

Tomasz Kacprzak

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Employment

- 2021 - present **Senior Data Scientist**, Swiss Data Science Center
Collaborations for adaptation of data science in physics, ML for climate science
- 2017 - present **Senior Scientist**, Institute of Particle Physics and Astrophysics, ETH Zurich
Idea originator and lead advisor for 6 PhD student papers and 8 MSc student papers
- 2014 - 2017 Post-doctoral research associate, Institute for Astronomy, ETH Zurich
First author of 3 papers, advisor: Prof Alexandre Refregier

Education

- 2010 - 2014 **PhD in Physics and Astronomy**, University College London, UK
Advisors: Prof Sarah Bridle, Prof John Shawe - Taylor
Thesis topic: *Statistical problems in Weak Gravitational Lensing*
- 2009 - 2010 **MSc Machine Learning**, First Class, University College London, UK
Advisors: Prof John Shawe-Taylor, Prof Ofer Lahav
Thesis topic: *Kernel methods for galaxy morphological classification*

Awards

- 2023 - 2025 NERSC Exascale Science Applications Program, NESAP for Learning
Principal Investigator, algorithmic and technical support (0.5 FTE NERSC post-doc)
Awarded by the National Energy Research Scientific Computing Center, USA
- 2020 - 2021 Computational production project: *Measuring Dark Energy with Deep Learning*
Principal Investigator, value 750'000 GPU-node hours, data at www.cosmogrid.ai
Awarded by the Swiss National Supercomputing Center (CSCS)
- 2017 - 2019 Grant: *Deep Learning for Observational Cosmology*
Principal Investigator, hired staff: Nathanael Perraudin (post-doc), Janis Fluri (PhD)
Awarded by Swiss Data Science Center, 600k CHF (500k GBP)
- 2019 Workshop: *Artificial Intelligence Methods in Cosmology*, June 9-12
Main applicant and lead organizer, grant value 4.8k CHF (4k GBP)
Awarded by Congressi Stefano Francini
- 2018 Preparatory project: *Parallel Deep Learning for Point Spread Function estimation*
Principal Investigator, grant value 1000 GPU node hours
Awarded by Swiss National Supercomputing Centre (CSCS)

Major scientific achievements

- 2018 - present Introduction of deep learning to cosmology, from prototypes [1807.08732], first practical measurements [1906.03156], and mature measurements on par with main analysis [2201.07771].
- 2015 - present Leadership of the simulation-based inference in Dark Energy Survey, using shear peak statistics for the Science Verification [1603.05040] and Year 3 [2110.10135] cosmology constraints.
- 2016 - present Lead of an independent, full image-level reanalysis of the Dark Energy Survey Year 1 data using simulation-based forward modelling framework Monte Carlo Control Loops [1906.01018].

Leadership and service

- 2022 - present **Simulations Working Group coordinator in the Dark Energy Survey**
Coordinating 6 projects led by junior researchers, membership of the Science Committee
- 2018 - 2019 **Lead organizer of workshop *Artificial Intelligence Methods in Cosmology***
Monte Verita, Ascona, June 2019, 46 participants, 6 invited speakers
- 2018 - 2020 Member of the IPA Institute Council, representative of non-permanent research staff
- 2017 - 2020 Coordinator of the Cosmology Seminar at ETH Zurich
- 2015 - present Referee for: Nature Astronomy, Physical Review, JCAP, MNRAS, CompAst, and others
- 2012 Observing for the Dark Energy Survey at the Blanco Telescope, CTIO, Chile

Supervision

Idea originator and lead advisor for 3 post-doc projects, 7 PhD projects, 13 MSc projects.
8/13 MSc projects resulted in articles published or accepted to peer-reviewed journals, marked with [↗](#).

