hausdorff center for mathematics

UNIVERSITÄT BONN

HCM NEWS 2/24

Jessica Fintzen awarded EMS Prize

Jessica Fintzen has won another highly prestigious accolade, this time the European Mathematical Society's (EMS) Prize. The professor of the University of Bonn's Mathematical Institute and member of the Hausdorff Center for Mathematics (HCM) was handed the award on Monday, July 15, during the ninth European Congress of Mathematics (ECM) in the Spanish city of Seville.

The ECM is held every four years, alternating at two-yearly intervals with the International Congress of Mathematicians, at which the illustrious Fields Medal is presented. "So it's a bit like the World Cup and European Championships in soccer," Jessica Fintzen explains. Whilst the Fields Medal is awarded to mathematicians under 40 from anywhere in the world, the EMS Prize sets an age limit of 35. It is open to any mathematician who holds European citizenship or is currently conducting research in Europe. In a way, therefore, the EMS Prize can be seen as the "little sister" of the Fields Medal, especially since no fewer than 11 of its winners (including Peter Scholze) have gone on to be awarded what is the most famous prize for mathematics in the world, the Fields Medal.

Jessica Fintzen is being honored for "her groundbreaking work on the representation theory of p-adic groups." She is regarded as one of the world's leading mathematicians in this field, which connects number theory and representation theory, and has already won numerous awards including the Frank Nelson Cole Prize in Algebra at the start of this year and the London Mathematical Society's Whitehead Prize back in 2022. She was recently awarded a medal for giving the Cours Peccot lectures at the Collège de France. "These prizes are a huge motivation for me," Jessica Fintzen says. "I'm always looking ahead; there's still a lot to do. This particular prize is very special for me, because it can be awarded for any discipline in mathematics." The €5,000 prize money is of secondary importance as far as she is concerned. Jessica Fintzen's research is in pure mathematics and concerns groups and so-called p-adic numbers. Groups are sets whose elements can be composed so that certain rules apply, such as the associative law. An example of a group is the symmetry group of a cube, which contains all operations that keep the cube invariant. In representation theory, groups are described by matrices, i.e. by linear maps between vector spaces, which are mathematically very well understood. If you start with the field of rational numbers, you can extend and complete it in

various different ways to obtain larger fields. A very well-known way of doing this results in the field of real numbers known from school. Another possibility leads to the so-called p-adic numbers for each prime number p. In Jessica Fintzen's research, the aim is to describe groups over these fields of p-adic numbers with the help of matrices, i.e., to "represent" them. The class of groups over all p-adic numbers can be visualized as a large ocean, where each prime number p stands for a specific location in the ocean and where an infinite chain of groups extends deep into the ocean. In recent work, Jessica Fintzen, together with other scientists from all over the world, has now succeeded in bringing everything from the infinite depth of this ocean back to the surface, where the general linear groups over finite fields are located, which are already very well known. These "depth-zero representations" of p-adic groups have a great influence on the well-known Langlands program, in which far-reaching conjectures are made that link number theory and representation theory of groups, and which is considered one of the most important mathematical programs in modern mathematics.

Geordie Williamson receives the Max Planck Humboldt Research Award 2024

Artificial intelligence and computer science are driving developments in many areas of society – including in scientific research. This has prompted the Max Planck Society and the Alexander von Humboldt Foundation to honor outstanding achievements in the use of algorithms in mathematics, microscopy and climate research in 2024: The Max Planck-Humboldt Research Award, endowed with 1.5 million euros, goes to **Geordie Williamson**, Professor at the University of Sydney. Williamson uses artificial intelligence (AI) for his fundamental work in mathematics. The prizewinner will also cooperate closely with the Department of Mathematics at the University of Bonn in this field. The awards will be presented on December 3rd in Berlin.

Scientists today use artificial intelligence in many areas, especially in the natural sciences, for tasks such as analyzing data or images. In theoretical mathematics, on the other hand, AI has barely been used thus far. Now Geordie Williamson is aiming to change that. In his previous work he has already used artificial neural networks, which can guide mathematical intuition by drawing attention to previously unrecognised relationships in a large number of mathematical objects. Artificial intelligence can also help to generate examples or counterexamples that prove or disprove mathematical assumptions. Although artificial neural networks can recognise patterns in large data sets very efficiently and effectively, they know nothing about mathematics. It therefore remains the task of mathematicians to filter out the sensible proposals from AI, to interpret them and, in the case of new assumptions about mathematical relationships, to prove or disprove them. Geordie Williamson wants to optimize the possibilities of using AI in theoretical mathematics in the collaboration made possible by the Max Planck-Humboldt Research Award. To this end, he will work closely with researchers from the University of Bonn and the Max Planck Institute for Mathematics in Bonn, where he will also spend two periods of several months each. Catharina Stroppel from the Hausdorff Center for Mathematics (HCM) and the Mathematical Institute at the University of Bonn is the future host for Geordie Williamson. The joint project is entitled “Computation and AI of mathematical discovery”. “The collaboration will enable us to advance research in theoretical mathematics guided by artificial intelligence,” says Catharina Stroppel. AI should help to recognize new structures in mathematics, make predictions and be able to make mathematical conjectures, says the scientist, who is looking forward to working with the award winner. “A lot of know-how in the field of computer algebra and programming will come to Bonn - and we will contribute our mathematical expertise to the project.”

Connecting the countable with geometry

Geordie Williamson's previous research work was characterized, among other things, by the fact that he brought together different fields such as combinatorics and geometry. In simple terms, combinatorics can be understood as the branch of mathematics that is dedicated to everything that can be counted; it includes subjects such as graph theory and discrete mathematics. Geometry is about objects in spaces, i.e. straight lines, surfaces, and solids, just like in school maths. Both sub-areas come together in a simple example when the intersection points of a curve and a surface are to be counted. Geordie Williamson has now opened up ways of solving combinatorics problems with geometric tools, for which purpose he first had to develop a kind of common mathematical language for the two fields so that combinatorial problems could be worked on in geometry, but geometry could also be translated into combinatorics. With this approach, Geordie Williamson has proved or disproved various assumptions that mathematicians have been working on intensively, but to no avail, for a long time.

