Detailed academic CV

Rebecca Anne Hedwig Waldecker,
born 9th April 1979 in Aachen.

Contents

Personal details

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Academic positions

- Since October 2009 a junior professor for groups and geometries at the University of Halle (Germany). Successfully evaluated in summer 2012.
- May 2007 – September 2009 Research Fellow at the University of Birmingham, funded by the Leverhulme Trust, on a grant with Paul Flavell.
- January – April 2007 Honorary Lecturer at the University of Birmingham, School of Mathematics.

Education and qualification

- Habilitation in summer 2013 (finished on 28th June), official ceremony 10th January 2014.

  Title of thesis: "Local arguments for Glauberman's Z*-Theorem".
- PhD in April 2007, at the Christian-Albrechts-Universität zu Kiel (Germany).

  Submission of PhD thesis in December 2006, title: " Isolierte Involutionen in endlichen Gruppen" (Isolated involutions in finite groups).

  PhD defence in January 2007, passed with distinction.

  Grade: 1 (highest).
- 2003 – 2006 PhD student at the Christian-Albrechts-Universität zu Kiel.
- Diplom (undergraduate degree) in Mathematics, Econometrics and Statistics in July 2003, at the Christian-Albrechts-Universität zu Kiel.

  Title of the Diplom thesis: "Über verallgemeinerte Fitting-π-Untergruppen in endlichen Gruppen" (Generalised Fitting-π-subgroups in finite groups).

  Grade: 1 (highest).
- 1998 – 2003 Undergraduate student at the Christian-Albrechts-Universität zu Kiel.
- Abitur (A-levels) in June 1998, with distinction.
- School: 1989 – 1998 Kiel, 1986 – 1989 Schönberg, 1985 – 1986 Aachen.

Publications

Most of my publications are linked from the website
http://conway1.mathematik.uni-halle.de/∼waldecker/research.html.

Research articles in journals or books:

[1] *Isolated involutions in finite groups*, Memoirs of the American Mathematical Society, Volume 226, Number 1061 (2013).

[2] *A note on groups in which the centraliser of every element of order 5 is a 5-group*, with Sarah Astill and Chris Parker. Siberian Mathematics Journal **53**, no. 5 (2012), 967–977. (Russian)
There is an English version linked from my webpage.

[3] *Isolierte Involutionen in endlichen Gruppen* (Isolated involutions in finite groups), book based on my PhD thesis. Südwestdeutscher Verlag für Hochschulschriften (2012).

[4] *Special primitive pairs in finite groups.*
Archiv der Mathematik **97**, No. 1 (2011), 11–16.
Erratum in Archiv der Mathematik **98**, No. 5 (2012), 413–414.

[5] *Isolated involutions whose centraliser is soluble.*
Journal of Algebra **321** (2009), 1561-1592.

[6] *A theorem about coprime action.*
Journal of Algebra **320** (2008), 2027–2030.

Articles in Conference Proceedings:

[7] *Soluble Radicals.* Oberwolfach Report No. 20/2008.

Books:

[8] *Primality testing for beginners*, English version of the book [10] below, with Lasse Rempe-Gillen. To appear in the series *Student Mathematical Library* of the American Mathematical Society.

[9] Contribution "Wo Symmetrie ist, da ist eine Gruppe nicht weit" (Where there is symmetry, a group is not far) to the book *Facettenreiche Mathematik – Einblicke in die moderne mathematische Forschung* (Multifarious mathematics) edited by Katrin Wendland und Annette Werner. Vieweg+Teubner (2011).

[10] *Primzahltests für Einsteiger – Einführung in ein Gebiet zwischen Zahlentheorie, Algorithmik und Kryptographie für Schule und Studium* (Primality testing for beginners), with Lasse Rempe. Vieweg+Teubner (2009).

Other publications:

[11] *Local Arguments for Glauberman's Z*-Theorem*, habilitation thesis.

[12] "Und was studierst du?" (And what is it that you are studying?) Contribution to the annual booklet of the Georg-Cantor-Vereinigung (2010).

Submitted papers:

[13] *Transitive permutation groups where nontrivial elements have at most two fixed points*, with Kay Magaard (Birmingham), 40 pages. Submitted to the Journal of Pure and Applied Algebra.
This is the first paper in a series of articles where we classify specific permutation groups. This project is supported by the DFG.

