


# Benjamin Matthias Ruppik

## Curriculum Vitae

✉ [bruppikmath@gmail.com](mailto:bruppikmath@gmail.com)  
✉ [s6berupp@uni-bonn.de](mailto:s6berupp@uni-bonn.de)  
✉ [bruppik@mpim-bonn.mpg.de](mailto:bruppik@mpim-bonn.mpg.de)  
[ben300694.github.io](https://ben300694.github.io)  
 [ben300694](https://github.com/ben300694)



### Personal Information

Name Benjamin Matthias Ruppik (he/him)  
Date of birth 1994-06-30  
Place of birth Aachen, Germany  
Nationality German

### Education

January 2022–2024 **Topological Data Analysis in Natural Language Processing**,  
*HHU Düsseldorf.*

October 2018 – December 2021 **PhD student in Mathematics, specializing in Low-dimensional topology, advised by Arunima Ray and Peter Teichner;**  
**member of the Bonn International Graduate School of Mathematics (BIGS);**  
**funded by the the International Max Planck Research School on Moduli Spaces (IMPRS)**,  
*Max-Planck-Institute for Mathematics, Vivatsgasse 7, 53111 Bonn,*  
*Expected graduation: First quarter of 2022.*

July 2016 – August 2018 **Master of Science in Mathematics, University of Bonn,** .

October 2013 – June 2016 **Bachelor of Science in Mathematics, University of Bonn,** .

2004 – July 2013 **Abitur, Gymnasium Haus Overbach, Jülich-Barmen,** .

### Papers and Preprints

Daniel Kasprowski, Johnny Nicholson, Benjamin Ruppik:

'Homotopy classification of 4-manifolds whose fundamental group is dihedral'

To appear: [Algebraic and Geometric Topology](#)

[arXiv:2011.03520](#)

Abstract: We show that the homotopy type of an oriented Poincaré 4-complex is determined by its quadratic 2-type provided its fundamental group is finite and has a dihedral Sylow 2-subgroup. This applies in the case of smooth oriented 4-manifolds whose fundamental group is a finite subgroup of  $SO(3)$ , examples of which are elliptic surfaces with finite fundamental group.

Michael Klug, Benjamin Ruppik:

'Deep and shallow slice knots in 4-manifolds'

[Proc. Amer. Math. Soc. Ser. B 8 \(2021\), 204-218](#)

[doi:10.1090/bproc/89](#), [arXiv:2009.03053](#)

Abstract: We consider slice disks for knots in the boundary of a smooth compact 4-manifold  $X^4$ . We call a knot  $K \subset \partial X$  *deep slice* in  $X$  if there is a smooth properly embedded 2-disk in  $X$  with boundary  $K$ , but  $K$  is not concordant to the unknot in a collar neighborhood  $\partial X \times [0, 1]$  of the boundary. We point out how this concept relates to various well-known conjectures and give some criteria for the nonexistence of such

deep slice knots. Then we show, using the Wall self-intersection invariant and a result of Rohlin, that every 4-manifold consisting of just one 0- and a nonzero number of 2-handles always has a deep slice knot in the boundary. We end by considering 4-manifolds where every knot in the boundary bounds an embedded disk in the interior. A generalization of the Murasugi-Tristram inequality is used to show that there does not exist a compact, oriented 4-manifold  $V$  with spherical boundary such that every knot  $K \subset S^3 = \partial V$  is slice in  $V$  via a null-homologous disk.

Jason Joseph, Michael Klug, Benjamin Ruppik, Hannah Schwartz:

'Unknotting numbers of 2-spheres in the 4-sphere'

J. Topology 14.4 (2021), 1321-1350

doi:10.1112/topo.12209, arXiv:2007.13244

Abstract: We compare two naturally arising notions of “unknotting number” for 2-spheres in the 4-sphere: namely, the minimal number of 1-handle stabilizations needed to obtain an unknotted surface, and the minimal number of Whitney moves required in a regular homotopy to the unknotted 2-sphere. We refer to these invariants as the stabilization number and the Casson-Whitney number of the sphere, respectively. Using both algebraic and geometric techniques, we show that the stabilization number is bounded above by one more than the Casson-Whitney number. We also provide explicit families of spheres for which these invariants are equal, as well as families for which they are distinct. Furthermore, we give additional bounds for both invariants, concrete examples of their non-additivity, and applications to classical unknotting number of 1-knots.'

Daniel Kasprowski, Mark Powell, Benjamin Ruppik:

'Homotopy classification of 4-manifolds with finite abelian 2-generator fundamental groups'

Submitted

arXiv:2005.00274

Abstract: We show that for an oriented 4-dimensional Poincaré complex with finite fundamental group, whose 2-Sylow subgroup is abelian with at most 2 generators, the homotopy type is determined by its quadratic 2-type.

