Johannes Carmesin

SCIENTIFIC CV

Personal summary

2019–2021 **Postgraduate Certificate in Higher Education (PGCHE)**
With distinction, Birmingham

2018 **Habilitation in Mathematics**
Postdoctoral teaching and research qualification, Hamburg

2012–2015 **PhD: Scholar of the Studienstiftung des deutschen Volkes**
Awarded *summa cum laude*, Hamburg

2007–2012 **Undergraduate studies: Scholar of the Studienstiftung des deutschen Volkes**
Completed half a year early, with distinction, including five published papers, Hamburg

Career to date

2024– **Full Professor (W3-Chair in Discrete Structures)**
TU Freiberg (Germany), Faculty of Mathematics and Computer Science, tenured

2022–2023 **Head of Group in Combinatorics, Probability, and Algorithms**
Birmingham, School of Mathematics, leading a team of 8 permanent staff members

2021–2024 **Reader (Associate Professor)**
Birmingham, School of Mathematics, tenured

2018–2021 **Birmingham Fellowship (Tenure-Track)**
Birmingham, School of Mathematics, permanent research position

2015–2018 **Junior Research Fellowship**
Emmanuel College, Cambridge, independent researcher

Research grants and awards

- European Prize in Combinatorics (Prague, 2023; awarded every two years to the best combinatorialist under 35, awarded by Jaroslav Nešetřil)
- DFG-Sachbeihilfe (Freiberg, 2024 – 2027)
- EPSRC Early Career Fellowship (Birmingham, 2020–2024, PI, £1M, focused on the development of 3-dimensional graph minors theory, with a success rate of approximately 20-25%)
- Junior Research Fellowship (Cambridge, 2015–2018, living stipend)
- PhD scholarship of the Studienstiftung des deutschen Volkes (Hamburg, 2012–2015, living stipend)
- Undergraduate scholarship of the Studienstiftung des deutschen Volkes (Hamburg, 2008–2012, living stipend)

Selected Publications

My research spans a wide range of topics within Combinatorics, including Graph Minors, Matroids, Connectivity, Electrical Networks, and Infinite Graphs. My research has exciting connections to Topology, Probability Theory, Set Theory, Algorithms, Group Theory and Differential Geometry of 3-manifolds.
Fourteen of my papers have been published or accepted in Combinatorica or JCTB, the two leading journals in Combinatorics. In total I have written about 50 papers. My three best papers are:

1. **Canonical decompositions of 3-connected graphs** (with J. Kurkofka), IEEE Symposium on Foundations of Computer Science (FOCS) 2023, 50 pages

   One of the most fundamental tools in graph theory is the theory of connectivity, which decomposes a graph into smaller pieces, solving the problem of interest locally before combining these solutions globally. While the theory of separators of size one or two has been well understood since the 1960s due to Tutte's Theorem, it was long believed that an extension to separators of size three was impossible. In this paper, we introduce a new perspective that allows such an extension, impacting both Group Theory and Computer Science.

2. **Local 2-separators**, Journal of Combinatorial Theory, Series B, Volume 156, 2022, Pages 101-144

   The emergence of Data Science has led to new challenges for Graph Theory, where algorithms need to be faster and scale efficiently in large networks. Traditionally, graph algorithms focused on polynomial time solutions, but recent applications require algorithms that run independently of the number of vertices, often using parallel computing. In this paper, I refine the theory of graph connectivity to study locally separating vertex sets, leading to applications in Group Theory, Graph Theory, and Large Networks.

3. **Embedding simply connected 2-complexes in 3-space I–V**, to appear in Memoirs of the AMS, pp. 136

   This work characterizes the embeddability of simply connected 2-dimensional simplicial complexes in 3-space, analogous to Kuratowski's characterization of graph planarity. It addresses key questions posed by Abel Prize winner Lovász, geometer Pardon, and combinatorialist Wagner. Using methods from Topology, Differential Geometry of 3-manifolds, Algebra (Matroid Theory), and Combinatorics, we present a quadratic time algorithm for embedding verification. These results were featured in the Opening Lecture at the prestigious Oberwolfach Workshop and inspired further work in my group and beyond.

Selected Plenary Lectures

1. Eurocomb (2023), Prague
2. Kolkom (2023), Heidelberg
3. Virtual Math Colloquium (2021), IBS, Korea
4. Matroid Union Seminar (2020 and 2023), Online Seminar of the Matroid Community
5. **CANADAM** (2019), 400 participants, Vancouver, Canada
6. **Oberwolfach Workshop on Graph Theory** (2019), Opening Lecture, Oberwolfach, Germany
7. Colloquia in Combinatorics (2019), London

8. Dimea (2019), Brno, Czech Republic
9. **Structure in Graphs and Matroids** (2017), Tutte Centennial Conference, Waterloo, Canada
10. Higher Infinity Workshop (2015), Cambridge, Newton Institute
11. Workshop on Random Walks on Graphs and Potential Theory (2015), Warwick

All the above are plenary lectures of approximately 50 minutes in duration.

Other contributions to the mathematics community

Editorships

- Associate Editor for the journal *Innovations in Graph Theory* (since 2023; open access and non-commercial).
- Associate Editor for the journal *Discrete Mathematics* (since 2019).

Conference Organisation

- **Bertinoro Workshop on Algorithms and Graphs** (October 2025) Co-organized with Wollan and Bonamy, focusing on the intersection of algorithms and graph theory.
- **Ukrainian Summer School in Combinatorics** (September 2025) Co-organized with Pikhurko, offering advanced training for PhD students and early-career researchers.
- Conference for UK Master's Level Mathematics Students (2023) Co-organized with Turner, providing a platform for Master's students to present their research.
- Interactive Open Problem Workshop (January 2021) Organized for rising PhD students and postdocs to encourage collaborative exploration of open problems.
- Summer School for PhD Students and Postdocs (2015) Co-organized with Bowler, focusing on advanced topics in graph theory.

Reviewing

- Chair of two EPSRC Panels (2023; total funding awarded: £20M); panel member in 2021.
- Member of the EPSRC Full College (2020–2024), reviewing grant applications and serving on panels.
- Reviewer of PhD theses internationally (France, UK, New Zealand).
- Recognized by EPSRC for outstanding reviewing; regular reviewer of grant applications.
- Participated in the selection process for the Studienstiftung des Deutschen Volkes and admissions at my college in Cambridge.
- Reviewer for the Research Evaluation at Charles University, Prague.
- Referee for more than 70 journal papers.

Public Engagement

- Survey on graph theory published in the *Jahresbericht der Deutschen Mathematiker Vereinigung* (2022). This invited article discusses major challenges in graph theory for the next century, prepared in honour of the Abel Prize awarded to L. Lovász.
- Initiator of *Probe Uni* (2025, annually): A strategic recruitment programme for TU Freiberg, designed to attract talented students.
- Public lecture as part of the series *Mathematik im Gespräch* at the Erlebnisland Mathematik, Dresden (2025).
- Public mathematics lecture in Birmingham (2020).

- Workshops for high school students as part of the "Talentförderung Mathematik" programme (2006–2012). Delivered 4-hour workshops every two weeks and coordinated the programme in the Harburg area.