[14] *Finite simple $3'$-groups are cyclic or Suzuki groups*, 11 pages, with Imke Toborg (Halle). Submitted to Archiv der Mathematik.

[15] *M_9-free groups*, with Juliane Pölzing (Halle), 24 pages. Submitted to the Journal of Group Theory.

Manuscripts:

[16] *Transitive permutation groups with trivial four point stabilizers*, with Kay Magaard, 64 pages. To be submitted to the Journal of Pure and Applied Algebra.
This is the continuation of our work in [13], again supported by the DFG.

[17] *Simple permutation groups with trivial three point stabilisers*, in preparation. This work is related to the topic of the DFG-project.

[18] *Quadratic 3-elements and special primitive pairs*, with Chris Parker. In preparation.

Grants and prizes

- 2012: Award for the best talk at the EWM Conference in Bielefeld.
- 2008: "Head of School's Prize for Excellence in Teaching" (University of Birmingham).
- 2003 – 2006: PhD funding (grant) from the Studienstiftung des deutschen Volkes.
- 2002: Grant from the Studienstiftung des deutschen Volkes (not used) and from the DAAD (German Academic Exchange Service) for a research visit at the Institute "Henri Poincaré" in Paris for two month, during the preparation of my diploma thesis.
- 1998 – 2003: Funding from the Studienstiftung des deutschen Volkes as an undergraduate student.

Financial funding

- 2013/14

  More financial funding from the DFG (German Research Council) for the continuation of the project on permutations groups during the year 2014 (joint work with Kay Magaard).

- 2013

  Financial funding from the Georg-Cantor-Vereinigung to support the stay of my colleague Mario Mainardis in Halle (September 2013).

- 2012/13

  Financial funding from the DFG (German Research Council) supporting the collaboration with Kay Magaard, for the year 2013.

- 2012

  Financial funding from the Georg-Cantor-Vereinigung to support a conference organised with Ralf Köhl (Gießen) at 23rd and 24th March 2012 in Halle.

- 2011

  DFG-Mercator-Professorship for six months for Chris Parker (Birmingham), application together with Gernot Stroth.

- since 2010

  Financial funding from the faculty to support the visits of Ulrich Meierfrankenfeld and Kay Magaard as guest professors (for one month), application together with Gernot Stroth.

- 2010 to 2013

  Annual special funding supporting my PhD student Imke Toborg.

- 2010

  Financial funding from the Georg-Cantor-Vereinigung and the "Vereinigung der Freunde und Förderer der MLU Halle-Wittenberg" to support the Northern German Group Theory Colloquium 2010 in Halle.

- 2007

  Financial funding from the London Mathematical Society for a conference celebrating Rob Curtis' 60th birthday (University of Birmingham), organised together with Simon Goodwin, Corneliu Hoffman and Chris Parker.

Selected talks

- Nikolaus Conference, RWTH Aachen, 6th December 2013: "Permutation groups where non-trivial elements have few fixed points".
- Pure Mathematics Colloquium, University of Hamburg, 19th November 2013: "Permutation Groups".
- Algebra Seminar, University of Birmingham, 28th February 2013: "Permutation groups where non-trivial elements have few fixed points".
- „Women leading in Mathematics", University of Birmingham, 27th February 2013: "Permutation Groups".
- EWM Conference in Bielefeld, 1st November 2012: "Permutation groups where non-trivial elements have few fixed points".
- Banff International Research Station (Canada), "Groups and Geometries" meeting, 4th September 2012: "Special primitive pairs in finite groups".
- TU Braunschweig, Northern German Group Theory Colloquium, 30th June 2012: "C55-Gruppen".
- EPFL Lausanne, 8th November 2011: "The Z*-Project".
- University of Aberdeen, Postgraduate Group Theory Conference, 25th June 2011: "Local arguments for the Z*-Theorem".
- TU Braunschweig, Baer-Colloquium, 28th May 2011: "Das Z_p^*-Projekt".
- Research Institute for Mathematical Sciences, Kyoto University, 9th March 2011: "The Z_p^*-Project".
- Tokyo University of Science, 6th March 2011: "Local arguments for the Z*-Theorem".
- FU Berlin, 15th September 2010: "Eine neue Sichtweise auf den Z*-Satz".
- Colloquium in celebration of B. Baumann, University of Gießen, 9th July 2010: "Eine neue Sichtweise auf den Z*-Satz: der nicht-auflösbare Fall".