## Talks

### Research

- 2021-07-07 'Fundamental groups of knotted surface complements',  
MPIM Bonn Visit of the Fachbeirat (virtual).
- 2021-06-25 'Casson-Whitney unknotting numbers',  
BIGS Bonn Lightning Talk session (virtual).
- 2021-05-13 'Homotopy classification of 4-manifolds with dihedral fundamental group',  
[Geometric Topology Grad and Postdoc Seminar \(GT GAPS\)](#) (virtual).
- 2021-02-10 'Group trisections and smoothly knotted surfaces',  
shared talk with [Sarah Blackwell](#) and [Vincent Longo](#) in the [Virtual Trisectors Meeting](#).
- 2021-01-20 'Unknotting 2-knots with Finger- and Whitney moves',  
[Building bridges seminar](#) (virtual).
- 2020-11-05 'Casson-Whitney unknotting numbers of knotted 2-spheres in the 4-sphere',  
[Iowa Topology Seminar](#) (virtual).
- 2020-04-02 'Deeply slice knots',  
[Geometric Topology Grad and Postdoc Seminar \(GT GAPS\)](#) (virtual).
- 2019-06-14 'Stable classification of 4-manifolds',  
reporting on my master thesis in the LKS-Seminar (organized by Stefan Friedl and Clara Löh) at the university of Regensburg.

### Expository

- 2021-07-15 'Markov's Theorem on the unrecognizability of 4-manifolds',  
[SIPS-GT 2021](#).
- 2021-06-23 'Explicit immersions of the  $n$ -torus into  $\mathbb{R}^n$ ',  
[Bonn Topological manifolds seminar](#).
- 2021-06-09 'Differential Cohomology: Introduction',  
IMPRS seminar at MPIM Bonn.

- 2021-03-10 'Zeeman's fibration theorem and trisecting knotted surface groups',  
[Pisa Baby-Geometri Seminar](#).
- 2020-11-26 'Introduction to the Adams Spectral Sequence',  
IMPRS seminar at MPIM Bonn.
- 2020-11-24 'Seifert surfaces and what happens when we push them into the 4-ball, Examples of Trotter and Livingston',  
Seminar on knotted surfaces organized by [Peter Teichner](#)
- 2020-11-09 'Some of Freedman's results on topological 4-manifolds',  
[Exotic 4-manifolds learning seminar](#).
- 2020-05-03 'Rasmussen's s-invariant and the local Thom conjecture',  
IMPRS seminar at MPIM Bonn.
- 2019-11-21 'Fulton MacPherson compactifications'  
shared talk with [David Gay](#) in the Seminar on configuration spaces and diffeomorphisms at MPIM Bonn.
- 2019-04 Co-organized (with [Danica Kosanović](#)) a [Study group on Milnor invariants](#).
- 2019-04-24 'Homology of the little disks operad',  
IMPRS seminar at MPIM Bonn.
- 2018-10-31 'The trefoil and figure-eight are not slice - An introduction to knot concordance',  
IMPRS seminar at MPIM Bonn.
- [Posters](#)
- 2019-07 'Ribbon concordances and doubly slice knots',  
Poster for the BIGS exhibition at the Mathematical institute in Bonn.

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## Conferences & Travel

- 2021-09 MATRIX-MFO Tandem Workshop ID 2136a: Invariants and Structures in Low-Dimensional Topology, September 5 - 11, 2021;  
Talk: 'Concordances in  $(\text{non-orientable 3-manifold}) \times [0, 1]$ '.
- 2021-07 [Tech Topology Summer School on 4-Manifolds](#), online, July 26 - 30, 2021;  
TA for Aru Ray's course 'Topological 4-manifolds: the disc embedding theorem and beyond',  
Recorded Lightning Talk: 'Casson-Whitney unknotting numbers'.
- 2021-07 [Young Topologists Meeting 2021](#), online, July 5 - 16, 2021.
- 2021-06 [TopFlavours \(Topology in Distinct Flavours\) 2021](#), online, June 17 - 18, 2021;  
Talk: 'Group trisections and smoothly knotted surfaces'.
- 2021-06 [Nearly Carbon Neutral Geometric Topology Conference](#), online, June 14 - 25, 2021;  
Postcard from a Geometric Topologist: 'Pushing Seifert surfaces into the 4-ball'.
- 2021-05 [Summer Trisectors Workshop 2021](#), online, May 27 - June 5, 2021.
- 2021-04 [GTA: Philly 2021 Temple Graduate Student Conference in Algebra, Geometry, and Topology](#),  
online, May 21 - 23, 2021.;  
Talk: 'Unknotting 2-Knots with Finger- and Whitney Moves'.
- 2021-04 [2021 Graduate Student Topology and Geometry Conference \(GSTGC\)](#), online, April 9 - 11,  
2021;  
Talk: 'Homotopy classification of 4-manifolds whose fundamental group is dihedral'.
- 2021 AIM Online Research Community on 4-dimensional topology;  
Lightning Talk: 'Deep and shallow slice knots in 4-manifolds',  
Research group '4-dimensional perspective on the untwisting number',  
Learning group 'Corks'.
- 2020-12 [Winter Trisectors Workshop 2020](#), online, December 7 - 11, 2020.

