Participants

Young Set Theory Workshop 2018

June, 25-29, 2018

Vittorio Bard, *Università degli Studi di Torino*, PhD student.

In my master thesis, I introduced the concept of "countable Borel act" (cB act for short), which is useful in order to unify two different notions of uniformity: one found when considering reductions between orbit equivalence relations of Borel actions of countable group (i.e. countable Borel equivalence relations), the other one found in computability theory (uniform Turing invariant functions are an important class of functions for which Martin's conjecture has been proven true). CB acts enable to talk about"uniform reducibility" between countable Borel equivalence relations, which seems to be easier to investagate that ordinary reducibility (many open questions about the latter have been solved for the former), but is still very closely related to it: for instance, a countable Borel equivalence relation is complete iff it is uniformly complete with respect to some cB act generating it. Hence, it would be interesting to explore more this concept, and there are actually many things to investigate. First of all, what generalizes to Borel orbit equivalence ralations (not necessarily countable)? It would also be interesting to introduce the idea of "non-deterministic" Borel act, and study the resulting notion of "non-deterministic uniformity", which also makes sense for Borel equivalence relations which are not even orbit equivalence relations.

Carolyn Barker, *University of Leeds*, PhD student.

I am a third year PhD student at the University of Leeds supervised by Professor John Truss. My work has focussed on partial orders and Ehrenfeucht-Fraisse games. I began by investigating some questions related to my supervisor's work on Ehrenfeucht-Fraisse games on coloured linear orders. I had already been working with partial orders prior to this so I set out to classify the equivalence classes of partial orders and to determine to what extent the results for linear orders generalise. As well as this I have been doing further work in the original context of linear orders, as well as trees and cyclic orders. As well as the usual notion, I have also been working with a restricted notion of Ehrenfeucht-Fraisse games where the game is played with "pebbles", of which there are fewer than there are moves, and these relate nicely to the branching number of trees and the width of partial orders.

Thomas Baumhauer, *TU Wien*, PhD student.

A cardinal characteristic is the minimal size of a set with certain properties. Some of the most important cardinal characteristics are associated with the ideal $\mathcal{M}$ of all meager subsets of 2^ω (or ω^ω) and the ideal $\mathcal{N}$ of all sets of Lebesgue measure zero. Their cardinal characteristics are related to each other in Cichoń's famous diagram. Recently there has been increasing interest in analogous cardinal characteristics on 2^κ (or κ^κ) for uncountable κ. While there exists a straightforward generalization of the meager ideal seemingly there is none for the null ideal. However recently

Saharon Shelah came up with a promising candidate in the case that κ is inaccessible. In my Ph.D. thesis (supervised by Martin Goldstern at the Technical University of Vienna) I plan to investigate Cichoń's diagram for this generalized case, in particular proving independence results using forcing iterations.

Filippo Calderoni, *Università di Torino*, PhD student.

My research interests lie in mathematical logic and descriptive set theory, in particular in the theory of Borel reducibility and analytic equivalence relations.

The primary goal of my research is to analyze the Borel complexity of concrete equivalence relations naturally occurring in mathematics. I am specially interested in classification problems occurring in algebra and group theory.

Raphaël Carroy, *KGRC, Vienna*, PostDoc.

Fabiana Castiblanco, *Universität Münster*, PhD student.

I am in my last year as PhD student at the Universität Münster working under the supervision of Prof. Dr. Ralf Schindler. My research interests lie in Forcing and the interaction between Inner Model theory and Descriptive Set Theory. Firstly, in joint work with Philipp Schlicht we studied the preservation of the property "$M_n^\sharp(x)$ exists" for every $x \in {}^\omega\omega$ under tree forcing notions. As result, we proved that if $(\mathbb{P}, \leq, ||)$ is an axiom A forcing notion in every inner model which is Σ^1_1-definable, then $\mathbb{P}$ preserves the existence of $M_n^\#(x)$, $x \in {}^\omega\omega, n < \omega$. Provided this fact, we conclude that such a $\mathbb{P}$ does not add any new equivalence classes to thin provably $\boldsymbol{\Delta}^1_{n+3}$ equivalence relations under the existence of $M_n^\#(x)$, $x \in {}^\omega\omega$. Related to the lifting of elementary embeddings in generic extensions and therefore to the preservation of sharps for reals, in joint work with Ralf Schindler we characterize the reals $x \in V$ that are generic by set forcing over L:

Theorem. *The following are equivalent:*

1. *x is set-generic over L*
2. *there is some $p \in L$ such that for all elementary embedding $j : L_\alpha \to L_\beta$ with critical point κ, where $j \in L$, $L_\alpha \models \mathsf{ZFC}^-$ and $p \in L_\kappa(\subset L_\alpha)$, there is some $\tilde{j} : L_\alpha[x] \to L_\beta[x]$ with $\tilde{j} \supset j$ and $L_\alpha[x] \models \mathsf{ZFC}^-$.*