- 2022 - present Arne Thomsen, PhD, *Cosmology with deep learning of combined probes in DES*
- 2022 - present Virginia Ajani, post-doc, *Peak statistics of combined probes in DES*
- 2021 - present Beatrice Moser, PhD, *Evolution of galaxy samples with ABC forward modelling in DES*
- 2022 - present Silvan Fischbacher, MSc, PhD, *Redshift requirements for cosmic shear with intrinsic alignment* [↗](#)
- 2022 Gaspard Aymerich, MSc, *Interpretability of deep-learning methods applied to LSS surveys*
- 2022 Ting Tan, MSc, *Assessing theoretical uncertainties for cosmological constraints from weak lensing* [↗](#)
- 2022 Dominik Zürcher, PhD, *Dark energy survey year 3 results: Cosmology with peaks* [↗](#)
- 2022 Janis Fluri, PhD, *Full Λ CDM Analysis of KiDS-1000 Weak Lensing Maps using Deep Learning* [↗](#)
- 2018 Nathanael Perraudin, post-doc data scientist, *Deep learning on the sphere* [↗](#)
- 2020 Timothy Wing Hei Yiu, MSc, *A tomographic spherical mass map emulator of KiDS-1000* [↗](#)
- 2020 Benjamin Suter, MSc, *Cosmology with machine learning and human-designed statistics*
- 2019 Dominik Zürcher, PhD, *Cosmological forecast for non-Gaussian statistics in large-scale surveys* [↗](#)
- 2019 Janis Fluri, PhD, *Cosmological constraints with deep learning from KiDS-450 weak lensing maps* [↗](#)
- 2019 Conrad Schwanitz, MSc, *Interpretability measures for deep learning based on weak lensing maps*
- 2019 Sajanth Subramaniam, MSc, *Systematics-invariant cosmological constraints with deep learning* [↗](#)
- 2018 Jörg Herbel, PhD, *Fast Point Spread Function Modeling with Deep Learning* [↗](#)
- 2018 Sandro Marcon, MSc, *Emulation of cosmological mass maps with conditional GANs* [↗](#)
- 2018 Ankit Srivastava, MSc, *Cosmological N-body simulations: a challenge for scalable GANs* [↗](#)
- 2018 Janis Fluri, PhD, *Cosmological constraints from noisy convergence maps through deep learning* [↗](#)
- 2018 Alex Stauffer, MSc, *Approximate Bayesian Computation in cosmology with the ABCpy package*
- 2018 Jonathan Rosenthal, MSc, *Generative Temporal Models for Cosmology*
- 2017 Janis Fluri, MSc, *Weak lensing peak statistics in the era of large scale cosmological surveys* [↗](#)
- 2017 Andres Rodrigues, MSc, *Fast cosmic web simulations with generative adversarial networks* [↗](#)
- 2017 Jorit Schmelzle, MSc, *Cosmological model discrimination with deep learning*

Teaching

- 2019 - 2020 Lecturer for UG course *Statistical Methods and Analysis in Experimental Physics*
 Topical block: Bayesian methods, machine learning, simulations-based inference
 Tasks: lectures, preparing assignments, leading the tutorials for approx. 50 students
- 2019 Lecturer for the UG course *Astrophysics 1*, topical block: *Introduction to Cosmology*
- 2019 - 2020 Guest lecturer for UG course *Introduction to Data Science* at University of Zurich
 Topics: deep learning, convolutional neural networks, generative models
- 2017 - 2018 Course coordinator for undergraduate module *Physics 1 and 2*, approx. 300 students
 Tasks: creation of exercises, preparation of exams and coordination of marking
- 2016 - 2017 Teaching assistant for MSc course *Advanced Statistical Methods in Cosmology*
 Tasks: curriculum development, creating assignments, leading tutorials
- 2017 Leader of the tutorial sessions, masters-level module *Cosmological Probes*

Selected presentations

- 2023/06 *Emerging topics in applications of Optimal Transport*, ITS, ETH Zurich, CH
- 2023/05 *ML X Astrophysics Symposium*, Flatiron Institute, New York, USA, [invited talk](#)
- 2023/03 *University Observatory Munich Colloquium*, Munich, DE, [invited talk + 2-day tutorials](#)
- 2022/09 *SDSC internal seminar*, topic: “Accelerated Machine Learning on New HPC Clusters”
- 2022/07 *Key Challenges in Galaxy and CMB lensing*, Cambridge, UK, [invited guest talk](#)
- 2022/06 *Bayesian Deep Learning in Cosmology*, Paris, FR, [invited keynote talk](#) [↗](#)
- 2022/06 *Space Science Data Center Seminar*, Rome, IT, [invited seminar talk](#)
- 2022/04 *Berkeley ML and Science Forum*, Berkeley, USA, [invited seminar talk](#)
- 2021/10 *Cosmology seminar*, University of Geneva, CH, [invited seminar talk](#)
- 2021/07 *Cosmology from Home 2021*, online
- 2021/05 *Dark Energy Spectroscopic Instrument: Artificial Intelligence Seminar*, [invited talk](#)
- 2020/10 *German Center For Cosmological Lensing Seminar*, Bohum, DE
- 2020/10 *Institute of Cosmology and Gravitation Colloquium*, Portsmouth, UK, [invited talk](#)
- 2020/01 *Applied Machine Learning Days: Machine Learning and Space*, Lausanne, CH
- 2019/12 *Machine Learning Tools for Research in Astronomy Workshop*, Ringberg, DE
- 2019/10 *LSST Dark Energy Science Collaboration*, online
- 2019/09 *Cosmology seminar*, SLAC, Stanford, USA, [invited talk](#)
- 2019/08 *Understanding Cosmological Observations Workshop*, Benasque, ES
- 2019/07 *Applied Inverse Problems*, Grenoble, FR, [invited panel talk](#)
- 2019/11 *8th KIAS workshop on cosmology and structure formation*, Seoul, KR
- 2019/04 *IDIAP Research Institute Seminar*, Moriond, CH, [invited talk](#)
- 2018/10 *Computational Science Seminar*, University of Zurich, CH, [invited seminar talk](#)
- 2018/06 *Cosmology Seminar*, University College London, UK
- 2018/04 *Swiss Data Science Center Project Day*, Bern, CH, [invited talk](#)
- 2017/10 *Dark Universe*, Munich, Germany
- 2016/07 *Celebrating the Century of Gravitational Lensing*, Leiden, NL
- 2013/06 *Weak Lensing Beyond The Ordinary*, Nice, FR
- 2013/08 *GREAT3 Kickoff meeting*, JPL, Pasadena, USA

