetry and invariance, multi-agent systems, adversarial learning, mathematical foundations

[**Physics**]: higher spin theories, gauge/gravity duality and holography, AdS/CFT correspondence, quantum gravity, scattering amplitudes, twistor theory, gauge field theory

WORK EXPERIENCE

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; partaking in study groups on scalability, model development, and reinforcement learning

Research Scientist Intern at I.B.M., Dublin: (May Sep 2018)
Deep learning for pollution modelling and forecasting, using traffic and weather data, replacing an expensive PDE-based model with a scalable ML model by imposing consistency constraints across the boundaries of the small domains of a mesh that decomposes a larger 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 Department of Physics, HU Berlin: (Oct 2011 Sep 2013)
Quantum Field Theory I & II, Linear Algebra and Analytical Geometry I & II

Organization of seminars for secondary school students at the TU Berlin: (2006 2012)
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*, *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 Internship at the Fraunhofer Inst. for Open Comm. Systems, Berlin (Aug 2007)
Data analysis: classifying neural signal data using k-fold cross-validation

Student Internship 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 [~1.5 years]	• A platform for light-weight multi-player online games, with the purpose of *developing machine learning-based agents to play*: www.arenarium.com • Data analysis pipelines and ML models while at IBM (see above)
Tensorflow [~5 months]	• Agent development for the Arenarium • Deep learning applications while at IBM (see work experience above)
Mathematica [~13 years]	• Master thesis (see below) • Everything that needs mathematical modelling, calculations or visualisation (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)
C [1 month]	• Scripted bot for rogue-like game Sil
MongoDB [~1 year]	• Managing agent database for the Arenarium • Handling multiple databases while at IBM (see above)
Latex [~14 years]	• Publications, hobby projects, almost everything written

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 was able to formulate an action principle for 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 1.6
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: In this thesis 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 2.3
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.

Patent Applications

[A] **P. Haehnel**, J. Mareček, J. Monteil and F. O'Donncha, patent application in *deep learning for PDE-based models*, filed through IBM with USPTO on September 4th, 2018

Publications

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

[2] T. Adamo, **P. Haehnel** and T. McLoughlin, *Local twistor connection of conformal higher spin curvature tensors*, (in preparation)

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

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

[5] **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

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

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, Brussles, 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

Honors

- Sep 2015 'String Theory Universe' travel grant for a short-term scientific mission, visiting Prof. L. Mason at the Mathematical Institute, University of Oxford
- 2007 – 2010 Scholarship of the German National Academic Foundation
- 2007 School's best graduation in physics
- 2007 3rd place at the Germany-wide, and additional 2nd place at the Berlin-wide competition of the 42th competition 'Jugend forscht' ('youth researches')

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

Languages

German:	native
English:	fluent
French:	basic

Other Interests

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