- "Women in Mathematics" Seminar, University of Birmingham, 23rd March 2010: "On Burnside's p^aq^b-Theorem".
- University of Jena, 20th August 2009: "Sätze vom Z_p^*-Typ".
- University of Halle, 29th July 2009: "Auflösbare Radikale".
- University of Halle, 17th February 2009:"Sätze vom Z_p^*-Typ".
- Northern German Group Theory Colloquium in Kiel (Germany), 18th-19th July 2008: "Glauberman's Z*-Theorem".
- Groups and Geometries Meeting in Oberwolfach, 20th-26th April 2008: "Soluble Radicals".
- Group Theory Seminar at the Christian-Albrechts-Universität zu Kiel, 15th April 2008: "Auflösbare Radikale".
- George Glauberman Conference in Chicago, 24th-28th March 2008: "A local approach to Glauberman's Z*-Theorem".
- Pure Mathematics Colloquium at the University of Southampton, 22nd February 2008: "Glauberman's Z*-Theorem and the special role of elements of order 2".
- Northern German Group Theory Colloquium in Magdeburg, 9th-10th November 2007: "Isolated involutions in finite groups".
- Group Theory Seminar at the Christian-Albrechts-Universität zu Kiel, 6th November 2007: "Elements of order p acting quadratically".
- Algebra Seminar at the University of Aberdeen, 25th October 2007: "A local approach to Glauberman's Z*-Theorem".
- Algebra Seminar at the University of Manchester, 15th May 2007: "Isolated involutions in finite groups".
- Algebra Seminar at the TU Kaiserslautern, 24th April 2007: "Isolierte Involutionen in endlichen Gruppen".
- Algebra Seminar at the University of Birmingham, 31st January 2007: "Isolated involutions in finite groups".

Workshops and conferences

The next conference "Grüppchen" for young group theorists will be in Halle on 7th and 8th March 2014, organised by Ralf Köhl (Gießen) and me. On 10th and 11th October 2014 there will be a Colloquium for Gernot Stroth's 65th birthday at the University of Halle, organised by me (with Barbara Baumeister).

- Nikolaus Conference, 6th-8th December 2013 (Aachen).
- "The Mathematics of John Thompson", Conference for J. G. Thompson's 80th birthday, 9th-11th September 2013 (Cambridge, UK).
- EWM Conference, German Chapter, 1st-2nd November (Bielefeld).
- Conference for Z. Janko's 80th birthday, organised with Gernot Stroth, 19th October 2012 (Halle).
- "Groups and Geometries" meeting, 3rd-7th September 2012 (Banff).
- Conference for young group theorists "Das Grüppchen", organised with Ralf Köhl, 23rd-24th March 2012 (Halle).
- "Groups 2012", conference in celebration of Bernd Fischer's 75th birthday, 12th-16th March 2012 (Bielefeld).
- Workshop on geometric presentations of finite and infinite groups, 17th-23rd July 2011 (Birmingham).
- Baer-Colloquium, 28th May 2011 (Braunschweig).
- Joint seminar for young group theorists, organised with Ralf Köhl, 18th March 2011 (TU Darmstadt).
- RIMS Joint Research on Algebraic Coding Theory, Combinatorial Designs and Related Areas, 7th-9th March 2011 (Kyoto).
- Colloquium in celebration of Bernd Baumann, 9th July 2010 (Gießen).
- Summer School on Finite Simple Groups and Algebraic Groups, Berlin, 31st August – 10th September 2009.
- Groups and Geometries Meeting in Oberwolfach, 20th-26th April 2008.
- Conference on the local and global analysis of groups and related objects, in honor of George Glauberman, Chicago, 24th-28th March 2008.

- Conference on Groups and Symmetries for Rob Curtis' 60th birthday, Birmingham, 20th-22nd September 2007.
- Summer School on Fusion Systems, Birmingham, 30th July – 3rd August 2007.
- London Mathematical Society Triangle Meetings in autumn 2005 and in the years 2007, 2008, 2009.
- Summer School on Finite Groups and Related Geometrical Structures (Italy) 2004, 2005, 2006, 2007, 2008, 2010, 2011, 2013.
- Northern German Group Theory Colloquium 2002, 2003, 2004, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013.