Publications

Authored 21 papers on own original ideas, including 7 as the lead author. Significantly contributed to 12 papers by students at the ETH Zurich Cosmology Group in a support role, and 33 international collaboration papers. Most important publications are listed first. Citation count as of 11 Nov 2022 provided by NASA ADS.

Selected papers on own original ideas, lead author or lead advisor:

CosmoGridV1: a simulated w CDM theory prediction for map-level cosmological inference

T. Kacprzak, J. Fluri, A. Schneider, A. Refregier, J. Stadel
 JCAP 2023, 02, 050, 29, 2209.04662, citations: 7

DeepLSS: breaking parameter degeneracies in large scale structure with deep learning of combined probes

T. Kacprzak, J. Fluri
 PhysRevX (impact factor 14.5), 2022, 2, 031029, 2203.09616, citations: 6

A Full w CDM Analysis of KiDS-1000 Weak Lensing Maps using Deep Learning

J. Fluri, T. Kacprzak, A. Lucchi, A. Schneider, A. Refregier, T. Hofmann
 PhysRevD, 2022, 105, 8, 083518, 2201.07771, citations: 14

Cosmological constraints with deep learning from KiDS-450 weak lensing maps

J. Fluri, T. Kacprzak, A. Lucchi, A. Refregier, A. Amara, T. Hofmann, A. Schneider
 PhysRevD, 2019, 100, 6, 1906.03156, citations: 87

DeepSphere: Efficient spherical convolutional neural network with HEALPix sampling for cosmology

N. Perraudin, M. Defferrard, T. Kacprzak, R. Sgier
 Astronomy and Computing, 2019, 27, 130, 1810.12186, citations: 68, including in computer science: 161

Cosmological constraints from noisy convergence maps through deep learning

J. Fluri, T. Kacprzak, A. Lucchi, A. Refregier, A. Amara, T. Hofmann
 PhysRevD, 2018, Vol. 98, 12, 1807.08732, citations: 51

Cosmological model discrimination with deep learning

J. Schmelzle, A. Lucchi, T. Kacprzak, A. Amara, R. Sgier, A. Réfrégier, T. Hofmann
 unpublished, 1707.05167, citations: 55

Fast Cosmic Web Simulations with Generative Adversarial Networks

A. C. Rodriguez, T. Kacprzak, A. Lucchi, A. Amara, R. Sgier, +3 authors
 CompAst, 2018, 5, 1, 4, 11, 1801.09070, citations: 71

Cosmology constraints from shear peak statistics in Dark Energy Survey Science Verification data

T. Kacprzak, D. Kirk, O. Friedrich, + 84 authors (DES collaboration)
 MNRAS, 2016, 463, 4, 1603.05040, citations: 119

Dark Energy Survey Year 3 results: Cosmology with peaks using an emulator approach

D. Zürcher, ... T. Kacprzak, + DES Collaboration (102 authors)
 MNRAS, 2022, 511, 2, 2075-2104, 2110.10135, citations: 37

A tomographic spherical mass map emulator of the KiDS-1000 survey using conditional GANs

T. W. H. Yiu, J. Fluri, T. Kacprzak
 JCAP 2022, 12, 013, 40, 2112.12741, citations: 3

Measurement and calibration of noise bias in weak lensing galaxy shape estimation

T. Kacprzak, J. Zuntz, B. Rowe, S. Bridle, A. Refregier, A. Amara, L. Voigt, M. Hirsch
 MNRAS, 2012, 427, 1203.5049, citations: 82

Monte Carlo Control Loops for cosmic shear cosmology with DES Year 1

T. Kacprzak, J. Herbel, A. Nicola, + 53 authors (DES collaboration)
 PhysRevD, 2020, 101, 8, 082003, 1906.01018, citations: 16

