

Marek Kaluba

Curriculum vitae

Technische Universität Berlin
Institut für Mathematik
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Past and Current Positions

- 2021 **PostDoc**, *Karlsruher Institut für Technologie*, Karlsruhe, Germany.
- 2019–2021 **PosDoc**, *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.
visiting position
- 2014–2021 **Assistant Professor**, *Adam Mickiewicz University in Poznań*, Poznań, Poland.
Non-linear analysis and applied topology group

Research Visits

- 2020 *University of Virginia*, Charlottesville, 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

- 2020 (with D. Kielak and P.W. Nowak) On Kazhdan's property (T) for $\text{Aut}(F_n)$ and $\text{SL}_n(\mathbb{Z})$ *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

- 2020 (with Z. Błaszczuk) Constructions of exotic actions on product manifolds with an asymmetric factor, accepted in *Kyoto Journal of Mathematics*, arXiv:1603.04888
- 2019 (with P.W. Nowak and N.Ozawa) $\text{Aut}(\mathbb{F}_5)$ 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. Błaszczuk) Effective topological complexity of spaces with symmetries *Publicacions Matemàtiques*, **62** No. 1 (2018), 55-74, arXiv:1510.08724
- 2017 (with Z. Błaszczuk) 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. Pawłowski) 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

Submitted Publications

- 2021 (with P-E. Caprace, M. Conder and S. Witzel) Hyperbolic generalized triangle groups, property (T) and finite simple quotients, arXiv:2011.09276

Datasets

- 2020 Marek Kaluba, Dawid Kielak, and Piotr W. Nowak.
Approximate sum of squares decompositions for $\text{Adj}_5 + k \cdot \text{Op}_5 - \lambda \Delta_5 \in \text{ISAut}(\mathbb{F}_5)$ (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 $\text{SAut}(\mathbb{F}_5)$ (Version 1.3). Zenodo. doi:10.5281/zenodo.1133440

Research software

- *PropertyT.jl* (sum of squares formulation of positivity problems in group rings)
- *GroupRings.jl* (computations in group rings of infinite discrete groups)
- *Groups.jl* (computations in finitely presented groups, especially the automorphism groups of free groups)
- *Polymake.jl* (a julia interface to polymake software for computational convex geometry)
- *RamanujanGraphs.jl* (rigorous computations of spectral gaps for Ramanujan graphs for $\text{PSL}(2, \mathbb{F}_q)$)
- *SymbolicWedderburn.jl* (effective generic block diagonalization for semidefinite problems enjoying group symmetry)

- *ArbLib.jl* (thin, efficient julia wrapper around F.Johannsons Arb library)

Conference Talks (since 2016)

- 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 Software 2020, online conference
- 2020 *Small Hyperbolic groups with property (T)*
Groups and Geometry, MFO Oberwolfach, Germany
- 2020 *Lectures on property (T) for $\text{Aut}(F_n)$*
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 *$\text{Aut}(F_n)$ has property (T)*
at **Outer Space in Bielefeld**, Bielefeld, Germany (plenary talk)
- 2019 *$\text{Aut}(F_n)$ has property (T)*
at **Rigidity conference**, Warsaw, Poland (plenary talk)
- 2018 *$\text{Aut}(F_5)$ 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
- 2017 *Certifying numerical estimates of spectral gaps*,
at **Applied Topology**, Będlewo, Poland

Conferences Organized

- 2021 kpa70, *online*, the main organizer
- 2018 Glances@Manifolds 2018, *Kraków*, member of the Organizational committee
- 2016 Glances@Manifolds, *Kraków*, member of the Organizational committee

Seminars Organized

- Between 2012 and 2015 I was the main organizer of the seminar of the Topology and Geometry group at AMU, Poznań
- Between 2015 and 2017 I organized Young Researchers Colloquium at IMPAN, Warsaw

Supervision Students

- since 2018 Piotr Mizerka, graduate student, co-advising doctoral thesis *Computational methods in excluding of exotic actions on manifolds*
expected graduation in 2021
- since 2020 Łukasz Patryk Michalak, graduate student, co-advising doctoral thesis *O grafach Reeba i powiązanych obiektach*
expected graduation in 2021
- 2018 Tomasz Sternal, advising of bachelor thesis *Persistence Weighted Gaussian Kernels in Topological Data Analysis*
thesis awarded with honours

Scripts

- 2012 *Elementary Differential Geometry*, text-book accompanying the course, (128 pages, in Polish), available [here](#)
- 2010 *Topology of Manifolds*, lecture notes from summer course by M. Kreck, A. Stipsicz and Z. Szabó.

Teaching experience

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 B1 (intermediate)
Polish C2 (proficiency, first language)