Refereeing, organisation and outreach activities

I am a referee for *Archiv der Mathematik*, for the *Indian Journal of Pure and Applied Mathematics*, the *Journal of Algebra*, the *Journal of Group Theory*, the *Munster Journal of Mathematics* and the *Journal of Pure and Applied Algebra*, and I write reviews for the *American Mathematical Society*.

At the moment I am a member of the Georg-Cantor-Vereinigung, of the "Vereinigung der Freunde und Förderer des Mathematischen Seminars der CAU Kiel" and of the "Vereinigung der Freunde und Förderer der MLU Halle-Wittenberg", moreover of the DHV and of "European Women in Mathematics". I work in the university research award committee (for a number of different awards) and a gender equality committee. In 2012 I have been appointed a liaison professor for those students who hold a grant from the Studienstiftung des deutschen Volkes.

In 2011 I initiated an annual meeting for young group theorists that is designed to bring undergraduate and postgraduate students together who work in different areas of group theory. They are invited to give talks on their research topics and hence they gain experience in speaking about their own research in front of a friendly audience. We established feedback routines to improve everyone's speaker's skills and a social dinner simplifies bonding and networking. These meetings are organised by Ralf Köhl (Gießen) and me.

I frequently participate in outreach activities of my university (or, by invitation, elsewhere) like the "Girls' Day" to attract new students (particularly female students), the "Long Night of Science" for a public audience and master classes for school students.

Research interests

Most of my research comes from questions about the structure of finite groups. I am particularly interested in so-called local methods and results related to the Classification of Finite Simple Groups (CFSG) and in applications of group theoretic results. Therefore a part of my work is dedicated to refining and extending existing methods as well as developing new techniques in abstract group theory. An increasing amount of time goes into answering questions from other mathematical areas that can be translated into group theoretic problems and then solved.
In what follows I give an overview over my current plans.

1. Permutation groups where every non-trivial element has at most four fixed points

The automorphism group G of a compact Riemann surface X of genus at least 2 is finite, as we know from Hurwitz's Theorem. There even is a bound on its size that depends only on the genus of the surface. Hence some questions from complex analysis or algebraic geometry can be asked in the language of finite group theory.
For example Schoeneberg proves that, for all non-trivial automorphisms $g \in G$ that have at least five fixed points on X, all these fixed points are Weierstrass points. This means that, as soon as G possesses non-trivial elements with at least five fixed points, we have a tool to find Weierstrass points of X. But what happens if G has no such elements?
In the language of group theory:

Classify the finite permutation groups where every non-trivial element has at most four fixed points!

In my most recent project Kay Magaard and I are working on the above problem. We begin with a finite group G that acts faithfully and transitively on a set Ω. First we suppose that every non-trivial element in G has at most two fixed points on Ω. Excluding regular action and the special case of Frobenius groups, we suppose that G actually possesses an element with exactly two fixed points. In our analysis of this situation, we come across some series of finite simple groups, for example $\mathrm{PSL}_2(q)$ and $\mathrm{PSU}_3(q)$ in both odd and even characteristic, $\mathrm{PSL}_3(q)$ in odd characteristic and the Suzuki groups. Of these series, only the two-dimensional groups and the Suzuki groups provide series of examples and we classified all possibilities for G and

Ω. Starting with a tentative list, we show that a minimal counter-example is simple and then, by applying the Classification of Finite Simple Groups, we are able to show that our list is complete and that all simple examples are classified. This work has already been submitted (JPAA, see [13]).
At the moment I am working on a classification-free proof that the only simple groups that occur are $\mathrm{PSL}_2(q)$, the Suzuki groups and $\mathrm{PSL}_3(4)$ (see [17]).

This work was supported by the DFG, and it will still be supported in 2014.
Currently we are finalising our manuscript for the case where at most three fixed points are allowed in order to submit it to the JPAA (see [16]).
In 2014 we will attack the last remaining case with at most four fixed points and hence finish the first large part of this project.

2. Elements of order 3 acting quadratically

This problem originates in Paul Flavell's paper *An equivariant anlogue of Glauberman's ZJ-Theorem* and has lead Chris Parker and me to the following question:

Let G be a finite group that acts faithfully on a finite dimensional vector space V over a finite field of characteristic 3. Suppose that there exist a 2-local subgroup L of G and a 3-element $a \in G$ such that $a \in O_3(L)$, but $a \notin O_3(G)$. What can we say about G and its action on V if a acts quadratically on V?