Solving knot theory problems with the help of AI

As part of the collaboration with researchers from the University of Bonn and the Max Planck Institute for Mathematics, all possible as a result of the award, Williamson will tackle various mathematical problems with the help of artificial intelligence. Amongst the problems that they will tackle is a problem in knot theory. In simple terms, this can be explained by the fact that it is often impossible to recognize whether “knotted structures“, such as in a string, are actually knotted. What this means is: does the knot remain intact when you pull on the ends of the cord or does it unravel? One aim of the project is to identify these cases in a simple way so that these uninteresting cases can be quickly filtered out and the researchers can focus on the real knots. AI is set to provide support here and assistance in gaining new mathematical insights.

ERC Starting Grants for Markus Hausmann

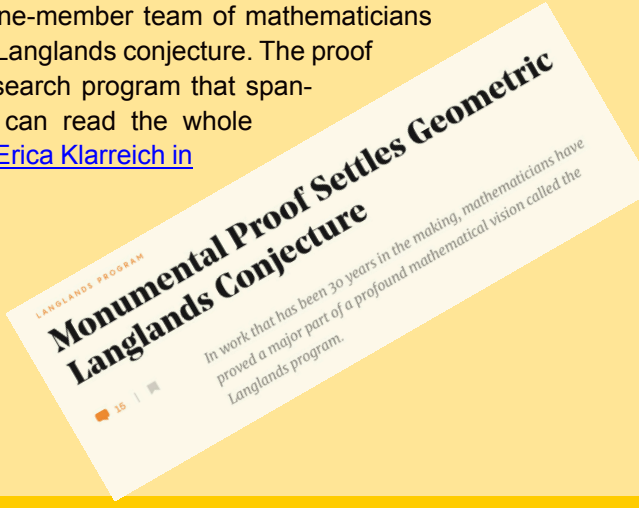
There have never been so many ERC Starting Grants at once at the University of Bonn: no fewer than seven researchers have been successful with their applications in the highly competitive European Research Council (ERC) funding process. With a funding of some €1.5 million, **Markus Hausmann** from the Mathematical Institute, will be able to realize his project “Bordism of symmetries: From global groups to derived orbifolds” (BorSym) over the next five years.

Markus Hausmann from the Mathematical Institute at the University of Bonn is a mathematician whose research covers algebraic topology and its interaction with algebraic geometry, representation theory and tensor triangular geometry. He is engaging in basic mathematical research with his project, entitled “Bordism of symmetries: From global groups to derived orbifolds” (BorSym), in which he will use algebraic methods to study the symmetry of spaces. As he explains: “The project studies connections between group actions on geometric objects, the algebra of equivariant formal groups and bordism rings of orbifolds. From this interplay we hope to obtain new insights into long-standing open problems on symmetries." The ERC will be giving BorSym close to €1.5 million in funding over the next five years. Markus Hausmann plans to use the money “to assemble a big team of postdocs and doctoral students so that we can address the unanswered questions together. I wouldn’t be able to do anything like this without the grant.”

Markus Hausmann studied mathematics at the University of Bonn, staying on to complete a PhD in the same subject in 2016. He then moved to work as a postdoc at the University of Copenhagen before taking up positions as an Akademischer Rat auf Zeit (a lecturer with temporary civil servant status) at the University of Bonn and as an associate professor at the University of Stockholm. In July 2023, Markus Hausmann returned to his alma mater, where he now researches and teaches in his current role as Professor of Mathematics as well as being a member of the HCM.

Proof of the geometric Langlands conjecture by Dennis Gaitsgory

The Langlands Program is one of the largest projects in modern mathematics and consists of various branches. Over the years, our Max Planck Institute for Mathematics in Bonn has gained a reputation as one of the hubs for the Langlands Program. We are proud that MPIM Director and HCM member Dennis Gaitsgory led a nine-member team of mathematicians that proved the geometric Langlands conjecture. The proof is the culmination of a research program that spanned three decades. You can read the whole story in a recent article by Erica Klarreich in the Quanta Magazine.



Gerd Faltings elected member of the Order Pour le Mérite

Gerd Faltings, Emeritus Director of the Max Planck Institute for Mathematics in Bonn, was elected member of the Order Pour le Mérite. The Order has 34 German and 37 foreign members, including 17 Nobel Prize winners.

Being elected to the Order Pour le Mérite is one of the highest honors that can be awarded to scientists and artists in Germany. The association of artists and scholars was founded in 1842 by Prussian King Frederick William IV and revived in 1952 by Federal President Theodor Heuss. The Order Pour le Mérite is under the protectorate of the Federal President. It is financed and organized by the Minister of State for Culture and the Media. Two other directors of the Max Planck Institute for Mathematics, Friedrich Hirzebruch and Yuri Manin, were already members of the Order.

Gerd Faltings studied mathematics and physics at the University of Münster. In 1978/79 he was a guest student at Harvard University in Cambridge, Massachusetts. Back in Münster, he qualified as a professor in 1981. Afterwards, he was a professor in Wuppertal and moved to Princeton University in New Jersey, USA, as a full professor at the beginning of 1985. From 1994 until his retirement in 2023, Gerd Falting was one of the directors at the Max Planck Institute for Mathematics in Bonn. Gerd Faltings is a member of the academies in Düsseldorf, Göttingen, Berlin and Halle, the European Academy, the Royal Society (London) and the National Academy of Science (Washington). He received the Fields Medal in 1986, the Leibniz Prize in 1996, the von Staudt Prize in 2008, the Heinz Gumin Prize in 2010, the King Faisal International Prize in 2014, the Shaw Prize in 2015, the Georg Cantor Medal in 2017, and many other awards. Gerd Faltings is known for his work in arithmetic geometry. He proved the Tate conjecture for abelian varieties over number fields, the Shafarevich conjecture for abelian varieties over number fields and the Mordell conjecture.

