Marek Kaluba

Curriculum vitae

Karlsruher Institut für Technologie
Fakultät für Mathematik
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Past and Current Positions

04-09.2022 **Replacement Professor**, *Heidelberg Universität*, Heidelberg, Germany

since 2021 **PostDoc**, *Karlsruher Institut für Technologie*, Karlsruhe, Germany
Priority Programme 2026 GEOMETRY AT INFINITY, project: *Property (T)*

2019–2021 **PostDoc**, *Technische Universität*, Berlin, Germany
MATH+ program *Approximate Convex Hulls With Bounded Complexity*

2015–2017 **Assistant Professor**, *Mathematical Institute of Polish Academy of Sciences*, Warsaw, Poland

2014–2021 **Assistant Professor**, *Adam Mickiewicz University in Poznań*, Poznań, Poland

Research Visits

2021 *University of Oxford*, Oxford, UK

2020 *University of Virginia*, Charlotesville, USA

2018 *Tokyo University of Science*, Tokyo, Japan
Technische Universität, Berlin, Germany

2016 *CCM-UNAM*, Morelia, Mexico
CINVESTAV, Mexico City, Mexico

2015 *Max Planck Institute for Intelligent Systems*, Tübingen, Germany

2014 *Department of Environmental and Mathematical Sciences* in Okayama, Japan

2011 *Hausdorff Research Institute for Mathematics*, Bonn, Germany

Education

2010–2014 **Graduate Studies**, *Adam Mickiewicz University*
PhD thesis title: *Constructions of Smooth Exotic Actions on Homotopy Complex Projective Spaces and Products of Manifolds*,
prepared under the supervision of prof. Krzysztof Pawałowski

2005–2010 **Undergraduate Studies in Mathematics**, *Adam Mickiewicz University*
M.Sc. thesis title: *Group Actions on Highly Symmetric Manifolds*,
prepared under the supervision of prof. Krzysztof Pawałowski

Publications

2022 (with Z. Błaszczyk) Constructions of exotic actions on product manifolds with an asymmetric factor, *Kyoto Journal of Mathematics*, 2022, vol. **62**, no. 3, 1-10, arXiv:1603.04888

2021 (with P-E. Caprace, M. Conder and S. Witzel) Hyperbolic generalized triangle groups, property (T) and finite simple quotients, accepted to *Journal of London Mathematical Society* arXiv:2011.09276

2021 (with D. Kielak and P.W. Nowak) On Kazhdan's property (T) for $\mathrm{Aut}(F_n)$ and $\mathrm{SL}_n(\mathbb{Z})$ *Annals of Mathematics*, **193** No. 2 (2021), 539-562, arXiv:1812.03456

2020 (with B. Lorenz and S. Timme) Polymake.jl: A New Interface to **polymake** *Mathematical Software – ICMS 2020*, **12097** (2020), 377 - 385, arXiv:2003.11381

2019 (with P.W. Nowak and N.Ozawa) $\mathrm{Aut}(\mathbb{F}_5)$ has Kazhdan's property (T) *Mathematische Annalen*, **375** (2019), 1169-1191, arXiv:1712.07167

2018 (with P.W. Nowak) Certifying numerical estimates of spectral gaps *Groups Complexity Cryptology*, **10** No. 1 (2018), 33-41, arXiv:1703.09680

2018 (with Z. Błaszczyk) Effective topological complexity of spaces with symmetries *Publicacions Matemàtiques*, **62** No. 1 (2018), 55-74, arXiv:1510.08724

2017 (with Z. Błaszczyk) On equivariant and invariant topological complexity of smooth $\mathbb{Z}/_p$-spheres *Proceedings of American Mathematical Society*, **145** No. 9 (2017), 4075-4086, arXiv:1501.07724

2015 (with W. Marzantowicz and N. Silva) On Representation of the Reeb Graph as a Sub-Complex of Manifold *Topological Methods in Non-linear Analysis*, **45** No 1 (2015) 287-307, arXiv:1405.4579

2014 (with K. Pawałowski) Group actions on complex projective spaces via group actions on disks and spheres *The Topology and the Algebraic Structures of Transformation Groups*, Proceedings of RIMS – Kokyuroku No. 1922 (2014), 147-153

2012 (with W. Politarczyk) Non-symplectic actions on complex projective spaces *Journal of Symplectic Geometry*, **10** No. 1 (2012), 17-26, arXiv:1004.2737

In preparation

2022 (with P.W. Nowak and P. Mizerka) Spectral gap for the cohomological Laplacian of $\mathrm{SL}_3(\mathbb{Z})$ *submitted* arXiv:2207.02783

2022 (with D. Kielak) Kazhdan constants for Chevalley groups over the integers *in preparation*

Datasets

2021 Pierre-Emmanuel Caprace, Marston Conder, Marek Kaluba and Stefan Witzel, *kalmarek/SmallHyperbolic: v2.0.* Zenodo doi:10.5281/zenodo.5517417

2020 Marek Kaluba, Dawid Kielak, and Piotr W. Nowak, *Approximate sum of squares decompositions for* $\mathrm{Adj}_5 + k \cdot \mathrm{Op}_5 - \lambda\Delta_5 \in \mathrm{ISAut}(F_5)$ (Version 2.0). Zenodo. doi:10.5281/zenodo.1958995