Let $\mathcal{A}$ denote the set of quadratic elements of $O_3(L)$ and let $G_0 := \langle \mathcal{A}^G \rangle$.

Conjecture: *$G_0/O_3(G_0)$ is a non-empty central product of quasi-simple groups with centre of order 2. Modulo their centre, these quasi-simple groups are isomorphic to alternating groups of odd degree.*

We have been working on a proof of this conjecture for quite some time, without appealing to the Classification of Finite Simple Groups, and it seems to us that the problem is really hard. There are some results available, based on the CFSG, for example by Andrew Chermak, that show that our conjecture is in fact true, so working out the details of these arguments is the path that I am following at the moment. The results should lead to a generalisation of one of the main results in Flavell's article and also to a generalisation of my theorems in the paper *Special primitive pairs in finite groups*, see [4], but there are still some technical details to look at before this work can be published. (See [18].)

3. Subgroup lattices

In her diploma thesis, my PhD student Imke Toborg had been working on questions about subgroup lattices of finite groups. Together with her supervisor Roland Schmidt and her colleague Siyka Andreeva (Kiel), she worked on classification results for finite groups that do not contain a specific lattice in their subgroup lattice. To phrase this more precisely and to explain my plans for future projects, let L_{10} denote the subgroup lattice of the dihedral group D_8. Let L_5 be the unique non-modular lattice with five elements and let $\mathcal{L}$ denote the family of sublattices of L_{10} that contain L_5. Including L_{10} and L_5, there are eight lattices in this family, and the six "proper" ones are denoted by L_6, L_7, L_8, M_8, L_9 and M_9.
For all $L \in \mathcal{L}$, a finite group G is called L-free if and only if the subgroup lattice of G does not contain L as a sublattice. A natural question is: What do the L-free finite groups look like?
The L_5-, L_6- and L_7-free groups, respectively, had already been completely classified (for a while) when Andreeva, Schmidt and Toborg decided to turn to L_8-free groups and M_8-free groups. Their classification has been published in 2011. Moreover Schmidt has proved some general results about L_{10}-free groups, for example their solubility. But it seems that much work has still to be done in order to understand the structure of L_{10}-free finite groups and, unsurprisingly, the prime 2 will have a special role to play. This can already be seen in Schmidt's results about L_{10}-free groups whose order has only two distinct prime divisors.
Together with research students I am working on the open cases. Juliane Pölzing studied M_9-free groups for her Master's Thesis and our classification result has been submitted to the Journal of Group Theory, see [15]. With another student I will work on L_9-free groups in 2014. But also I would be interested in further investigations of L_{10}-free groups, for example in a completion of the work that Schmidt has begun on L_{10}-free groups whose order has at most two prime divisors.

4. Generalising Glauberman's Z*-Theorem

After Glauberman had published his Z*-Theorem in 1966, it was of course considered an interesting question whether his result could be generalised for odd primes. He addresses this question himself in his paper and indicates

where problems might occur. There was some progress in this direction and in particular some special cases were successfully treated (for example by Shult, Rowley and Broué), but it was only after the completion of the CFSG when a general version of the Z*-Theorem for odd primes could be established. Contributions that are independent of the CFSG have also been made by Flavell and Robinson and there is an ongoing common interest of group theorists and representations theorists to make more substantial progress.
Here is a version of a general Z_p^*-Theorem:

Z_p^*-Theorem. *Suppose that G is a finite group, that p is prime and that $x \in G$ is an isolated element of order p. Then $\langle x \rangle O_{p'}(G) \trianglelefteq G$.*