Cantor Medal for the first spokesperson of the HCM

Felix Otto – our first ever HCM spokesperson – has been awarded the Cantor Medal of the German Mathematical Society (DMV). We congratulate him warmly! The Cantor Medal is the most important scientific award of the DMV. It is usually awarded every two years. The prize money amounts to 4,000 euros. Felix Otto, born in 1966, studied at the Rheinische Friedrich-Wilhelms-Universität Bonn, where he also completed his doctorate. He was professor at the University of California in Santa Barbara (1998), professor at the University of Bonn (1999), speaker of the Collaborative Research Center 611 “Singular Phenomena and Scaling in Mathematical Models” at the University of Bonn (2002-2006) and spokesperson of the Hausdorff Center for Mathematics (2006-2009). He is Director and Scientific Member at the Max Planck Institute for Mathematics in the Sciences (since 2010), Honorary Professor at the University of Leipzig (since 2010), Full Member of the Berlin-Brandenburg Academy of Sciences and Humanities (since 2014), member of the German Academy of Sciences Leopoldina (since 2008) and was awarded the Gottfried Wilhelm Leibniz Prize in 2006, the most important research prize of the German Research Foundation.

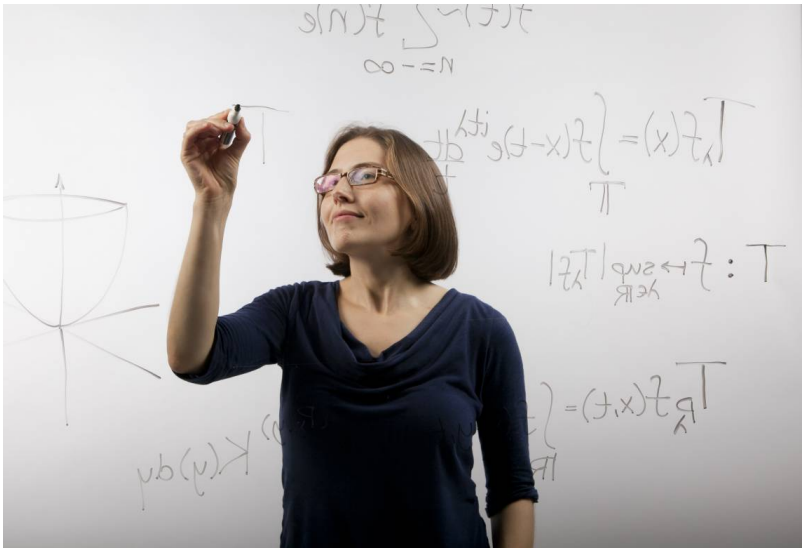
Lean project at HCM: Carleson's classic result and a generalization

Two HCM mathematicians, IRU group leader **Floris van Doorn** and Hausdorff Chair **Christoph Thiele**, have started a new Lean project together with some of their postdocs and PhD students. They prove a new generalization of one of Carleson's theorems, namely finding certain bounds for a generalized Carleson operator on so-called doubling spaces, and formalize this proof. Moreover, they explicitly reduce Carleson's classical result on pointwise convergence of Fourier series to this new theorem. Both proofs are presented in great detail and are suitable as a blueprint for a verification with the current possibilities of Lean. Even Carleson's classical result has not yet been verified on the computer. Terence Tao has published an article about this project on Mathstodon, which met with an impressive response. The main website for the project is https://florisvandoorn.com/carleson/, and the Zulip channel for coordinating the project is at https://leanprover.zulipchat.com/#narrowstream/442935-Carleson.

Anton Bovier elected fellow of the European Academy of Sciences

Anton Bovier, professor at the Institute for Applied Mathematics at the University of Bonn and member of the Hausdorff Center for Mathematics (HCM), has been elected as fellow of the European Academy of Sciences (EurASc). EurASc is a fully independent international association of distinguished scholars that aims to recognize and elect to its membership the best European scientists with a vision for Europe as a whole, transcending national borders, and with the aims of strengthening European science and scientific cooperation. It is completely independent of any national entity in its membership, election processes, deliberations, and actions. One of EurASc's purposes is to play a role complementary to those of national academies and the European Academies' Science Advisory Council (EASAC).

Lillian Pierce elected fellow of the Association for Women in Mathematics



Lillian Pierce, Bonn Research Chair and member of the Hausdorff Center for Mathematics (HCM), has been elected a fellow of the Association for Women in Mathematics (AWM) for her many contributions in the support of women both locally and nationally through the organization of such events as “Re:boot Number Theory”, “A room of one’s own”, and Graduate Research Opportunities for Women (GROW). The Executive Committee of the Association for Women in Mathematics (AWM) has established the AWM Fellows Program to recognize members who have demonstrated a sustained commitment to the support and advancement of women in the mathematical sciences.

Lillian Pierce received a BA in Mathematics and graduated as valedictorian of Princeton University in 2002. She earned an MSc by Research at the University of Oxford as a Rhodes Scholar in 2004, and a PhD from Princeton in 2009. After holding postdoctoral positions at the Institute for Advanced Study and University of Oxford and a year as a Bonn Junior Fellow at the Hausdorff Center for Mathematics (HCM), Pierce took a faculty position at Duke University, where she is presently the Nicholas J. and Theresa M. Leonardy Professor of Mathematics. In 2022, Lillian Pierce was named a Bonn Research Chair. The Bonn Research Chairs (BRC) program of the HCM provides visiting positions for eminent scientists. Pierce’s research combines techniques of analytic number theory and harmonic analysis, with particular interests in Diophantine equations, exponential and character sums, class groups, oscillatory integrals, and singular integrals. Lillian Pierce’s work has been recognized by a Presidential Early Career Award for Scientists and Engineers, a Simons Fellowship, a Joan and Joseph Birman Fellowship, a Sloan Research Fellowship, a von Neumann Fellowship, a Marie Curie Fellowship, and most recently, in 2023, a prestigious Guggenheim Fellowship. She was an invited speaker, representing number theory and analysis, at the International Congress of Mathematicians in 2022. Lillian Pierce is also deeply invested in making the mathematics community a better place for women, gender minorities and underrepresented groups in mathematics. She created and organized innovative events like “Re:boot Number Theory”, “A room of one's own” as well as a variety of supporting events in her local community, and has been running two successful iterations of GROW. In addition, she has been organizing many conferences (for example ENFANT & ELEFANT) and three summer schools in Bonn, and was one of the organizers of the HIM trimester program on Harmonic Analysis and Analytic Number Theory.