During the last months, we have focussed on the construction of models containing special sets of reals without a well-ordering of the reals. In joint work with Jörg Brendle and Ralf Schindler, we have constructed a model in which Lusin and Sierpiński sets coexist, there is a Hamel basis, a Vitali set and a Bernstein set but there is no a well-ordering of the reals. Also, we have add to this model a Mazurkiewicz set, that is, a subset of the plane $\mathbb{R} \times \mathbb{R}$ which intersects every line in exactly two points. This work is still in progress.

Tomasz Cieśla, *University of Warsaw*, PhD student.

I am mostly interested in descriptive set theory, especially orbit equivalence relations induced by actions of Polish groups.

Fernando Damiani, *University of Rome, La Sapienza*, PhD student.

The Game Theory and the Axiom of Determinacy have lots of applications and consequences. Two for all, the Wadge Hierarchy and the relative consistence of large cardinals' existence. At the moment, as I'm just approaching to the subject as a first year PhD, I am interested in the understanding of these consequences, and any other that might be applied in others branches of mathematics. At the end of this period I'll be able to focus my research on some of these themes.

Ben De Bondt, *Ghent University*, Master Student.

I am a graduating master student at Ghent University and plan to start a Ph.D. in fall 2018. The subject (as well as the host university) of my Ph.D. project is, at the moment of writing, still dependent on the outcome of ongoing application procedures.

My interests in set theory are at this point still very broad. A theme I find particularly interesting concerns the intricate connections that regularly turn up between set theory and concepts of a model theoretic nature, as they do for example in the study of strong logics. Further, I am also very interested in the interactions between set/model theory on the one hand and topics from classical analysis (such as Banach space theory, topology, measure theory) on the other.

I think attending the workshop will be a great opportunity to get in touch with many different directions modern set theory is currently heading and to meet with the researchers working on these topics.

Carl Dean, *University of Illinois at Chicago*, PhD Student.

I am a second year PhD student under Dima Sinapova. My current interests lie in singular cardinal combinatorics and the tree property. Currently I'm reading "Aronszajn Trees and Failure of the Singular Cardinal Hypothesis" by Itay Neeman.

As a prospective set theorist, I think there is an advantage in learning as much about different areas of set theory as possible. The Young Set Theory Workshop gives me the opportunity to interact and network with other set theorists with various interests.

Ben Erlebach, *University of Toronto*, Masters' Student.

Monroe Eskew, *KGRC, University of Vienna*, PostDoc.

I am interested in large cardinal properties that can consistently hold at small cardinals. I have focused on varieties of precipitous ideals and versions of Chang's Conjecture. I am particularly interested in cases when these kinds of properties, while coincident at large enough large cardinals, may be mutually exclusive at successor cardinals.

Elliot Glazer, *Harvard*, PhD Student.

I am a first-year graduate student at Harvard University. Naturally, I'm not fully sure what exactly my research will be, but my advisor will almost certainly be Professor Hugh Woodin, so I expect to do some sort of project related to inner model theory and determinacy. Depending on the state of the Ultimate L program within the next year, I might begin investigating the models Woodin has developed.

Thus far, I've mainly learned the basics of inner model theory and determinacy. My undergraduate thesis was some expository notes on $0^{\#}$, comparing the modern inner model theoretic approach to $0^{\#}$ where it is defined as a baby mouse, to the approach based on Ehrenfeucht-Mostowski models. It is meant to introduce the reader to the fundamental ideas of inner model theory and how canonical inner models can be constructed from mice.

Michał Tomasz Godziszewski, *Institute of Mathematics, Polish Academy of Sciences*, PhD student.

I am a first-year PhD student at the Polish Academy of Sciences, working under supervision of Piotr Koszmider. My main interests are forcing, forcing axioms, infinite combinatorics, set theory of the real line, as well as applications of set theory in topology and analysis. I am currently learning to apply iterated forcing, proper forcing and forcing with models as side conditions. I am also finishing PhD studies in formal logic, at the Philosophy Institute, University of Warsaw, where I am writing a thesis on satisfaction classes in nonstandard models of arithmetic and set theory in the context of the multiverse debate.

Jan Grebik, *Institute of Mathematics of the Czech Academy of Sciences*, PhD student.

I am a second year PhD student at the Charles University in Prague, working under the supervision of D.Chodounsky. The main topic of my studies is the descriptive set theory and its application to another parts of mathematics such as set theory, forcing, ergodic theory, theory of Borel equivalence relations, combinatorics etc. Last year I worked with M.Hrusak and C.Uzcategui on problems concerning tall Borel ideals on ω and Borel selector for tall families on ω. Very recently I started to work with J.Hladky and M.Dolezal on problems from the theory of graphons i.e. limits of dense graph sequences.

