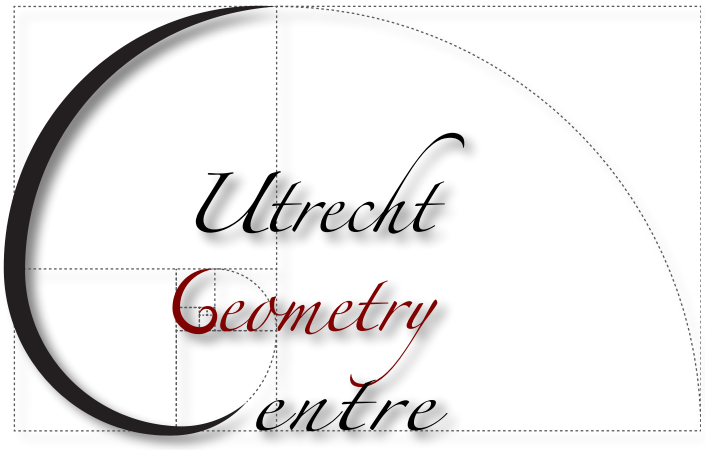

What is UGC?

The 'Utrecht Geometry Centre' ('UGC' for short) is a new programme (masters and PhD track) within the Utrecht Graduate School of Natural Sciences that was set up by geometers at the Mathematical Institute of Utrecht University in 2014 in order to consolidate a long tradition.

We offer a two-year master programme and a four-year PhD programme. As a master student at UGC, you can compose your own dedicated portfolio in geometry (a course sampler is found below). You enrol in an "orientation" seminar, attend two master seminars, and receive training in research proposal writing. As a PhD student at UGC, you are appointed as University employee and, apart from doing research, teach tutorials. You follow a programme of advanced courses, and receive a yearly research allowance for travel and visitors.

Summary of the research programme

The research focus of the Utrecht Geometry Centre is on modern 'Geometry' in its many forms (algebraic, combinatorial and analytic), as well as on the interaction between these sub-disciplines themselves and with neighbouring fields such as logic, number theory and physics. More specifically, we cover arithmetic and algebraic geometry, differential geometry, algebraic topology, and (random) discrete geometry.

Geometry is the theory of space. The history of the subject shows that "space" is a multi-faceted concept; it refers equally well to the phase space of a classical mechanical system, the differential-geometrical space of general relativity or the operator-theoretic space of quantum mechanics from physics, as to the internet as a huge graph of connections or a big relational data base (containing, for example, linguistic or (bio-)chemical data). Rather than the question "What is (physical) space?" we consider the problem "**What are possible concepts of space?**". Mathematics keeps on inventing new such concepts of space, often before their practical applications, and is flexible in seeing geometry where it was not expected at first glance.

Core research themes

(a) Consideration of so-called "moduli spaces". Within this framework, one considers all spaces of a given kind, which allows one to deform one space into another, or classify all possible space structures. These can be as diverse as the (algebraic) moduli space of curves, or the (metric) moduli space of Riemannian manifolds, ranging all the way to

invariants of symplectic or Poisson manifolds.

(b) Consideration of spaces up to very weak equivalences ("homotopies") and geometric concepts in "higher" structures and categories. In this mindset, one can look at spaces through very crude "topological" approximations and relate them to concepts in logic.

(c) The study of spaces having no classical "points", through the study of non-commutative algebras and stacks. These spaces reveal "hidden structure", invisible from considering them as sets of points.

(d) The introduction of aspects of randomness in geometry. From this point of view, one can study the most probable geometric properties of a given kind of space.

Surprisingly, (a) connects to theoretical physics (most notably, classical physics, quantization, string theory, quantum gravity and other high energy physics), and was used more recently in counting numbers of RNA-complexes in biochemistry; (b) is relevant for computer security and the theory of formal languages (through type theory) on the one hand, and quantum field theory on the other hand, (c) relates to quantum statistical mechanics, quantum gravity and number theory, and (d) is relevant for the study of large discrete sets of data (forensic, DNA, …).