The Association for Women in Mathematics (AWM) is a non-profit organization founded in 1971. The AWM currently has more than 3500 members representing a broad spectrum of the mathematical community — from the United States and around the world. Since its founding in 1971, the AWM has grown into a leading society for women in the mathematical sciences, and is one of the societies comprising the Conference Board of the Mathematical Sciences. AWM’s programs not only support those who participate in them directly, but also help influence the mathematics culture more generally, so that young women entering the field today encounter an environment in which they can thrive in their mathematical endeavors. AWM wants to promote equitable opportunity and gender-inclusivity, and to increase the presence and visibility of women in the mathematical sciences.

Georg Forster Research Fellowship for Gabriel Deugoue from Cameroon

Gabriel Deugoue from Cameroon has been selected for the Georg Forster Research Fellowship Program for Experienced Researchers of the Alexander von Humboldt Foundation and will be a guest and researcher in Bonn for a total of 15 fellowship months starting in July this year. Gabriel Deugoue is a guest of Sergio Albeverio at the Institute for Applied Mathematics in Bonn. The Alexander von Humboldt Foundation awards Georg Forster Research Fellowships to researchers with outstanding qualifications in all disciplines from developing and emerging countries.

HAUSDORFF EVENTS

“Smooth paths: Academia” – an HSM event for postdocs and PhD students

There will be frequent joint events for postdocs and PhD students as part of the new Hausdorff School for Mathematics (HSM). This summer, we made a first start with the event “Smooth paths: Academia”. The program consisted of a lecture by Carsten Balleier on funding opportunities from the German Research Foundation for early career researchers and a panel discussion with our mathematics professors Lillian Pierce (Bonn Research Chair), Martin Rumpf, Stefan Schwede and Laura Vargas-Koch, in which they gave informal advice on pursuing academic careers in mathematics and answered many questions from the audience.

The event was very well attended with around 60-70 participants and there was a very lively exchange during the subsequent informal get-together in the Plückerraum. The event was organized by our own PhD students Radu Toma and Viktória Klász. Many thanks to both of them! HCM Managing Director Magdalena Balcerak Jackson, who is also responsible for various early career initiatives at HCM, was very pleased:

“It was very exciting to hold the event with two dedicated young mathematicians. We should take the good turnout as an incentive to bring our postdocs and PhD students together much more in future and encourage them to take an active part in organizing events.“

Poster session of the PhD students

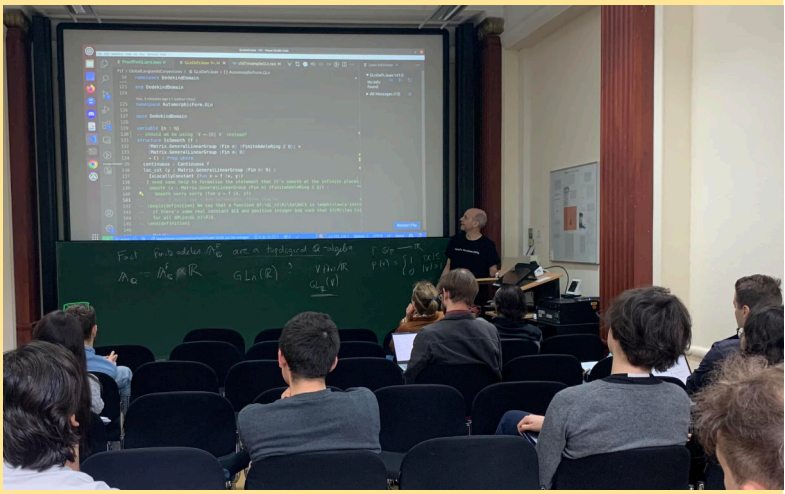
In June, as every year, our PhD students presented their research projects at the BIGS poster session - a broad spectrum ranging from very pure to very applied mathematics.

Women in… Formal Math

On one of the weekends during the trimester program “Prospects of Formal Mathematics”, a joint workshop of “Women in Formal Mathematics” and “Women in EuroProofNet” took place at HIM. Only women were invited as speakers. The aim of the workshop was to highlight the contributions of women in the field of computer-aided proof methods and the formalization of mathematics. In addition, new connections and collaborations were established. The event was organized by Sandra Alves & Valeria de Paiva (Topos Institute).

Lecture by Kevin Buzzard on the formalization of mathematics

Kevin Buzzard, one of the world's leading Lean experts, gave a public lecture on “Teaching mathematics to computers” as part of his research visit to the HIM trimester program “Prospects of Formal Mathematics”. In his lecture he presented how the influence of computers on mathematics has increased: Computers have evolved in mathematical research from being mere “calculators” to important tools in proving theorems. Kevin Buzzard gave a very vivid presentation of the concrete work with the proof assistant Lean and the individual steps of formalization to the lay audience interested in mathematics. He also clearly distinguished the field from topics such as AI language models and machine learning.