Fiorella Guichardaz, *University Albert-Ludwigs Freiburg im Breisgau*, PhD student.

As a PhD student in Freiburg, supervised by Prof. Mildenberger, I had the chance to learn some basics about different topics including set theory of the real line, constructibility, cardinal invariants, forcing tecnique with side conditions, equivalent definitions of proper forcing, an introduction of matrix iterations, an introduction to large cardinals. I am now moslty focusing on forcing iterations with ord-transitive models, their constructions and the related properties.

A model M is called ord-transitive if for every $x \in M$ which is not an ordinal, $x \subseteq M$. For those models some easy definitions, such as being a subset, are not more absolute. Ord-transitive models were introduced in [1] and [2] and used in [3] together with almost countable support iterations to prove the consistency of the Borel Conjecture and the dual Borel Conjecture.

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Andreas Hallbäck, *Université Paris Diderot*, PhD student.

I am interested in descriptive set theory and logic. During my Master's I've studied operator algebras as well as application of descriptive set theoretic methods in this area. In my Master's thesis I studied definable graph theory. In my current research I am interested in continuous logic and possible applications to ergodic theory and operator algebras.

Jialiang He, *Department of Mathematics, Sichuan University*, PostDoc.

My research interests lie in field of set theory, more specifically, Cardinal Invariants Continuum and set-theoretic topology. My current work mainly focus on filters, ideals and the strusture of some orders among them, for an instance, $\leq$ T , $\leq$ K , $\leq$ RB , $\leq$ RK . I have solved several problems in these topics.

John Howe, *University of Leeds*, PhD Student.

My main interest is in the Big Ramsey degrees of homogeneous structures. First named as such by Kechris, Pestov and Todorcevic in '05, with ideas dating back to work of Galvin, Laver and Devlin from the '80s, this an infinite version of the structural Ramsey theory developed by Nešetřil and Rödl. The main change arising being that you cannot find monochromatic structures in most non-trivial cases but instead you look for the least number of colours you can restrict to. The main techniques involve coding structures into trees and then applying versions of Milliken's theorem but some follow from just the usual Ramsey's theorem. I also do some things related to generalised Baire space and particularly cardinal characteristics there. Occasionally I dabble in rejecting the axiom of choice.

Manuel Inselmann, *Kurt Gödel Research Center for Mathematical Logic*, PhD student.

I am a PhD student at the Kurt Gödel Research Center in Vienna, working under the supervision of Prof. Benjamin Miller.

Over the last decades, countable Borel equivalence relations became objects of great interest in descriptive set theory (see [2],[3],[6]). Several notions of reducibility, most prominently Borel reducibility and measure reducibility, have been the focus of research. The presence of a measure often allows one to gain much more insight than one is able to get in a purely Borel context. A well-known example of this comes from the notion of the μ-cost of an E-invariant Borel probability measure μ ([4],[8]), which provides a plethora of theorems, including a positive answer to a weak version of a dynamic analogue of the von Neumann conjecture ([7]).

It has been known for some time that there are continuum-many pairwise incomparable countable Borel equivalence relations under Borel reducibility ([1]). Nevertheless, both under Borel ans measure reducibility it remains unknown whether there exist successors of E_0.

My research efforts have been focused on generalizing the notion of cost to quasi-invariant probability measures. The other goal of this PhD project is to systematically scrutinize possible candidates that arise from as actions of algebraic groups, using methods from ergodic theory and descriptive set theory. Another line of my research consists in considering similar questions for actions of Polish groups.

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Sittinon Jirattikansakul, *Carnegie Mellon University*, PhD student.

I am a second year grad student from Carnegie Mellon University. My advisor is James Cummings. I am still on the middle way of studying, but roughly I interested in set theory, forcings, and also combinatorial set theory. What I am doing mainly now is studying proper forcing, totally proper forcing, and Dee-completeness, which is the generalization of proper forcing: a countable support iteration of dee-complete posets does not add real.

Alexander Johnson, *New College of Florida*, recent undergraduate (will start PhD in Fall).

My name is Alexander Johnson. I am currently a fourth year undergraduate majoring in mathematics at New College of Florida, and expect to graduate in May this year. I will be starting my PhD in mathematics next Fall, pursuing a career as a research mathematician and college professor. In particular, I am interested in set theory and logic.