Fast Point Spread Function Modeling with Deep Learning

J. Herbel, T. Kacprzak, A. Amara, A. Refregier, A. Lucchi
 JCAP, 2018, 07, 54, 1801.07615, citations: 49

Redshift requirements for cosmic shear with intrinsic alignment

S. Fischbacher, T. Kacprzak, J. Blazek, A. Refregier
 JCAP 2023, 01, 033, 37, 2207.01627, citations: 1

Selected papers with substantial contribution:

Dark Energy Survey Year 3 Results: Cosmology from Cosmic Shear and Robustness to Modeling Uncertainty

L. Secco, ..., T. Kacprzak, + The DES Collaboration (153 authors)
 PhysRevD, 2022, 105, 2, 023515, 2105.13544, citations: 164
 Role: DES internal reviewer for this paper

Dark Energy Survey Year 1 results: Cosmological constraints from cosmic shear

M.A. Troxel, ..., T. Kacprzak, + 134 authors (DES collaboration)
 PhysRevD, 2018, 98, 4, 043528, 1708.01538, citations: 505
 Role: wrote IM3SHAPE, calibration and testing of shear catalog

Dark Energy Survey year 1 results: Cosmological constraints from galaxy clustering and weak lensing

T.M.C. Abbott, ..., T. Kacprzak, + 199 authors (DES collaboration)
 PhysRevD, 2018, 98, 4, 043526, 1708.01530, citations: 956
 Role: wrote IM3SHAPE, calibration and testing of shear catalog

Cosmology from cosmic shear with Dark Energy Survey Science Verification data

The Dark Energy Survey Collaboration (128 authors, alphabetical) + T. Kacprzak
 PhysRevD, 2016, 94, 2, 1507.05552, citations: 177
 Role: measurement and calibration of the cosmic shear signal, creation of simulations for testing and calibration

The DES Science Verification weak lensing shear catalogues

M. Jarvis, E. Sheldon, J. Zuntz, T. Kacprzak, S. L. Bridle + 90 authors (DES collaboration)
 MNRAS, 2016, 460, 2, 1507.05603, citations: 184
 Role: creation of simulations to test the methods, calibrations for the Im3shape measurement, paper writing

Cosmic shear measurements with Dark Energy Survey Science Verification data

M.R. Becker, ..., T. Kacprzak, + 104 authors (DES collaboration)
 PhysRevD, 2016, 94, 2, 022002, 1507.05598, citations: 95
 Role: wrote IM3SHAPE, calibration and testing of shear catalog

GREAT3 results - I. Systematic errors in shear estimation and the impact of real galaxy morphology

R. Mandelbaum, ..., T. Kacprzak, ... (43 authors)
 MNRAS, 2015, 450, 3, 2963-3007, 1412.1825, citations: 127
 Role: submission to the GREAT3 competition with the IM3SHAPE results

GALSIM: The modular galaxy image simulation toolkit

B.T.P. Rowe, ..., T. Kacprzak, ... (15 authors)
 Astronomy and Computing, 2015, 10, 121-150, 1407.7676, citations: 276
 Role: development of GALSIM, extended testing of the convolution module

Noise bias in weak lensing shape measurements

A. Refregier, T. Kacprzak, A. Amara, S. Bridle, B. Rowe
 MNRAS, 2012, 425, 1951, 1203.5050, citations: 134
 Role: idea development, paper writing

Cosmological Parameter Estimation and Inference using Deep Summaries

J. Fluri, A. Lucchi, T. Kacprzak, A. Refregier, T. Hofmann
 PhysRevD, 2021, 104, 12, 123526, 2107.09002, citations: 7
 Role: coordinating the collaboration with computer scientists Aurelien Lucchi and Thomas Hofmann, comments

Rapid Simulations of Halo and Subhalo Clustering

Authors: P. Berner, A. Refregier, R. Sgier, T. Kacprzak, L. Tortorelli, P. Monaco
 JCAP 2022, 11, 002, 29, 2112.08389
 Role: consulting, comments

The PAU Survey: Measurement of Narrow-band galaxy properties with Approximate Bayesian Computation

Authors: L. Tortorelli, M. Siudek, B. Moser, T. Kacprzak, ... + 21 authors (The PAUS Collaboration)
 JCAP, 2021, 12, 013, 45, 2106.02651, citations: 10
 Role: developing the galaxy population model and the Approximate Bayesian Computation engine

The redshift distribution of cosmological samples: a forward modeling approach

J. Herbel, T. Kacprzak, A. Amara, A. Refregier, C. Bruderer, A. Nicola
 JCAP, 2017, 08, 035, 1603.05040, citations: 19
 Role: contribution to model building and algorithms, co-advisor of J. Herbel (PhD student)