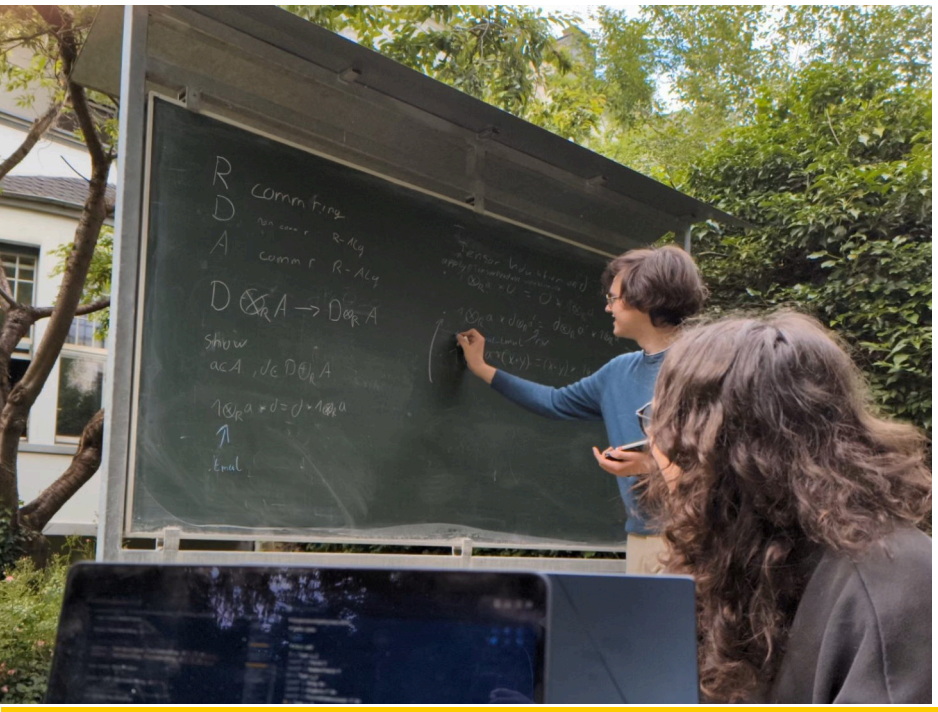


One more time Kevin Buzzard: Informal workshop with math students

Also as a part of the trimester program “Prospects of Formal Mathematics”, Kevin Buzzard conducted a five-day informal workshop together with Bonn math students and participants of the program. The two Bonn math students Ludwig Monnerjahn and Hannah Scholz took part in the workshop and report here from their perspective:

We had both already had experience with the formalization of mathematics in the proof assistant Lean, but the mathematical background of the Langlands program and Fermat's Last Theorem (FLT for short) was completely unknown to us. That's why we were in contact with Kevin days before the start of the workshop to find a suitable topic for us in the context of formalizing Fermat's Last Theorem. In the end, our task was to define a topology on a module that is induced by the underlying topological ring.

This week, each day began with a one-hour lecture in which Kevin roughly explained the underlying mathematics of the proof of FLT and possible difficulties in formalizing it. After lunch, we worked independently on our assigned topic. If we had any questions, we could always go to Kevin’s office, where he would help us and often talk to us for longer about various aspects of Lean and FLT. Through these conversations and the lectures in the morning, we learned a lot of new content both about mathematics in general and specifically about formalization. At the trimester's daily afternoon tea time, we had the opportunity to talk to some other scientists and hear about their projects. This gave us interesting insights into scientific work in the field of formalization. Once we were satisfied with our formalization, we created a pull request to the official Github repository of Kevin's work on FLT and received suggestions for improvement, which we then implemented. This process was repeated several times until Kevin was satisfied with our work. Getting direct feedback from an expert in this way was also very helpful for our other work in Lean.



We are very grateful to have had the chance to officially work on such an interesting research project through this workshop. This week has motivated us a lot to continue working on formalization. So much so that we even spent the following week working with Kevin on other small aspects of FLT.

Mathematical Salon

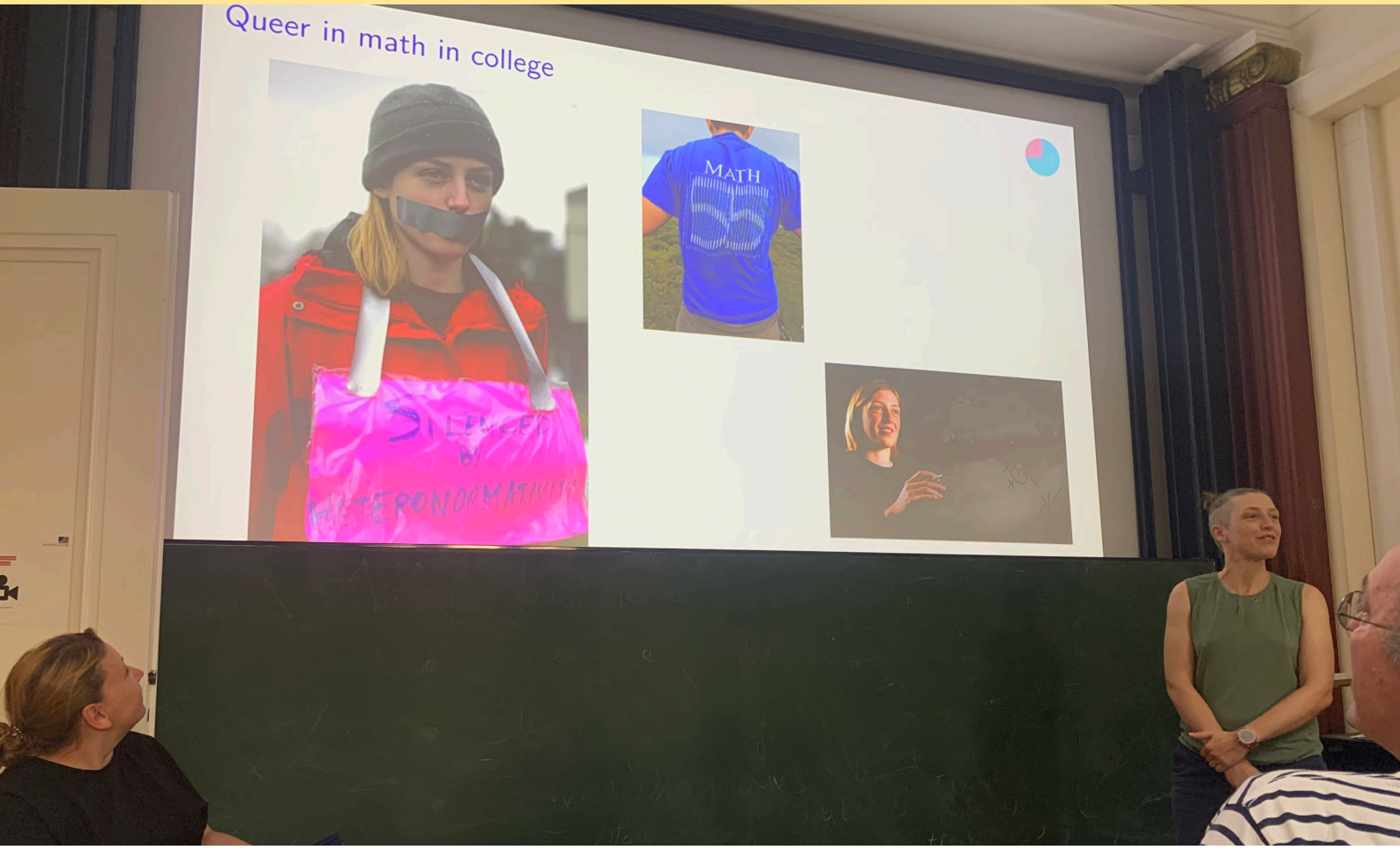
In May, we once again hosted a “Mathematical Salon”. The speaker was Leila Schneps, who works at the Institut de Mathématiques de Jussieu (University of Paris VI) in the field of number theory. She gave a lecture on “Forensic mathematics: when calculations are used in trials”. A lifelong passion for crime fiction was the reason for Leila Schneps to try her hand at writing. This led to a series of “Cambridge Mysteries”, which she published under her pseudonym Catherine Shaw. In 2013, Schneps and her daughter, mathematician Coralie Colmez, published the book “Math on Trial: How Numbers Get Used and Abused in the Courtroom”. In her lecture, she discussed current legal cases from various countries in which mathematical considerations have played a role. She impressively demonstrated how mathematics, especially statistics, can influence the outcome of criminal proceedings, particularly if it is misused or misinterpreted. The lecture was an appeal for more mathematical education. We should not rely too much on our intuition, which often leads us to wrong judgments. The audience felt this when they were involved in the assessment of the cases. The event was musically framed by Yeonsu Nam (oboe) and Lucas Spagnolo (flute), who also played passages from Mozart's “Magic Flute” as a duo.