- 2020-12 [Georgia Tech Topology Conference](#), online, December 4 - 6, 2020;  
Lightning Talk: 'Deep and shallow slice knots in 4-manifolds'.
- 2020-06 Summer Virtual Trisectors Workshop, online, June 22 - 25, 2020.
- 2020-06 [Nearly Carbon Neutral Geometric Topology Conference](#), online, June 1 - 14, 2020.
- 2020-04 [Net-COVID](#), Understanding and Exploring Network Epidemiology in the Time of Coronavirus, online
- 2020-02 [Winter Braids X](#), Pisa, February 17 - 21, 2020.
- 2019-10 Low-dimensional topology workshop, Regensburg, October 21 - 23, 2019.
- 2019-09 [Workshop on 4-manifolds](#), Bonn, September 16 - 20, 2019;  
Contributed slide 'Resolving Ribbon Singularities' to the picture show.
- 2019-07 [Swiss Knots](#), Zurich, July 16 - 19, 2019.
- 2019-06 [Knot concordance and low-dimensional manifolds](#), Le Croisic, June 17 - 21, 2019.
- 2019-05 [Knots and Braids in Norway](#), Trondheim, May 2019;  
Gong show talk: 'Doubly slice knots and satellites'.

## Theses

- PhD Thesis 'Knotted surfaces, Casson-Whitney unknotting and Deep slice disks', University Bonn, in preparation, supervised by Arunima Ray, PhD & Prof. Dr. Peter Teichner.
- Master Thesis 'Equivariant intersection forms of 4-manifolds', University Bonn, 2018, supervised by Dr. Daniel Kasprowski & Prof. Dr. Peter Teichner.
- Bachelor Thesis ' $\text{Torsion in } \Gamma(\pi_2 K)/\pi_1 K$ ', University Bonn, 2016, supervised by Dr. Daniel Kasprowski & Prof. Dr. Peter Teichner.  
Development of a SageMath module in Python to calculate an invariant of specific 2-complexes.

## Experience

### Vocational

- August 2013 – Present **Organist**, KIRCHENGEMEINDEVERBAND ALDENHOVEN-LINNICH, Linnich.  
Employed at Kirchengemeindeverband Aldenhoven-Linnich (Pfarrer-Reiff-Str. 15, 52441 Linnich-Welz) as organ player.
- October 2014 – September 2020 **Student associate**, MATHEMATICAL INSTITUTE OF THE UNIVERSITY OF BONN, Bonn.  
Employed as tutor for the lectures *Analysis I, II, Linear Algebra I, II, Introduction to Algebra, Introduction to Geometry and Topology, Topology I, II, Algebraic Topology I, II*.
- April 2018 – September 2018 **Student associate**, INSTITUTE OF COMPUTER SCIENCE III, Bonn.  
Semantic segmentation of RGB-images and point clouds captured by a Velodyne LiDAR;  
[ben300694/semanticLabelingTool](#)

### Miscellaneous

- 2021 **External PhD representative**, *Max-Planck-Institute for Mathematics, Bonn*.
- July 2017 – June 2018 **Treasurer for the Debating team at the University of Bonn**.
- July 2010 – January 2011 **Stay abroad**, Escondido, CA 92026, USA.  
First half of Junior Year at Calvin Christian School (2000 N Broadway, Escondido, CA).

## Computer skills

- General C/C++, PYTHON, [Go](#), HASKELL, PROLOG
- Web Development HTML
- Mathematics SAGEMATH, MAPLE, MATLAB
- Computer Vision OPENCV

Machine learning frameworks	TensorFlow, PyTorch
Miscellaneous	L <sup>A</sup> T <sub>E</sub> X, G <sub>IT</sub>

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## Languages

German	Mothertongue
English	Fluent
Latin	Basic

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## Interests

Piano, Organ

Bonn, October 29, 2021

*Benjamin Ruppik*  
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