

The Research Group

**Algebra and Analysis**

has the honor to invite you to the public defense of the PhD thesis of

**Sam Mattheus**

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:  
**Finite geometry and friends: tilings in abelian groups and  
combinatorics in spherical buildings**

Promotors:

**Prof. dr. Philippe Cara (VUB)**

**Prof. dr. Jan De Beule (VUB)**

The defense will take place on  
**Wednesday, May 25, 2022 at 17h in  
auditorium D2.01**

The defense will also be livestreamed via Zoom.  
Contact [sam.mattheus@vub.be](mailto:sam.mattheus@vub.be) for more information.

**Members of the jury**

Prof. dr. Stefaan Caenepeel (VUB, chair)

Prof. dr. Ann Dooms (VUB, secretary)

Prof. dr. Leandro Vendramin (VUB)

Prof. dr. Bart Bogaerts (VUB)

Prof. dr. Leo Storme (Ghent University)

Prof. dr. Valentina Pepe (Università di Roma  
La Sapienza)

Prof. dr. Aida Abiad (Eindhoven University of  
Technology)

**Curriculum vitae**

Sam Mattheus obtained his Master of Science in Mathematics at Ghent University in 2016. Afterwards, he started as an assistant at the Mathematics department of the Faculty of Engineering at the Vrije Universiteit Brussel. He combined teaching first-year mathematics courses in the bachelor of civil engineering with doctoral research under the supervision of prof. dr. Philippe Cara and prof. dr. Jan De Beule. He has presented his work at several international events and has published 11 scientific articles in peer-reviewed international journals. He has co-supervised bachelor's and master's thesis students and organized several events such as the 2019 summer school Finite Geometry and Friends at VUB.

**Abstract of the PhD research**

Finite geometry, the study of highly symmetric and structured configurations, has proven its worth in many branches of fundamental mathematics. Although one can investigate these finite structures on their own, they really shine in their various applications in coding theory, extremal combinatorics, computer science, and so on. In this thesis we contribute to the interplay of finite geometry with two other topics in algebra and combinatorics.

The first topic deals with tilings in finite abelian groups, which is in its essence not so different from day-to-day tilings where one tries to tile a surface with a fixed tile, without overlap. Already 50 years ago, researchers have investigated a classification of possible tilings, but quickly reached the limit of their techniques. Several conjectures were posed which related the existence of such tilings to algebraic properties or stating that in certain groups, only the obvious tilings are possible and no exotic examples occur. Both conjectures are open to this day, but progress is made in the thesis by looking at these problems from a geometric point of view. In this way we could, among other results, confirm the conjectures in small cases or refute it in other ones.

The second topic is situated in extremal combinatorics, where we try to derive global properties from local restrictions. A typical example is that of EKR-problems, named after the pioneers Erdős, Ko and Rado, where we look in a finite universe of objects for the largest subset such that no two are "far away", where this notion depends on the given context. We generalize problems that were previously studied and introduce a new algebraic technique which allows us to give new and simpler proofs of earlier results and put them in a broader context.

As happens often in mathematics, the obtained results raise more new questions than they answer. The interdisciplinary point of view seems to not have reached its limits yet and holds a lot of promise. As such, the underlying goal of the thesis is to offer a solid foundation for further research in this interplay of finite geometry and the aforementioned topics.