I have studied much set theory including the independence of the continuum hypothesis, forcing, infinitary combinatorics, and a handful of large cardinals. I have also studied model theory, and participated in a summer REU at the University of Chicago in 2017, studying the Keisler-Shelah Theorem which uses ultrapowers to give a semantic definition of elementary equivalence, Keisler's-order which is inspired thereby, and the abundance of indiscernible sequences in stable models. I am currently writing my undergraduate thesis on the Stability Spectrum Theorem as a continuation.

I am interested in Woodin's research regarding the linearity of large cardinals and a decision for the continuum hypothesis in a canonical model. I am also curious to see how research in stability theory can relate to large cardinals and models of ZFC. I am eager to learn more set theory at this year's Young Set Theory Workshop and to interact with researchers in the field.

Deborah Kant, *Humboldt University Berlin*, PhD student.

In my PhD in philosophy of set theory, I am working on the explication of the concept of naturalness in set theory. The basis for these investigations is an analysis of set-theoretic practice, i.e. how set-theorists describe their practice and how they use certain notions. In this context, I am also interested in the distinction between mathematics and metamathematics—a distinction which seems to become complex when it is applied in set theory.

Dominik Kirst, *Saarland University*, PhD student.

I am a second-year PhD student in computer science at Prof. Gert Smolka's Programming Systems Lab at Saarland University. Before that I obtained a bachelor's degree in computer science from Saarland University with a thesis on formalised set theory, and a master's degree in mathematics and foundations of computer science from Oxford University with a thesis on type systems corresponding to nominal automata. During this master's programme I took advanced courses in model theory and axiomatic set theory, which led to some work on formalised second-order set theory during my first year as a PhD student.

Second-order set theory (2ZF) is an axiomatisation of set theory where the axiomatic schemes for separation and replacement are replaced by single second- order formulas. This is the natural way to formalise set theory in a higher-order logic such as the dependent type theory underlying the Coq proof assistant our group is working with [1]. Contrarily to its more prominent first-order counterpart, 2ZF has a relatively determined semantics as its models only differ in height [2].

We formalised this result in Coq and showed that 2ZF is categorical in every cardinality, meaning that equipotent models are necessarily isomorphic [3]. In this paper we also proposed fully categorical axiomatisations 2ZFn fixing the amount of Grothendieck universes to a natural number n. These extended axiomatisations were shown to have models in dependent type theory in a follow-up paper [4], which is based on work of Aczel [5], Werner [6], and Barras [7]. As these results were solely presented to the community in interactive theorem proving I am now curious to discuss further ideas within the set theory community. I recently visited the 'Foundations in Mathematics: Modern Views' conference[1] which was already very helpful and where I was made aware of the 'Young Set Theory' workshop.

[1]https://fmv2018.weebly.com

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Lukas Daniel Klausner, *TU Wien*, PhD student (Martin Goldstern).

A cardinal characteristic is the minimal size of a set with certain properties. Many cardinal characteristics arise in quite a natural way, e. g. by considering certain ideals (such as the ideal $\mathcal{M}$ of meagre subsets of ω^ω or the ideal $\mathcal{N}$ of sets of Lebesgue measure zero). Several inequalities between such cardinal characteristics have been proven in the late twentieth century (some of which are collected in Cichoń's diagram and van Douwen's diagram). For a good overview, see Andreas Blass's "Combinatorial Cardinal Characteristics of the Continuum" in the *Handbook of Set Theory*, pp. 395–489, and Jerry E. Vaughan's "Small Uncountable Cardinals and Topology" in *Open Problems in Topology*, pp. 195–218, as well as Tomek Bartoszyński and Haim Judah's *Set Theory: On the Structure of the Real Line.* One current area of research is to construct models where more than two different cardinal characterics which are known to be in some inequality relation are forced to be different. To this end, a number of different methods has been developed, such as iterated forcing (with different restrictions on the support), matrix iterations, iterations along a template and creature forcing constructions.

In my thesis, which is supervised by Martin Goldstern of TU Wien (formerly also known in English as Vienna University of Technology), I aim to prove new results on the simultaneous separation of cardinal characteristics. Currently, we are working on improving creature forcing methods to separate cardinal characteristics; specifically, we are working on combining the recent results from "Creature Forcing and Five Cardinal Characteristics in Cichoń's Diagram" (by Arthur Fischer, Martin Goldstern, Jakob Kellner, and Saharon Shelah, to appear in *Arch. Math. Logic*) with the older results from "Many Simple Cardinal Invariants" (by Martin Goldstern and Saharon Shelah, *Arch. Math. Logic*, 32(3):203–221, 1993) and plan to investigate further how much more can be achieved using products of creature forcing constructions.

Marlene Koelbing, *KGRC, Vienna*, PhD student.

Michał Korch, *University of Warsaw*, PhD candidate just after the defence.