Science Festival

On July 7, the main focus on the Hofgartenwiese was on two central topics: AI and sustainability. Most of the stands presented hands-on science. The CO_2 footprint could be calculated in a playful way, sustainable materials made from miscanthus could be experienced and even a glazed frame of a beehive clearly showed the hustle and bustle. Tent number 16, in which HCM, together with TRA1 and the Lamarr Institute, presented the topic “Mathematical models, AI and virtual applications”, could be recognized from afar: by the many bright yellow T-shirts worn by all employees – and by the many visitors. On a blackboard, we illustrated how machine learning works in principle by means of a simple linear classification of data: Children could indicate whether they would go to the beach or stay at home given a certain combination of temperature and likelihood of rain. Depending on this, they placed green (“beach“) or orange (“at home“) cards on a simple temperature/rain probability matrix (“training data”). A line was then drawn between the two colors, indicating in which two areas an AI would predict its own decision (“beach” or “at home”) based on previous training. Further combinations (“test data”) were indicated on red cards, which could be used to check how plausible the prediction of the “AI” appeared to be. In the vast majority of cases, the children agreed with the “AI” assessment.

Queer in mathematics – we celebrate Pride Day

A very special event recently took place at HIM: We celebrated diversity in mathematics around Pride Day in Germany, together with Emily Riehl, professor at John Hopkins University, who was a guest of the trimester program “Prospects of formal mathematics”. In her public talk “Queer in math and queering math: in celebration of Pride”, Emily talked very personally about her journey as a queer mathematician and – moderated by Magdalena Balcerak Jackson – discussed with the audience whether an identity as a queer mathematician has an impact on the way one does mathematics. She also reported on Spectra, an association for LGBTQ+ mathematicians. In the mathematical part of her talk, Emily Riehl talked about how you can also think queer within mathematics, for example by embracing the concept of “equality” in mathematics more broadly than it is usually used in everyday life or at school.



Girls‘ Day

The topic of this year's Girls' Day was cryptography. How can information be encrypted? And how can encrypted messages be cracked? The schoolgirls explored these and other questions in two workshops with around 15 participants each, one for grades 5-7, the other for grades 8-10. The girls also gained an insight into possible mathematical careers and exchanged ideas with mathematicians, for example with Elena Dematté, one of our PhD students in Bonn. For the older schoolgirls, the workshop was held bilingually (German and English). The day ended with a visit to the Arithmeum.

