



### Career to date

- 2024 – **Full Professor, W3-Chair in Discrete Structures**  
TU Freiberg (Germany), tenured, Faculty for Mathematics and Computer Science
- 2023 **Full Professor, declined**  
Birmingham (UK), tenured, School of Mathematics
- 2022 – 2023 **Head of the group in Combinatorics, Probability and Algorithms**  
About 10 permanent members of staff and their teams, Birmingham
- 2021 – 2024 **Reader (Associate Professor)**  
Birmingham, tenured, School of Mathematics
- 2018 – 2021 **Birmingham Fellowship**  
Birmingham, tenure-track
- 2015 – 2018 **Junior Research Fellowship at Emmanuel College**  
Cambridge, independent researcher

### Education

- 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**  
for 'summa cum laude', i.e. a distinction, Hamburg
- 2007 – 2012 **Undergraduate studies: scholar of the Studienstiftung des deutschen Volkes**  
finished half a year early, with distinction and five papers, Hamburg

### Research grants and awards

- European Prize in Combinatorics (Prague 2023, awarded every two years to the best Combinatorialist under 35, awarded by Jaroslav Nešetřil)
- EPSRC Early Career Fellowship (Birmingham, 2020 –2024, PI, £1M)
- Junior Research Fellowship (Cambridge, 2015–2018, living stipend)

### Selected Publications

I have worked on a wide range of topics within Combinatorics (e.g. 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: to break a graph apart into smaller pieces, solve the problem of interest in those pieces and combine these local solutions to a global solution. How to decompose a graph along separators of size one or two has been completely understood since Tutte's Decompositions Theorem in the 1960s. Since then it was widely believed that an extension of Tutte's theorem was not possible for separators of size three, and the theory of 3-connected graphs has been invented to compensate for this defect. In this paper we introduce a new perspective on separators of size three that allows for such an extension after all. This theorem implies a fair share of the theory of 3-connected graphs, and brings along new applications in Group Theory and Computer Science.

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

The emerge of Data Science as a new discipline of Science provides new questions and challenges for well-established disciplines. It seems that in Graph Theory the key challenge is the following. While traditionally, it was desirable to prove theorems that lead to graph-algorithms that run polynomially in the number of vertices of the graph, now applications related to the internet and other large networks draw our attention to problems that require algorithms that run much faster: where the running time is independent of the number of vertices but where perhaps parallel computing is allowed.

For dense networks, the methods of graphons and flag algebras have been developed in the last decade to address new challenges arising from Large network algorithms and Data Science. Despite some effort, in the sparse regime, it remained open how to develop analogous techniques. Addressing this, I discover a way how the theory of graph connectivity can be refined to study vertex sets that are not separating globally but just locally. Since then I together with coworkers worked out various applications thereof in Group Theory, Graph Theory and Large networks.

3. **Embedding simply connected 2-complexes in 3-space I–V**, 2017<sup>+</sup>, submitted

We characterise the embeddability of simply connected 2-dimensional simplicial complexes in 3-space in a way analogous to Kuratowski's characterisation of graph planarity, by excluded minors. This answers fundamental questions of the Abel Prize Winner Lovász, the geometer Pardon and the Combinatorialist Wagner. The methods come from Topology and Differential Geometry of 3-manifolds, Algebra (Matroid Theory) and Combinatorics. A consequence is a quadratic time algorithm for checking whether a simply connected 2-complex is embeddable in 3-space. I have been invited to present these results in the Opening Lecture in prestigious Oberwolfach Workshop, and inspired quite a bit of follow-up works 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 about 50 minutes in duration.

## Teaching

At TU Freiberg, my team and I deliver the courses in Discrete Mathematics and Theoretical Computer Science. These include: Discrete Structures, Algorithmic and Structural Graph Theory, Algorithmic Geometry, Algorithms, Complexity Theory, and Advanced Topics in Graph Theory.

## Supervision

Recent interns: Romain Bourneuf (2023), Georgios Kontogeorgiou (2022), Lyuben Lichev (2019)  
Completed PhD students: Tsvetomir Mihaylov (2019 – 2023), Emily Nevinson (2020 –2024)

## Other contributions to the mathematics community

- 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).
- Chaired two EPSRC Panels (2023, total value 20M) and regular member of a further panel in 2021.
- Member of the EPSRC Full College (including review of grant applications for EPSRC and engagement as a panel member) (since 2020)
- Reviewer of grant applications; I obtained a recognition for outstanding reviewing from EPSRC.
- I have taken part in the selection process of new scholars for the Studienstiftung des Deutschen Volkes as well as for three years in the admission process for new students at my college in Cambridge.
- I was a reviewer for the Research Evaluation at Charles University, Prague, Czech Republic.
- I organised a Summer School for PhD students and postdocs together with Bowler.

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- I have trained pupils talented in mathematics at the 'Talentförderung Mathematik' from 2006 to 2012. I delivered one workshop myself every two weeks for 4 hours and coordinated the delivery of all such groups in the area of Harburg.
- In January 2021, I organised a small interactive open problem workshop for rising PhD students and early career postdocs, see [http://web.mat.bham.ac.uk/J.Carmesin/study\\_group.html](http://web.mat.bham.ac.uk/J.Carmesin/study_group.html).
- I referee for a broad range of journals (more than 70 papers reviewed to date).  
The journals I referee for include: Journal of the European Mathematical Society, Bulletin of the London Mathematical Society, Combinatorica, Journal of Combinatorial Theory (Series B), Advances in Combinatorics, Combinatorial Theory, European Journal of Combinatorics, Journal of Graph Theory, SIAM Journal on Discrete Mathematics, Discrete Mathematics, Abh. Math. Seminar Hamburg, Graphs and Combinatorics, Annals in Combinatorics, Order, Aequationes Mathematicae, AKCE International Journal of Graphs and Combinatorics.  
I reviewed for the following conference proceedings: ICALP, ESA, LAGOS, Eurocomb and SODA.

## Publications

About 50 papers, for details see my webpage <https://j-carmesin.github.io/>.