I am predominantly interested in set theory of the real line, especially in aspects related to measure and convergence (including convergence with respect to an ideal) of sequences of real functions, and in particular special subsets related to those notions. Recently, I have studied the possible generalizations of this theory to the generalized Cantor space 2^κ endowed with the topology of extensions of functions defined on an initial interval of κ (i.e.$\{[s]\colon s \in 2^{<\kappa}\}$, where $[s] = \{f \in 2^\kappa\colon f|\operatorname{dom} s = s\}$, is a base of this topology). In particular, I study the properties of subsets on 2^κ related to selection principles and their relation to notion of convergence of κ-sequences of functions with arguments and values in 2^κ.

Chris Le Sueur, *University of East Anglia*, Postdoc.

Maxwell Levine, *KGRC, Vienna*, PostDoc.

I am a Postdoctoral Fellow at the Kurt Gödel Research Center for Mathematical Logic.

My research so far has focused on singular cardinal combinatorics. The properties of singular cardinals are more subtle than their regular counterparts because they are partially but not entirely determined by ZFC. This phenomenon is notable in the behavior of the continuum function $\kappa \mapsto 2^\kappa$. Easton proved that the continuum function is arbitrary on regular cardinals (within the confines of monotonicity and König's Theorem) [3], but Silver proved a short while later that GCH cannot fail for the first time at a singular cardinal of uncountable cofinality [2].

So far I have studied singular cardinals through the interplay of the square properties of Gödel's constructible universe, reflection properties of large cardinals, and the scales used in the PCF theory of Shelah [1]. I am interested in expanding my research into inner model theory and applications to topology.

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Marc Lischka, *ETH Zürich*, PhD student.

We modify standard definitions of cardinal characteristics of the continuum using the asymptotic density of sets of naturals. For example:

Definition 1. A set $x \in [\omega]^\omega$ is said to **bisect** a set $y \in [\omega]^\omega$, *iff* the following holds:

$$\lim_{n\to\infty}\left(\frac{|x \cap y \cap n|}{|y \cap n|}\right) = \frac{1}{2}$$

A **bisecting family** is a family $\mathscr{S} \subseteq [\omega]^\omega$ such that each $y \in [\omega]^\omega$ is bisected by at least one $x \in \mathscr{S}$.

Define the **bisecting** or **density-splitting number** $\mathbf{\mathfrak{s}_{1/2}}$ as follows:

$$\mathfrak{s}_{1/2} := \min\{|\mathscr{S}| : \mathscr{S} \subseteq [\omega]^\omega \text{ is bisecting}\}.$$

This is a well-defined cardinal characteristic, since $[\omega]^\omega$ itself is an example of a bisecting family.

We can show that $\mathfrak{s} \leq \mathfrak{s}_{1/2} \leq \mathbf{non}(\mathscr{L})$ and would like to show that either inequality can consistently be strict.

Richard Matthews, *University of Leeds*, PhD student.

My primary research involves studying the nature of the universe and large cardinals is axiomatic systems weaker than ZFC, notably ZF, IZF and CZF. In particular I am interested in the behaviour of large cardinals without choice and how to define large sets in intuitionistic logic where the ordinals are no longer well ordered. One focus of my work over the first year of my PhD has been to study small large cardinal axioms (that is below measurable) in ZF.

As part of this, I have extensively studied the properties of worldly cardinals and how they relate to other large cardinals such as both weakly and strongly inaccessible cardinals. An interesting avenue from this that I have begun studying is how larger cardinal axioms affect the structure of the worldly cardinals below them. For example, what kind of singular large cardinals are produced by the assumption that there is a non-trivial embedding from V into some model M of ZF?

Ivan Ongay Valverde, *University of Wisconsin-Madison*, PhD Student.

My name is Iván Ongay-Valverde, I'm a fifth year grad student in the University of Wisconsin-Madison. My research area is Set Theory and my advisor is Kenneth Kunen. My research focus lies, principally, in investigating different properties of the reals, either topological or combinatorial, and their consistency with ZFC.

So far, I have done two projects to translate cardinal characteristics to computability highness notions that concluded as co-author papers, one of them already submitted and the other still in preparation. The first focus in prediction and evasion (as introduced by Blass) and the second in the localization numbers (as introduced by Newelski and Roslanowski). I also have a solo paper (already submitted) where I split a version of the prediction numbers and the localization numbers, i.e., a model were the k-globally prediction numbers are strictly bigger than the localization numbers. At the moment, I'm working in two projects that try to apply the work done by Itay Neeman with forcing with side conditions: one of them is in different versions of OCA and, the other, to use his countable iteration with Sacks forcing.

Supakun Panasawatwong, *University of Leeds*, PhD student.