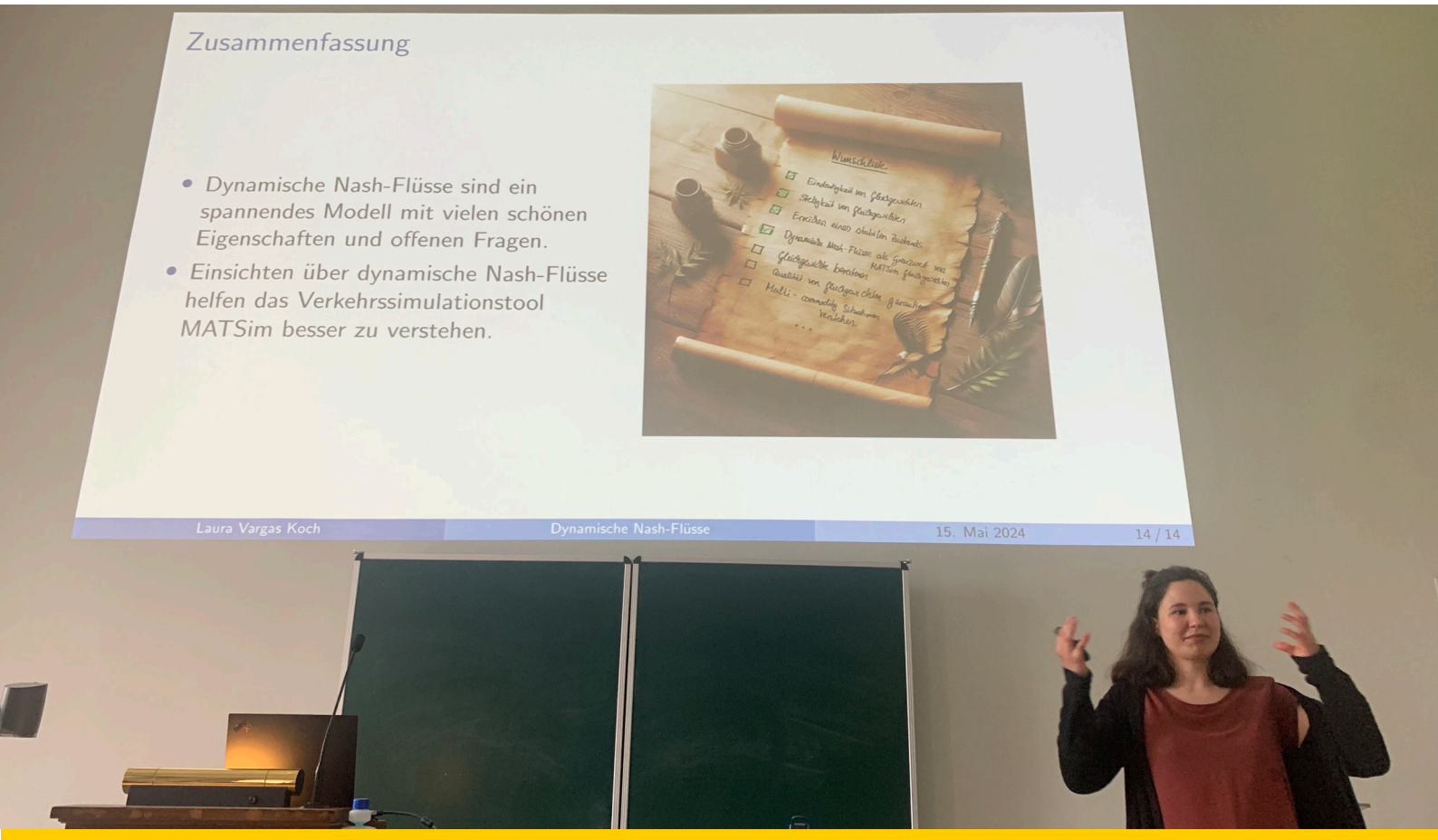
Dies Academicus

Several Bonn math professors gave their inaugural lectures at the Dies Academicus in May, providing basic insights into their research areas:

Our Bonn Junior Fellow **Gregor Gantner** from the Institute for Numerical Simulation gave a presentation on the adaptive finite element method. This is a method for the approximate solution of partial differential equations. In the adaptive approach, the refinements are not chosen homogeneously, but adaptively, i.e. the refinement is increased at the points where the error is estimated to be particularly high. Newer approaches for differential equations in time and space no longer follow this approach from one time step to the next, but consider time as an additional spatial component and choose adaptive methods in this common space-time domain. Particularly good convergence rates are obtained when using designs as finite elements that separate space and time particularly well, e.g. rectangles in the space dimension 1+1D. As the solution in space is often smoother than in time (e.g. in the heat conduction equation), so-called parabolic scalings can then be permitted, in which the length of the rectangles on the time axis is chosen to be significantly smaller (i.e. quadratic) than on the space axis and the polynomial degree in the space dimension is increased. In this way, optimal convergence rates are also obtained empirically for non-smooth solutions, although a general proof of this has yet to be provided.

Floris van Doorn from our new Interdisciplinary Research Unit (IRU) “Formal Mathematics” presented the proof assistant Lean. First, he presented the classical proof of Euclid, in which he showed that there are infinitely many prime numbers. Floris van Doorn then formalized and checked this proof with Lean - live! He also explained how, together with Patrick Massot and Oliver Nash, he formalized the proof of a theorem by Mikhael Leonidovich Gromov (1973) on the homotopy principle, which has a remarkable consequence: It is possible to rotate a sphere uniformly and continuously from the inside to the outside (whereby self-cuts of the sphere's surface are possible) without cutting or tearing it or creating a fold.

In her inaugural lecture, **Laura Vargas Koch** showed how dynamic Nash flows can be used as a very good model for the occurrence of equilibrium states in traffic simulations such as the MATSim software. In contrast to static, classical models, the special feature of dynamic Nash flows is that changes can be modeled over time. Laura Vargas Koch explained that the software is sometimes a kind of black box for typical users and the exact processes are barely understood, especially as stochastic decisions are also implemented. Mathematics helps to better understand the mechanisms and improve the software. If the time steps are reduced, the calculated travel time of the program empirically approaches that of the dynamic Nash flow and fluctuates less. Finally, Laura Vargas Koch presented another exciting property of dynamic Nash flows: They can be viewed as trajectories in a vector field that only move in one direction after a finite time.



HAUSDORFF MIXED

Bonn University ranks second in global math competition – outstanding individual results from our Bonn students

At this year's International Mathematics Competition for University Students (IMC) in Blagoevgrad (Bulgaria), held from August 5 to 11, the Bonn team was ranked second in the unofficial team score, making it the world's second most successful university in the competition behind Saint Petersburg State University. The International Mathematics Competition for University Students has been held annually since 1994. This year, 77 universities and over 400 students from all over the world took part. The team from the University of Bonn, consisting of Lennart Christian Grabbel, Henrik Jasper Schlüter, Boldizsár Mann, Juri Kaganskiy, Samuel Meyer, Cedric Friedrich and Olesia Gaiduk, supervised by Bonn team leaders Yuliya Kryvitskaya and Jiani Shen, also achieved outstanding results in the individual rankings: Lennart Christian Grabbel received a coveted Grand Grand First Prize and was the second-best participant in the field overall. Boldizsár Mann, Henrik Jasper Schlüter and Juri Kaganskiy were among the top 20 students worldwide, and the other participants from Bonn were also awarded prizes.

Almost every year, the team of math students from Bonn is among the top five teams at the IMC in Blagoevgrad. In recent years, many of its current members have represented Germany at the annual International Mathematical Olympiad (IMO) for school students and then decided to study mathematics in Bonn. The Bonn team is supported by the Hausdorff Center for Mathematics (HCM).