2018 Kaluba, Marek, Nowak, Piotr W., and Ozawa, Narutaka, *An approximation of the spectral gap for the Laplace operator on* $\mathrm{SAut}(\mathbb{F}_5)$ (Version 1.3). Zenodo. doi:10.5281/zenodo.1133440

Research software

- *SymbolicWedderburn.jl* (Amazing package to compute Wedderburn decomposition for endomorphisms of finite groups modules)
- *RamanujanGraphs.jl* (rigourous computations of spectral gaps for Ramanujan graphs for $\mathrm{PSL}(2, \mathbb{F}_q)$)
- *Arblib.jl* (thin, efficient julia wrapper around F.Johannsons `Arb` library)
- *Polymake.jl* (a julia interface to `polymake` software for computational convex geometry)
- *StarAlgebras.jl* (A package for computation in *-algebras with basis)
- *GroupsCore.jl* (An interface definition for abstract groups)
- *Groups.jl* (Computations in finitely presented groups, especially the automorphism groups of free groups)
- *KnuthBendix.jl* (Pure julia implementation of the Knuth-Bendix completion)
- *PropertyT.jl* (Sum of squares formulation of positivity problems in group rings)

Conference Talks (since 2018)

2022 Symmetry Reduction in Semidefinite Optimization,
Introduction to computational mathematics, Będlewo, Poland

2021 Symmetry Reduction in Semidefinite Optimization,
INFORMS Annual Meeting, Anaheim CA, USA

2021 Symmetry reduction for Sum-of-Squares programming
JuliaCon, *JuMP-dev track*, online conference, organized by Julia Computing,

2021 Groups graded by root systems and property (T)
kpa70+, online conference, organized at Tokyo University of Science, Tokyo, Japan

2021 Small hyperbolic groups with property (T)
kpa70, online conference, organized at AMU, Poznań, Poland

2020 Polymake.jl: a new interface to **polymake**
International Congress on Mathematical Softtware 2020, online conference

2020 *Small Hyperbolic groups with property (T)*
Groups and Geometry, MFO Oberwolfach, Germany

2020 *Lectures on property (T) for* $\mathrm{Aut}(F_n)$
Zariski-dense subgroups and number-theoretic techniques in Lie groups and geometry, ICTS Bangalore, India (invited plenary lectures, cancelled due to COVID-19)

2019 *Non-commutative optimisation and Kazhdan's property (T)*
at **Buildings, Varieties and Applications**, MPI Leipzig, Germany

2019 $\mathrm{Aut}(F_n)$ *has property (T)*
at **Outer Space in Bielefeld**, Bielefeld, Germany (plenary talk)

2019 $\mathrm{Aut}(F_n)$ *has property (T)*
at **Rigidity conference**, Warsaw, Poland (plenary talk)

2018 $\mathrm{Aut}(F_5)$ *has property (T)*
at **The 45th Symposium on Transformation Groups**, Kumamoto, Japan

2018 *Computational aspects of property (T)*,
at **Joint meeting of the Italian Mathematical Union and the Polish Mathematical Society**, Wrocław, Poland

2018 *Computational aspect of property (T)*,
at **International Conference on Manifolds, Groups and Homotopy**, Isle of Skye, Scotland

Conferences Organized

2021 kpa70, *online conference organized at AMU, Poznań*, the main organizer

2018 Glances@Manifolds 2018, *Kraków*, member of the Organizational committee

2016 Glances@Manifolds, *Kraków*, member of the Organizational committee

Seminars Organized

2012-2015 Main organizer of the seminar of the Topology and Geometry group at AMU, Poznań

2015-2017 Main organizer of the Youg Reserchers Colloquium at IMPAN, Warsaw

Supervision of Students

2019-2022 Łukasz P. Michalak, co-advising doctoral thesis *On Reeb graphs and related objects*

2018-2021 Piotr Mizerka, co-advising doctoral thesis *Excluding and constructing of exotic group actions on spheres*

2018 Tomasz Sternal, bachelor thesis *Persistence Weighted Gaussian Kernels in Topological Data Analysis*

Teaching experience

- Computational Group Theory, novel lecture
  University of Heidelberg 2022,
  Karlsruhe Institute for Technology 2022

Courses taught at the Department of Mathematics and Computer Science of AMU:

- Elementary Differential Geometry, 2010, 2011, 2012, 2013, 2014
- Introduction to Logic and Set Theory, 2010, 2011, 2012, 2013, 2014, 2017
- Abstract Algebra for Computer Sciences, 2015, 2018
- Calculus 1 for Computer Sciences, 2018, 2019, 2020
- Calculus 2 for Computer Sciences, 2017

Courses taught at other departments of AMU:

- Introduction to Mathematics for Geo-Sciences, 2012
- Introduction to Mathematics for Biological Sciences, 2012, 2013, 2014
- Introduction to Statistics for Biological Sciences, 2014, 2017, 2018
- Essential Mathematics for Cognitive Sciences, 2015

Language skills (CEFR)

English	C2 (proficiency)
German	B2 (intermediate)
Polish	C2 (proficiency, first language)