Our researchers connect these recent trends in geometry and build bridges, by studying, for example, random curves, representations-up-to-homotopy, by inventing new structures in moduli spaces based on number theory and by relating invariants of geometric structures to differential equations.

The Utrecht Geometry Centre offers state-of-the-art education and research in these areas in an international environment with frequent visitors and a lively discussion climate. It consistently receives the highest evaluation scores in research quality assessments. We offer the most elaborate and broad geometry education in The Netherlands, combining the best of national teaching and research infrastructure with a wealth of engaging local research activities and seminars.

The school's detailed mission and long-term strategy

The Utrecht Geometry Centre aims to cover a spectrum of modern 'Geometry' as broad as possible and to nurture its different components, as well their interaction with neighbouring fields such as logic, number theory and physics. This broadly cast spectrum permeates all of its activities, from undergraduate education to core research, and in its policy of appointing research and teaching staff. The Centre considers the maintenance f its breadth and depth in both research and education of vital importance.

`Geometry' originates from the formalisation of measurement, and is thus at the basis of most of the sciences. After the development of Greek axiomatic geometry and Cartesian coordinate geometry, which incorporated aspects of logical reasoning and algebra, modern geometry started in the 19th century with the advent of algebraic geometry, differential geometry, and topology. 20th century geometry, partly inspired by physics and computer science, has added to this diverse palette the study of spaces by (non-commutative) algebras, "spaces of spaces", and structures from category theory, and has introduced an element of randomness.

Geometry has often preceded (modern) applications: for example, GPS-technology uses differential geometry and discrete geometric optimisation; cryptographic protocols increasingly use ideas from arithmetic geometry, and search algorithms use linear spaces. Geometry has always been intricately linked with theoretical physics, and the advent of quantum mechanics (and later quantum field theory, string theory and quantum gravity) has only fortified these bonds. On the other hand, the more recent theoretical study of the structure of data involves more and more geometry such as (random) discrete structures, but also approximation of big data sets by manifolds. The Centre fosters awareness of all these possibilities in its education and research.

The Centre covers algebraic and analytic aspects of geometry; more specifically: arithmetic and algebraic geometry over various fields, as well as complex, symplectic and differential geometry, algebraic topology, and (random) discrete geometry.

At a national level, the programme coordinates the NWO-research cluster “Geometry and Quantum Theory” (with hubs at UvA and RU and further involving researchers from UL, RuG and VU).

Utrecht has a very strong tradition in algebra, geometry and related fields (algebraic and arithmetic geometry, algebraic groups, commutative algebra and K-theory, number theory, singularities, logic), especially in viewing the subdisciplines as parts of a larger continuous spectrum of geometry. The origins of this tradition go back to the presence of Freudenthal at UU, and in the past, the Centre has engaged such prominent scientists as Duistermaat, Looijenga, Moerdijk, Oort, Springer and Zagier and provided extended visiting professorships to Arnold, Borel, and MacPherson.

Its tradition is to foster interaction rather than subdivision. This explains perhaps why the distribution of specific expertise over programme members may evolve with time. On top of that there are shifts in emphasis over the years, in some cases under the influence of newly appointed faculty or postdocs. This ensures that our research stays mainstream and up-to-date.

The school’s detailed core research programme

The research programme of the school centres upon the invention, development and study of abstract geometric structures as overarching theories for other sciences, enabling the portation of geometric thinking and reasoning to areas where they were hitherto unexpected and unveiled.