I am a third year PhD student at the University of Leeds under supervision of Prof. John Truss. Recently I worked on several notions of finiteness in the absence of the axiom of choice. There are about 10 different definitions which are currently under review. Some of their properties had been studied by Degen, Goldstern, and Truss.

Now I am working on a relation between $\aleph_0$-categorical structures and weakly Dedekind-finite sets. Some results are studied by Walczak-Typke. I'm trying to achieve a further result via the FM-model construction. Given an $\aleph_0$-categorical structure $\mathcal{A}$, the set of atoms $U_{\mathcal{A}}$ of the FM-model induced by $\mathcal{A}$ is weakly Dedekind-finite. Furthermore let $\mathcal{B}$ be a structure on $U_{\mathcal{A}}$, we have $\mathrm{Th}(\mathcal{B})$ must be $\aleph_0$-categorical with the unique (up to isomorphism) countable model definable from the original structure $\mathcal{A}$. Also I am trying to get a similar result for Dedekind-finite sets.

Luis Pereira, *University of Lisbon*, Junior Researcher.

I've finished my Ph. D. in Paris in 2007. I specialized in the Combinatorics of Singular Cardinals with an emphasis on Cardinal Arithmetic. I am interested in connections between the PCF conjecture and more standard combinatorics. For example, in my Ph. D. thesis I studied the notion of continuous tree-like scales and its connections to the problem of free subsets of set mappings, which itself is connected to the PCF conjecture for intervals.

During this workshop I would like to discuss with young researchers in fine-structure or in the forcing of fine-structural objects.

Alejandro Poveda, *Universitat de Barcelona*, PhD Student.

My main interests are related with problems involving Large Cardinals and Forcing. To be more precise, I am interested in how forcing (normally, Prikry type forcings or iterations of them) can be used to investigate the region encompassed between measurables and strong compact and also between supercompact and Vopenka principle.

Vibeke Quorning, *Copenhagen*, PhD student.

Milette Riis, *University of Leeds*, PhD student.

My research is on the Generalised Shift graph, first introduced in a paper by Erdös and Hajnal. These graphs are generated from a set S with an ordering $<$, and a "type" τ. This gives all the necessary information to construct the graph. I have looked at a variety of graphs generated by certain ordered sets – in particular, I have considered ordinals and dense totally ordered sets without endpoints. I have also narrowed down the types I am looking at to types of the form $1\hat{}n3\hat{}m2\hat{}n$.

I have so far proved various results, mainly to do with reconstructing the set S and the type tau from the graph $G(S, \tau)$ (generated by S and τ), but also to do with reconstructing the graph G from its automorphism group, and determining the chromatic number of such a graph. Over the next year, I intend to extend my results to include more cases. I will consider general total orderings, and also partial orderings, and I would like to extend all my results to types of the form $1\hat{}n3\hat{}m2\hat{}n$ if possible.

Dan Saattrup Nielsen, *University of Bristol*, PhD student.

My research is currently split into two parts, roughly speaking working in two different sections of the large cardinal hierarchy. The first one being down between weakly compacts and measurables, the so-called Ramsey-like cardinals, which are cardinals characterised as critical points of elementary embeddings between small structures.

The second section concerns the large cardinals between a Woodin and a Woodin limit of Woodins (in particular way below a superstrong), where I'm working with the core model induction to (try to) find lower consistency bounds of combinatorial statements and/or forcing axioms.

Ali Sadegh Daghighi, *Amirkabir University of Technology*, Ph.D. (Graduated).

My research area is mathematical logic, particularly set theory in which I have conducted some research on automorphisms and self-elementary embeddings of the set theoretic universe in the non-wellfounded context. I also did some research on Shelah cardinals and definable tree property so far. My present research project is along the lines of the eightfold problem, namely investigating the consistency of tree property, approachability and reflection in the uncountable cofinality case.

Jonathan Schilhan, *Kurt Gödel Research Center*, PhD student.

I am a student at the Kurt Gödel Research Center (KGRC) in Vienna under supervision of Vera Fischer. My research is mainly in combinatorial set theory and forcing.

In combinatorics of the real line one typically considers notions of maximality in structures of the form infinite mod finite. If we consider for example the Boolean algebra $\mathcal{P}(\omega)/\text{fin}$ then maximal antichains are so called mad families and maximal chains correspond to the notion of a tower. One of the main questions is then: how do different such notions relate to each other? One way of tackling this question is to associate with each notion of maximality a characteristic value defined as the least size of such a maximal family. These are so called cardinal characteristics. An ever increasing amount of forcing techniques has been developed in order to separate such cardinal characteristics or to get specific constellations of them. I am interested in further developing these techniques.

