Algebra

The main focus of the algebraists at the University of Birmingham is group theory. This branch of mathematics celebrated its 100th birthday recently, though many of the physical manifestations of group theory, such as symmetry, have been known for thousands of years and are represented in the art and architecture of several continents, and the roots of modern group theory can be traced to romantic figures such as Galois who died in a duel in 1832 at the age of 20. Group theory underpins important technology, such as the automatic teller machine, by forming a large part of the theoretical basis for cryptography.

The research interests of the members of the group are given below.

Open all sections

Professor Paul Flavell

Head of School
Professor in Algebra

Paul's main area of research is Group Theory, which is an area of Abstract Algebra. In very general terms, groups are used to measure the abstract notion of symmetry. As a consequence, they appear in very many areas of science as well as being fascinating objects of study from the pure mathematical point of view.

There are two themes to Paul's research. Firstly, the further development of the abstract theory of finite groups. Secondly, participation on the ongoing international project to produce a new and simplified proof of the Classification Theorem for the Finite Simple Groups.

In the abstract theory of finite groups, the theory of Automorphisms of Finite Groups presents many formidable challenges and opportunities to considerably extend existing theory. For example Paul's Hall-Higman-Shult type theorem for arbitrary finite groups is a generalization of classical theorems regarding representations of solvable groups to nonsolvable groups. As an application, Paul has obtained a local version of Thompson's Thesis, which relates the structure of the fixed point subgroup of an automorphism to that of the whole group.

Paul has developed a substantial theory concerning automorphisms. In particular, relating local structure to global structure. Further high points of this work to date are new proofs of the Solvable and Nonsolvable Signalizer Functor Theorems. These results are two of the pillars on which both the first generation and second generation Gorenstein-Lyons-Solomon proofs of the Classification Theorem of the Finite Simple Groups are built.

Another long standing interest is Generation Properties of Finite Groups. A highlight of this work is Paul's short and direct proof that a finite group is solvable if and only if every pair of its elements generate a solvable subgroups. This result had previously been obtained by Thompson as a corollary of his monumental classification of the Minimal Simple Groups.

Profile (/staff/profiles/maths/flavell-paul.aspx)

Professor Chris Parker

Professor in Group Theory

Chris's main research interests are in group theory.

Recently his research has been focussed on theorems designed to recognise simple groups from some fragment of their p-local subgroup structure. These theorems are intended to be used in the projects aimed at understanding the classification of the finite simple group. For example together with Stroth (Halle) and Rowley (Manchester), he has shown that many of the finite simple group can be identified from the structure of the centralizer of an element of order 3.

Chris is also interested in research which applies the classification of finite simple group. In work with Kay Magaard (Birmingham) and Ben Fairbairn (Birkbeck), he has determined those quasisimple groups which can be used to construct a Beauville surface.

Profile (/staff/profiles/maths/parker-christopher.aspx)

Professor Sergey Shpectorov

Professor in Group Theory and Geometry

Sergey's main interests lie in Group Theory, especially actions of Groups on various geometric objects, such as diagram geometries and buildings.

Profile (/staff/profiles/maths/shpectorov-sergey.aspx)

Dr Kay Magaard

Reader in Algebra

Kay's research interests lie in:

- Maximal subgroups of simple groups;
- The action of the mapping class group on Nielsen classes;
- Constructive recognition of exceptional groups of Lie type; and
- Representation theory of simple groups and unitriangular groups.

Profile (/staff/profiles/maths/magaard-kay.aspx)

Dr Simon Goodwin

Senior Lecturer

Recently Simon has been mainly interested in the representation theory of finite W-algebras. He is also interested in the structure of algebraic groups and finite groups of Lie type. In particular, in questions about their conjugacy classes.

Profile (/staff/profiles/maths/goodwin-simon.aspx)

Homepage (http://web.mat.bham.ac.uk/S.M.Goodwin/)

Dr Corneliu Hoffman

Senior Lecturer

Corneliu Hoffman interests lie in Group Theory, Representation Theory and Galois Theory. Recently he applied Bass-Serre theory and similar homological means to the question of classifying amalgams of linear groups. he is also interested in geometric group theory, more precisely in expander graphs via groups with property (T).