In this section, we explain our current research agenda in more technical terms. Our main research challenges for the near future lie in the following directions:

- In **algebraic geometry**, the study of moduli spaces by diverse new methods:
    - o the study of the cohomology of the moduli space of curves by automorphic forms, including new theories of automorphic forms and links to the Langlands programme;
    - o the study of “random” structures in the theory of stable reduction (=analytical boundaries of moduli spaces of curves), such as curves with a random reduction graph;
    - o the computation and study of numerical invariants relating to curve counting, and their connection with integrable systems and mathematical physics;
    - o the study of moduli spaces of sheaves in relation to string theory;

o applications of geometry to number theory, in particular: applications of geometric class field theory and the Langlands programme to point counting;
o the study of combinatorial structures underlying the theory of generalized hypergeometric functions as inverse period maps;
o the study of geometric structures in homotopy type theory (in relation to the univalent foundations project).

- In **differential geometry**, the development of theories of existence and classification of geometric structures, both more classical (metric, foliated, non-commutative or symplectic) and new (contact, Poisson or generalised-complex):

o answering global questions in Poisson geometry: construction of invariants for Poisson structures (e.g., analogues of GW- and SW-invariants), (topological) obstructions to their existence;
o the application of symplectic and Poisson geometric methods to partial differential equations and dynamical systems and vice versa;
o the development of normal forms and surgery operations in Poisson geometry and in generalized complex geometry, with applications to string theory;
o the development of a metric theory of non-commutative Riemannian geometry;
o the study of general semisimple symmetric spaces;
o the development of geometric structures underlying the theory of topological modular forms, with applications to quantum field theory.

The subdivision into individual questions is a bit artificial and many of them interrelate, also between the more “algebraic” and the more “differential” geometric areas.

The participating scientists

Prof dr GLM (Gunther) Cornelissen (1971) holds the **Chair in Geometry and Number Theory.** He received his PhD from Gent (B) in 1997. After that, he spent four years as researcher at the Max-Planck Institute in Bonn (D), before joining Utrecht University, first as lecturer, and since 2007 as full professor. He held (>1 month) visiting positions at Caltech, the Hausdorff Institute Bonn, and the Universities of Leuven, Saarbrucken and Warwick. He published 36 scientific papers (≈600pp). He supervised 4 postdocs, 7 PhD students and 15 master students. He received an FWO-pre-doctoral grant; FWO-post-doctoral grant (x2); Visiting researcher grant (MPIM); NWO-VIDI; NWO-VICI; ESF-network grant “ITGP” and a GQT-PhD-grant. His total grant income is about 2.7 M€ (of which about 600k€ in collective grants). He is member of the Royal Holland Society of Sciences and Humanities (KHMW) and was elected 21st Charles R. DePrima lecturer at Caltech, and Arbeitstagung, Joint New York Number Theory Seminar and Clay Mathematics Institute speaker. He serves as (founding) director of the national research school in mathematics (WONDER), and was board member of the steering committee of the ESF-network ITGP and of the GQT-research cluster and vice-chair of the national committee on mathematics research (PWN-OC). He organised more than 30 research events (seminars, workshops, conferences and high school teacher training). His research spans arithmetic geometry, algebraic geometry, logic, non-commutative geometry and mathematical physics. He studied automorphic forms for function fields, orbifolds in non-archimedean geometry, equivariant deformation theory of curves, undecidability and rational points, applications of

noncommutative geometry and differential geometry to number theory and applications of number theory in physics.

Prof dr MN (Marius) Crainic (1973) holds the **Chair in Differential Geometry**. He received his PhD from Utrecht in 2000. He was Miller Fellow at Berkeley in 2001-2002 and KNAW Fellow at Utrecht until 2007, after which he was tenured lecturer and senior lecturer, before becoming full professor in 2012. He held visiting positions (>1 month) at Clermont-Ferrand and the Institut Henri Poincaré (Paris). He has published 34 research papers (≈1000pp). He supervised 10 post-docs and 8 PhD students. His major grants include a KNAW-Fellowship; NWO-VIDI; ERC-Starting Grant; NWO-VICI; NWO-VC (x4) and a GQT-PhD grant; the total grant income is ca. 4.7 M€. He received the 2008 André Lichnerowicz Prize for contributions to Poisson Geometry, was five-fold speaker at ESI Wien, delivered six invited talks at the Poisson conferences and four at "Higher Structures". He was invited twice to MSRI Berkeley and seven times to MF Oberwolfach. He is Director of the national research cluster GQT in Geometry and Quantum Theory and was coordinator of the "MRI Master Class" (the former graduate programme of the former research school MRI). He is coordinator for the Mathematics Olympiad for Utrecht. He has organised more than 10 major conferences and was on the Scientific Committee for Poisson 2010, 2012, 2014. He serves on the editorial board of Mathematica and Indagationes Mathematicæ. His research interests span Differential Geometry and Non-commutative Geometry, in particular, Poisson Geometry. He has studied cyclic homology, foliations, groupoids, rigidity in Poisson geometry, introduced Poisson Topology and representations-up-to-homotopy. He gave the first integrability conditions and geometric proofs for linearisation theorems for Poisson manifolds.