Here we say that $x \in G$ is **isolated in** G if and only if the only conjugate of x in $C_G(x)$ is x itself. If p is odd, then an equivalent version of this definition that can be found in the literature is that x is the only conjugate of x in every Sylow p-subgroup of G that contains it. The name "Z_p^*-Theorem" comes from the fact that $\langle x \rangle O_{p'}(G) \trianglelefteq G$ if and only if x is contained in $Z_p^*(G)$, the full pre-image of $Z(G/O_{p'}(G))$ in G.
My most important research project since 2004 has been work towards a new proof for Glauberman's original result, i.e. the Z*-Theorem for the prime 2. My objective was to find a proof that
– establishes Glauberman's result in as much generality as possible, at least it should be applicable in the context of revision programmes for the CFSG;
– uses local group theoretic arguments and
– is based on techniques that could, at least partially, be transferred to the general Z_p^*-Theorem.
Philosophically speaking, the second aspect is meant to express that this new approach should serve as a test for the strength of local arguments. This is because Glauberman's arguments are character theoretic and he uses deep results from block theory. But the Z*-Theorem plays such a fundamental role in group theory, so can it be proved with methods from within group theory?
My work in this direction culminated in the paper listed as [6] in the publications list. The special case where the centraliser of an involution is soluble had already been successfully treated (see [3]). For a precise statement we denote by a $\mathcal{K}_2$-group a finite group G where all 2-components in the centraliser of any isolated involution in subgroups or factor groups of G are known simple groups.

Z*-Theorem for $\mathcal{K}_2$-groups. *Suppose that G is a $\mathcal{K}_2$-group and that $z \in G$ is an isolated involution. Then $\langle z \rangle O(G) \trianglelefteq G$.*

This result is not as strong as the original Z*-Theorem, but it is applicable in the context of the ongoing revision programmes for the CFSG. The proof is based on local group theoretic arguments that can in part be generalised for odd primes, and it demonstrates the strength of a number of local techniques that play a role in the CFSG itself. Even though the proof is relatively long and technical, the interplay between different group theoretic ideas can be seen in a context that is much less complicated than, for example, the proof of the classification theorem.

In the last three years I spent much time on revising the strategy of the proof in the non-soluble case. Let G be a minimal counter-example to Glauberman's Z*-Theorem and assume that $z \in G$ is an isolated involution that is not contained in $Z^*(G)$. The case where $C := C_G(z)$ is soluble had been treated already, even in more generality, so it is left to consider the case where C possesses a 2-component. In this situation it is much harder to analyse the structure of $C/O(C)$ and it is here where the K_2-group hypothesis comes in later. The first step is to limit the number and shape of 2-components of C and then to derive the exact possibilities for $F^*(C/O(C))$. The next step is concerned with the structure of more subgroups of G (that are somehow linked to C) and this is where involution centralisers distinct from C come into play. It is an important result that the centralisers of specially chosen involutions are either maximal subgroups or properly contained in maximal subgroups of G of odd prime characteristic. Combining all the information that we have, the situation reduces to a scenario where G possesses a special primitive pair of prime characteristic q as introduced in [2]. This leads to a contradiction.

Now that this part of the Z*-project is completed, the next aim is to understand special cases for odd primes and to investigate them with local methods. My PhD student is working on a new approach to Rowley's result from his paper *3-locally central elements in finite groups* from 1981:

Suppose that G is a finite group and that $x \in G$ is a 3-locally central 3-element. Then $\langle x \rangle O_{3'}(G) \trianglelefteq G$.

A 3-element $x \in P \in \mathrm{Syl}_3(G)$ is said to be 3-locally central if and only if, for all non-trivial subgroups R of P, we have that $x \in Z(N_G(R))$. Rowley gives some motivation for his result that originates in investigations of a minimal counter-example to the "Z_3^*-Theorem". Together with my student I am working on arguments that need fewer classification results and that give us more insight into the local structure of a group with a 3-locally central element. We hope that some of our ideas can be generalised.

As mentioned earlier, there is an ongoing effort from a representation theoretic point of view as well to understand the Z_p^*-Theorem, and Geoffrey Robinson has had many interesting insights into the problems that occur and into what strategies might be promising. I am confident that the interplay between local methods and character theoretic results will one day make new progress possible.

For illustration of some of these ideas, let G denote a minimal counterexample to the general Z_p^*-Theorem. Hence let G be a finite group, let p be an odd prime and assume that $x \in G$ is an isolated element of order p that is not contained in $Z_p^*(G)$. For all proper subgroups H of G that contain x we suppose that $x \in Z_p^*(H)$, and for all $N \trianglelefteq G$ such that $x \notin N$ we suppose that, in $\overline{G} := G/N$, we have that $\overline{x} \in Z_p^*(\overline{G})$.
Then G' is a non-abelian simple subgroup of G of index 1 or p and the case $|G : G'| = p$ leads to information about p-fusion in G and the structure of Sylow p-subgroups. Moreover G does not have cyclic Sylow p-subgroups. As can be seen in the new approach to the Z*-Theorem, the Sylow subgroups that are normalised by an isolated element play an important role. So we ask:
For what primes $q \in \pi(G)$ does G possess an x-invariant Sylow q-usubgroup? Is it sufficient to look for non-trivial x-invariant q-subgroups?
Geoff Robinson distinguishes two cases:

Case 1: G has x-invariant Sylow 2-subgroups. This turns our attention to 2-local subgroups of G that contain x and to the interesting special case that $C_G(x)$ has even order.