On the other hand one needs to consider the possibility of strong ZFC relations between such cardinals as was shown by the recent unexpected $\mathfrak{p} = \mathfrak{t}$ result. Concerning this type of results I am particularly interested in the old open question, attributed to Roitman, of whether $\mathfrak{d} = \omega_1 \to \mathfrak{a} = \omega_1$.

Another aspect I am interested in are definability properties of such maximal families in the sense of Descriptive Set Theory. It is a classical result of Mathias that there are no analytic mad families. However A. Miller has shown that coanalytic mad families exists in L. Recently V. Fischer and I have applied the same method to show that coanalytic towers exist in L.

I am also working on the generalized notions of cardinal characteristics for uncountable κ.

David Schrittesser, *Kurt Gödel Research Center, University of Vienna*, FWF Senior Researcher.

My research in descriptive set theory, and mostly independent results, that is, forcing. I'm interested in implications or lack thereof between statements of the form "every set in the projective hierarchy has regularity property A" and variations. Regularity properties are things like being measurable or having the Baire property; usually, they are associated to a σ-ideal on the reals (or some Polish space). Further, I'm interested in infinite combinatorics, especially in the existence of definable maximal discrete sets for relations on Polish spaces (these can be seen as a higher-dimensional analogue of irregular sets). I'm also interested in inner model theory, large cardinals, and class forcing.

Salome Schumacher, *ETH Zürich*, PhD student.

I am a PhD student at ETH Zurich working under the supervision of Lorenz Halbeisen. At the moment I am mainly interested in magic sets and weak choice principles.

A set $M \subseteq \mathbb{R}$ is a magic set if for all nowhere constant and continuous functions f and g

$$g[M] \not\subseteq f[M] \iff f \neq g.$$

I showed that adding and removing countable sets does not destroy the property of being magic. If $\text{add}(\mathcal{M}) = \mathfrak{c}$, we can even add and remove sets of cardinality less than $\mathfrak{c}$.

C_n^- states that every infinite family $\mathcal{F}$ of sets of size n has an infinite subset $\mathcal{G} \subseteq \mathcal{F}$ with a choice function on $\mathcal{G}$. And RC_n states that every infinite set X has an infinite subset $Y \subseteq X$ such that $[Y]^n = \{z \subseteq Y \mid |z| = n\}$ has a choice function. I am interested in the question for which $n \in \omega$ the implication $RC_n \Rightarrow C_n^-$ holds.

Roy Shalev, *Bar Ilan University*, Master Student.

As part os my thesis for master degree i'm researching ladder systems topologies and how different set theory axioms affect the properties of the topology. I explore subjects as "Does there exist a 1st-countable Dowker space in ZFC?" a question asked by Marry E. in 1970. I'm hoping to learn and stregthen my knowloedge in the field of set theory.

Forte Shinko, *Caltech*, PhD student.

I am interested in the hierarchy of Borel equivalence relations. More specifically, I have focused on classifying actions induced by group actions in geometry, such as boundary actions of hyperbolic groups and mapping class groups. Recently I have also been looking into constructions of large families of incomparable equivalence relations.

Nattapon Sonpanow, *Chulalongkorn University, Bangkok, Thailand*, PhD student.

My past research when I was an undergraduate was on cardinal numbers in the absence of the Axiom of Choice (AC). I was inspired by my supervisor and the research paper titled "Factorials of infinite cardinals" by John W. Jr. Dawson and Paul E. Howard (1976). The paper showed that, assuming AC, for any infinite cardinal $\mathfrak{p}$, $\mathfrak{p}! = 2^{\mathfrak{p}}$, where $\mathfrak{p}!$ is the cardinality of the set of all permutations on a set which is of cardinality $\mathfrak{p}$. Moreover, in the absence of AC, we cannot conclude any relationship between $\mathfrak{p}!$ and $2^{\mathfrak{p}}$ for an arbitrary infinite cardinal $\mathfrak{p}$. This brought me to study properties of infinite factorials in the absence of AC, and compare them with those of the cardinality of power sets. One of my discoveries is that "$\mathfrak{p}^n < \mathfrak{p}!$ for any natural number n and any infinite cardinal $\mathfrak{p}$" is provable in ZF (although "$\mathfrak{p}^2 \leq 2^{\mathfrak{p}}$ for any infinite cardinal $\mathfrak{p}$" is not). This result is in my latest paper "Some Properties of Infinite Factorials" which has recently been accepted for publication in the Mathematical Logic Quarterly. A part of my earlier results in my senior project had already been published in the Bulletin of the Australian Mathematical Society, entitled "A Finite-to-One Map from the Permutations on a Set".