Prof dr CF (Carel) Faber (1962) holds the **Chair in Algebraic Geometry**. He received his PhD in 1988 from Amsterdam (UvA). He was L.E. Dickson Instructor at the University of Chicago (USA), KNAW-Fellow at UvA Amsterdam and professor at KTH Royal Institute of Technology, Stockholm (S) and Johns Hopkins University, Baltimore (USA), before joining Utrecht Universty in 2013. He held visiting positions (>1 month) at the Max-Planck-Institut in Bonn (D), the Institut Mittag-Leffler (S) and Princeton University (USA). Together with Ekedahl he organized a year-long programme at the Institut Mittag-Leffler. He also received three Oberwolfach Research in Pairs opportunities. He wrote 31 research papers (≈750pp). He has supervised 4 post-docs and 6 PhD students. His major grants include two NWO projects; NSF-grants; four VR (Swedish NSF) grants; and a collaborative grant from the K&A Wallenberg Foundation. His total grant income is ca. 5.5 M€ (of which about 3M€ in collective grants). He is a member of the Royal Swedish Academy of Sciences, the KNAW, and winner of the 2007 Göran Gustafsson Prize. He was also Research Member of MSRI Berkeley and foreign fellow of the GQT-research cluster, and was elected Arbeitstagung and Abel Prize Symposium speaker. He is editor of Arkiv för Matematik and associate editor of the American Journal of Mathematics and served as Director of Graduate Studies at the Department of Mathematics and Member of the Appointments Committee of the School of Science of KTH. He is member of the board of the GQT research cluster and organised more than 10 research events (seminars, workshops, conferences). His research is in algebraic geometry. He studies the moduli space of curves, more specifically, its tautological ring. He has computed the Chow ring of some moduli spaces and studied relations with Gromov-Witten theory and with the theory of automorphic forms.

Prof dr EP (Erik) van den Ban (1956) holds the **Chair in Lie Theory**. He received his PhD in 1982 from Utrecht. He was a Member of the Institute for Advanced Study, Princeton (USA) and held visiting positions at Berkeley, Copenhagen, the Max-Planck Institute and the Mittag-Leffler Institute. He has published 37 research articles (≈1500pp). He has supervised one post-doc and 6 PhD students. He is an editor of the Transactions and the Memoirs of the American Mathematical Society, and of Indagationes Mathematicæ. He was director of GQT and is currently Head of the Department of Mathematics at Utrecht University. His research interest is in analysis on symmetric spaces, where he has proven some fundamental results, such as the Plancherel formula and Paley-Wiener theorems.

Prof dr F (Frits) Beukers (1953) holds the **Chair in Number Theory**. He received his PhD in 1979 from Leiden. He was a member of the Institute for Advanced Study, Princeton (USA) and worked in Leiden before joining Utrecht. He was a distinguished visitor at PIMS. He has written more than 60 research papers (≈900pp). He has supervised 9 PhD students and around 50 master students. He is editor of Indagationes Mathematicæ, the International Journal of Number Theory and Epsilon Uitgaven. His research interest is in arithmetic geometry around transcendence, Diophantine equations and (generalised) hypergeometric functions. He gave a new proof of the irrationality of $\zeta(3)$ and computed the monodromy of hypergeometric functions.