Case 2: G does not have any x-invariant Sylow 2-subgroups. Then all proper subgroups of G that contain x have odd order and are hence soluble.

I also think that the analysis of maximal subgroups containing $C_G(x)$ will play an important role. In the special case of 3-locally central elements, such a centraliser will automatically be maximal itself. What happens in general? What methods can be extended from the prime 2?
My PhD student Imke Toborg has succeeded in finding a new proof of Rowley's result and we are confident that we will learn more about the Z_p^*-Theorem in general in the process. As a side product of our work, we found a new proof for the well-known fact that a finite simple $3'$-group is either cyclic or a Suzuki group, see [14].

Teaching

Teaching at the University of Halle:

In winter term 2013/14 I am on sabbatical and hence not teaching. For summer term 2014 the current plan is for me to lecture an advanced course on group theory, possibly with exercise classes or a complementing module.

1. Course "Galois theory", summer term 2013.
2. Seminar "Algebra and number theory", summer term 2013.
3. Seminar "Group theory in physics and chemistry", summer term 2013.
4. Course "Representation Theory" with exercise classes, winter term 2012/13.
5. Course " Algebra", winter term 2012/13.
6. Course "Linear Algebra" for first year students, with accompanying workshops. Winter term 2011/12 and summer term 2012.
7. Course "Groups and Geometries" with lectures and exercise classes, summer term 2011.
8. Algebra Seminar, summer term 2011.
9. One-Day-Workshop "Language and mathematical expression", 2011.
10. Course "Chamber systems and buildings" with lectures and exercise classes, winter term 2010/11.
11. Number Theory Seminar, winter term 2010/11.
12. Course "Galois theory" with lectures and exercise classes, summer term 2010.
13. Course "Algebra", winter term 2009/10.
14. Group Theory Seminar, winter term 2009/10.

Teaching at the University of Birmingham:

- Course "Number Theory II", spring term 2009.
- Course "Number Theory II", spring term 2008.

  For this course I was awarded the **Head of School's Prize for Excellence in Teaching**.
- Course "Number Theory II", spring term 2007.
- Course "History and Context of Mathematics (Pure Mathematics)", spring term 2007.
- Exercise classes "Sequences and Series", spring term 2007.
- Exercise classes "Number Theory" and "Polynomials, rings and metric spaces" and a master class, autumn term 2005.

Teaching at the University of Kiel (2001-2004):

- Exercise classes "Linear Algebra and Analysis for physicists",
- Exercise classes "Linear Algebra I, II" (several times),
- Exercise classes "Mathematics for first year students",
- Exercise classes "Group Theory I, II".

Other teaching experience, supervision and organisation

- Two students are currently working under my supervision (a PhD project and a Bachelor thesis), with more requests for supervising projects pending.

- In the last few years I have supervised six theses already, on the topics of local group theory for the Odd Order Theorem, base sizes for permutation groups, subgroup lattice theory, prime graphs for finite groups and solving strategies for Diophantine Equations. The next project for a Master's thesis will begin in spring 2014.

- In March 2013 I gave a talk for students at a summer academy on the topic "Symmetry".

- In February 2012 I taught a masterclass on the topic "Diophantine equations" (one week) at the University of Halle.

- In November 2010 I supervised a school student who worked on mathematical problems for two weeks.

- In 2007 I organised working groups with PhD students in Birmingham. One of them was on Fusion Systems, the other one was on recognition problems for finite groups (via involution centralisers).

- In 2005 and 2006 I taught a course for a summer academy for school students (respectively), together with my colleague Lasse Rempe (University of Liverpool).

  The course in 2005 was on primality testing and cryptography (and lead to the book [8] in the publications list) and the course in 2006 was on number systems.

- At the "Summer School on Finite Groups and Related Geometrical Structures" in Udine, Italy (2005) I gave lectures on spherical buildings, replacing Richard Weiss.