Now I am a Ph.D. candidate. I turn my interest to infinitary combinatorics. I have studied forcing including iterations and independence results concerning some cardinal characteristics of the continuum, Martin's Axiom, Baumgartner's Axiom, and Semi-Open Coloring Axiom. I have also studied more on properties of cardinal characteristics, the Ellentuck topology, Ramsey ultrafilters and P-points, and some relevant independence results. I am currently working on finding more properties of and consistency results concerning cardinal characteristics and related families.

Viera Šottová, *Institute of Mathematics of the Czech Academy of Sciences*, PhD student.

I am interested in selection principles, especially ideal versions of Scheepers' $\mathrm{S}_1(\Gamma,\Gamma)$-space, i.e., $\mathrm{S}_1(\mathcal{I}\text{-}\Gamma,\mathcal{J}\text{-}\Gamma)$-space. In some sense this spaces are also description of ideal versions of wQN-space. Therefore I concentrate on $C_p(X)$ and sequence selection principles $\mathrm{S}_1(\mathcal{I}\text{-}\Gamma_{\mathbf{0}},\mathcal{J}\text{-}\Gamma_{\mathbf{0}})$-space (known as Arkhangel'skii's α_4 property for ideal).

We also showed that cardinal invariant $\lambda(\mathcal{I},\mathcal{J})$ introduced by Supina is common critical cardinality of these spaces. Therefore I am interested in knowing different cardinal invariants which we know so far and try to find connection with our spaces.

Pieter Spaas, *University of California, San Diego*, PhD Student.

I work on the bridge between operator algebras and descriptive set theory. Recently I completed a paper studying the complexity of the classification problem for Cartan subalgebras in a class of von Neumann algebras. In particular I constructed examples where the corresponding equivalence relation is not classifiable by countable structures.

At the moment I am working on some related problems, both on the von Neumann algebra and the descriptive set theory side. The topics involved include the study of group actions using ergodic theory, descriptive set theory, and operator algebras, the classification of von Neumann algebras, and studying the structure of the equivalence relations showing up in these fields.

Sarka Stejskalova, *KGRC*, PostDoc.

Recently I finished my Ph.D. studies in which I focused on the tree property at κ^+ (there are no κ^+-Aronszajn trees), and the weak tree property (there are no special κ^+-Aronszajn trees), and the interplay with the continuum function. As is well known the tree property at κ^+ implies $\kappa^{<\kappa} > \kappa$, and therefore for instance the tree property at $\aleph_2$ decides the continuum hypothesis negatively.

Jointly with Radek Honzik, I showed that the tree property does not put any further restrictions on the continuum function below $\aleph_\omega$ (strong limit) in the sense that the tree property can hold at each $\aleph_{2n}$, $0 < n < \omega$, and the continuum function can be any monotonous function taking values below $\aleph_\omega$ which satisfies $2^{\aleph_{2n}} \geq \aleph_{2n+2}$, $0 \leq n < \omega$. A similar result holds for the weak tree property; in this case the weak tree property holds at each $\aleph_n$, $1 < n < \omega$.

I studied (jointly with Sy-David Friedman and Radek Honzik) the tree property at the double successors of singular cardinals with countable cofinality (e.g. $\aleph_\omega$).

Please see my web page for preprints.

Jarosław Swaczyna, *Institute of Mathematics, Łódź University of Technology*, PhD student.

Andrea Vaccaro, *University of Pisa & York University*, PhD student.

My main interests are set theory, logic and their applications to operator algebras. My research focusses on a fairly wide family of problems coming from the theory of C^*-algebras where a set theoretic perspective could provide new insights and results. Concrete examples of this approach which particularly interest me are Anderson conjecture, Naimark's Problem and the existence of outer automorphisms of the Calkin algebra.

Charles Valentin, *Université Paris Diderot - IMJ-PRG*, PhD student.

I am mainly interested in applications of Set Theory to the study C*-algebras. These include subjects like Naimark's problem, properties of the Calkin algebra, non-commutative analogue of the cardinal invariants of the continuum and the set-theoretic tools used to study those problems like infinite combinatorics, forcing axioms, ...

Alessandro Vignati, *Institut de Mathématiques de Jussieu - Paris Rive Gauche*, PostDoc.

I am a PostDoctoral Fellow at IMJ-PARG, Paris, where I work in the applications of Logic to Operator Algebras. I graduated at York University (Toronto, Canada) in May 2017 with the thesis

”Logic and C*-algebras: set theoretical dichotomies in the theory of continuous quotients” under the supervision of Ilijas Farah.

Currently I am working on several applications of set theory to C*-algebras, mainly on the (opposite) consequences of CH and of forcing axioms on the automorphisms structure of corona algebras (noncommutative versions of Cech-Stone remainders in topoogy).

More infos at www.automorph.net/avignati

Wolfgang Wohofsky, *Universität Kiel*, PostDoc.