Dr GR (Gil) Cavalcanti (1977) received his PhD from Oxford in 2004. He has written over 20 research papers (≈460pp). He is currently supervising 3 PhD students and has supervised 6 master students in the past. He received an EPSRC postdoctoral scholarship, a Junior Research Fellowship at Jesus College Oxford, a Marie-Curie Grant, NWO-VENI and NWO-VIDI (total grant income ca. 1.7 M€). His research interests are in generalised complex geometry (following Hitchin), Poisson geometry, symplectic topology, Kähler geometry and Hodge theory as well as the relations between these mathematical objects and string theory.

Dr AG (André) Henriques (1977) received his PhD in 2005 from MIT. Before coming to Utrecht, he worked in Münster (D). He held longer visiting positions at Berkeley and Oxford. He has written about 20 research papers (≈500pp). He is currently supervising 2 PhD students and has supervised 8 master students. He received funding from SFB Münster, NSF and GQT and is a recipient of the Charles B. Morrey prize. He initiated the Talbot graduate workshops in algebraic topology and taught in high school. He is a member of the Education Committee. His research interests include mathematical quantum field theory, algebraic topology, topological modular forms, and von Neumann algebras. He is engaged in a long-term project (with Bartels and Douglas) to provide a geometric structure underlying elliptic cohomology.

Dr M (Martijn) Kool (1981) received his PhD from Oxford in 2010. He worked at Imperial College London and University of British Columbia (Vancouver) and will be joining Utrecht in Januari 2015. He held scholarships from EPSRC, Lincoln College Oxford, BIGS (Bonn) and PIMS. He has written 8 research papers to date (≈270pp.). His research interest is in algebraic geometry, specifically, moduli spaces of bundles and invariants counting curves on surfaces. He organised the Geometry and Physics Seminar in Vancouver.

Dr JW (Johan) van de Leur (1958) received his PhD from Utrecht in 1986. Before coming to Utrecht, he was lecturer at MIT and had FOM and NWO post-doc positions at Twente. He was KNAW fellow and held a visiting professorship at Lund University. He has written about 50

research papers (≈1300pp.). He is director of the Master Programme in Mathematical Sciences at Utrecht and member of the Faculty Board of Sciences. His research interests are in Lie (super)algebras, solitons and integrable systems, with applications to mathematical physics.

Dr T (Tobias) Müller (1973) received his PhD from Oxford in 2007. He worked in Eindhoven, Tel Aviv and at CWI (Amsterdam) before joining Utrecht. He is currently supervising one PhD student. He received a Marie Curie Early Stage Researcher grant, a VENI grant from NWO and declined a "Project grant junior researcher" from the Swedish research council. He received an EPSRC award and scholarships from Prins Bernhard Cultuurfonds, Dr. Hendrik Muller's Vaderlandsch Fonds and Bekker-la-Bastide. He has written about 30 research papers (≈700pp.) in combinatorics, probability, percolation, discrete geometry including various flavours of random geometry. He organised seven workshops.

Dr J (Jaap) van Oosten (1957) studied Dutch Language and Literature and Mathematics at the University of Amsterdam, where he received his PhD in 1991. He worked in Parma, Utrecht, Amsterdam and Aarhus. He has written one book (≈300pp) and about 25 research papers (≈400pp). He has supervised two PhD students. His current research interest is in Realizability, Models of Constructive Set Theories and Homotopy Type Theory. He is the secretary of the Examination Board in Mathematics.

Dr FJ (Fabian) Ziltener (1977) received his Ph.D. from ETH Zurich in 2006. Subsequently he worked at LMU (München), University of Toronto and KIAS, the Korea Institute for Advanced Study. He was supported by grants from the Swiss National Science Foundation and received the "award of excellence" from KIAS in 2012. He has written about 10 research papers (≈300pp). His research interest is in symplectic geometry.