European Math Olympiad for Girls: German team wins gold in Georgia

The German team won one gold and two silver medals at the European Girls' Mathematical Olympiad 2024 (EGMO) in Tskaltubo (Georgia). A total of 212 young women from 54 countries took part in the top international tournament for mathematically gifted schoolgirls. As every year, the German team was supported by the HCM and accompanied on site by two PhD students from Bonn, the head of the delegation Susanne Armbruster and the deputy leader Luise Puhlmann.

Both are doing their PhD studies at the Research Institute for Discrete Mathematics in Bonn. Of the four German competitors, Vera Lavrova (18 years old) from the Felix-Klein-Gymnasium in Göttingen achieved the best result and won a gold medal. She will begin her math studies in Bonn in fall this year. Tina Ding (17 years old, Kempten, attends the Landesgymnasium für Hochbegabte in Schwäbisch Gmünd) and Melia Haase (17 years old, Gymnasium Zschopau) each won a silver medal. The young female mathematicians from the German team qualified with outstanding results in the preselection for the 2024 International Mathematical Olympiad.

The HCM in the Düsseldorf state parliament

In June, all Clusters of Excellence including the HCM from North Rhine-Westphalia presented themselves in the Bürgersaal of the Düsseldorf State Parliament. We were joined by the mathematics' Cluster of Excellence from Münster and the other five Clusters of Excellence of the Rheinische Friedrich-Wilhelms University Bonn.

Science Minister Ina Brandes (MKW) visited our presentation and was impressed by the high level of internationality, the excellent promotion of young talents and also the many new appointments of female mathematicians. North Rhine-Westphalia is currently the most successful state in the Excellence Strategy nationwide. Of the 57 clusters of excellence already funded, 14 are located in North Rhine-Westphalia.

FEMO: first prizes for children from the Bonn Math Club

We from the Bonn Maths Club once again organized the spring round of FEMO 2024 in Germany, and the children from the Bonn Maths Club achieved outstanding results. Particularly noteworthy: Emil Gauer (1st grade), Elliot Doy (2nd grade) and Noah Wang (5th grade) were the first three children from the Bonn Math Club to win first prizes. Many thanks to our math students Olesia Gajduk and Ruth Plümer for the great organization and to all the other math students and parents who ensured that everything ran smoothly on site. The FEMO is an international primary school mathematics competition (more precisely: for 1st to 5th grade), which has been organized organized twice a year by the Kazakh Fizmat Academy.

This year, 4,500 children from 18 countries took part in the competition. In Germany, participation is only offered by the Bonn Math Club. Around 50 children from Germany took part, half of them on site in Bonn and the other half - also under our supervision - online. We also have outstanding talents in the Bonn Math Club, four of whom should be highlighted as examples: Leonas Germann scored full score in the Kangaroo competition of the 4th grade. Only 110 fourth-grade children in the whole of Germany achieved this. Even fewer children (19) achieved this in the 5th grade, one of whom is a member of the Bonn Math Club and also won first prize in the state round of the Math Olympiad: Lennard Crncevic. The performance of Elliot Doy, only 8 years old, was also awesome. Not only did he, as mentioned, win one of the very few first prizes at FEMO... no, as a second grader, he won the 3rd grade section at the Pangea competition throughout Germany! And "our" children were also extremely successful in the Math Olympiad. Jonne Adolph, for example, is particularly proud of his full score in the national round of the 4th grade. Congratulations!

News from Bonn Mathematical Society

Mathematical pentathlon

As in previous years, the Bonn Mathematical Society (Bonner Mathematische Gesellschaft; BMG) organized an entertaining evening event on the evening before Corpus Christi. This year's event, entitled “Mathematical Pentathlon”, was a competition with five mathematical disciplines: PowerPoint karaoke, bridge building, quiz, pantomime and family duel. While the bridge-building competition, which involved building the longest possible overhanging bridge out of pieces of wood, required knowledge of the harmonic series or creativity, the pantomime competition required mathematical terms and theorems (e.g. Bolzano-Weierstrass theorem or Georg Cantor theorem). In the family duel, for example, a survey was conducted in advance to find out which Greek letter is the most frequently used in mathematics, and the teams had to guess which answers were mentioned most often. In addition to two teams of students, a team of PhD students and a team of professors also took part in the pentathlon. In the final, in which only the two most successful teams were allowed to compete, a student team (the “Pi-Raten") and the professors‘ team went head-to-head, with the professors’ team coming out on top in the end. As in previous years, an entertaining

moderation was provided by Thoralf Räsch, and the audience was also able to actively take part in the event, for example in the quiz. Of course, the BMG ensured absolute fairness during the competition with the generous support of lawyer Dr. Anneliese Stein (alias Antje Kiesel), the expert par excellence for the regulation for mathematical competitions with entertainment character.

Awarding of the BMG prizes

During the Mathematical Pentathlon, this year's BMG prizes for outstanding bachelor theses in mathematics were awarded by BMG President Rainer Kaenders. Students who have completed their Bachelor's degree by September 30 of the respective year are considered for the award. Two to three prizes are awarded to graduates of a Bachelor's degree in mathematics and one prize is awarded to a graduate of a Bachelor's degree in mathematics teacher training. The prize consists of a certificate and a cash prize. The following students were awarded for outstanding achievements in the academic year 2022/23 with a Bachelor's prize by the BMG:

- Philip McKeever, Bachelor Thesis: „Summen von drei quadratvollen Zahlen“, supervisor: Valentin Blomer
- Paul Paschmanns, Bachelor Thesis: „Single-Source Unsplittable-Flow“, supervisor: Vera Traub
- Anne Weiß, Bachelor Thesis: „Optimale polynomielle Approximation der Brownschen Bewegung“, supervisor: Andreas Eberle
- Julia Rötten, Bachelor Thesis (mathematics teacher training): „Magische Quadrate und Palindrome - Hinter der mathematischen Kulisse der Zauberei aus dem Buch von Ehrhard Behrends am Beispiel von ausgewählten Kapiteln“, supervisor: Thoralf Räsch

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