Profile (/staff/profiles/maths/hoffman-corneliu.aspx)

Dr Richard Kaye

Senior Lecturer

Structural properties of models of Peano arithmetic, and in particular their initial segments.

Richard is one of the main workers in the area of models of first-order arithmetic. There are a number of themes to this research, but most structural information about models of arithmetic relates to the order structure of the model. Richard's work includes linking this order structure to the automorphism group of models of PA, and to looking at new families of initial segments, such as generic cuts. In many cases the structural properties are best understood through a language expanding that of PA by adding other predicates and functions - one representing the cut in question for example. This leads to new ways of looking at second order theories of arithmetic (utilising coding devices for example). The recent and on-going work with Tin Lok Wong, a PhD student of Richard's at Birmingham illustrates these ideas very well.

Strengthenings of the notion of recursive saturation and resplendency, in particular arithmetical saturation and transplendency.

Recursive saturation is a very natural and useful property that many nonstandard models of arithmetic have. In some cases (e.g. when the model has a nonstandard truth definition) recursive saturation is available "for free". Recursive saturation is closely related to the idea of resplendence in second order model theory. However, recursive saturation alone is often not enough for some results. An older result by Kotlarski, Kossak and Kaye shows that a countable recursively saturated model of PA has an automorphism moving every nondefinable point if and only if the model satisfies the stronger property of being arithmetically saturated. In recent work Richard and his PhD student Fredrik Engstrom looked at a powerful extension of this to form expansions of the model simultaneously omitting a type. The resulting notion - transplendency - is very powerful and not as yet fully understood and is still the subject of current research.

Properties of nonstandard algebraic structures, in particular nonstandard finite symmetric groups, abelian groups and linear groups.

Algebra and logic combine very well. Richard has instigated a study of finite algebraic objects inside nonstandard models. This leads to some very attractive algebraic objects, including nonstandard symmetric groups (studied for example by Richard and his research student John Allsup) and nonstandard finite linear groups. Even nonstandard cyclic groups have interesting structure which is being investigated currently by another PhD student, Reading. Results in these areas show that symmetric groups are closely connected with so-called sofic groups, and nonstandard groups often have natural quotients with analytic structure and often with interesting measures. The work results in interesting new examples of algebraic objects with new means of reasoning about them. Nonstandard methods of this type can be applied to other areas too. Another PhD student of Richard's is currently investigating Conway-style Combinatorial Games and the sorts of nonstandard games that arise from model theoretic considerations applied to these.

Profile (/staff/profiles/maths/kaye-richard.aspx)

Dr Anton Evseev

Lecturer

The main area of Anton’s research is representation theory of finite groups, in particular, several intriguing “global-local” conjectures that relate representations of a finite group to those of its local subgroups.

Other activities include investigating and counting characters and conjugacy classes of the group of unitriangular matrices over a finite field and of other related groups.

Profile (/staff/profiles/maths/evseev-anton.aspx)

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Dr David Craven

Birmingham Fellow

The main areas of Dr Craven's research activity are representation theory of finite groups and fusion systems.

In finite group representation theory, Professor Raphael Rouquier of Oxford and Dr Craven have embarked on an ambitious project to prove, or at least make substantial progress on, Broué’s abelian defect group conjecture, particular for principal blocks of finite groups of Lie type. In recent work they have laid the foundations of a systematic attack on the geometric form of Broué’s conjecture, using the new concept of perverse equivalences.

In fusion systems, Dr Craven focuses on the algebraic side, attempting to construct an internal theory of fusion systems, that neither translates bolidy results from local finite group theory nor relies heavily on topological intuition, the two currently most successful methods of approaching the subject. This approach manifests itself in his recent theorem proving the equivalence of the two definitions of a simple fusion system.

Profile (/staff/profiles/maths/craven-david.aspx)