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2008 ANNUAL MEETING OF THE ASSOCIATION FOR SYMBOLIC LOGIC

University of California, Irvine
Irvine, California
March 27–30, 2008

The Annual Meeting of the Association was held on the campus of the University of California, Irvine on March 27–30, 2008. The program included the Nineteenth Annual Gödel Lecture, invited lectures on the work of the Karp prize winner, the life and works of Paul Cohen, a tribute to Paul Eklof, eight additional one-hour invited talks, and six special sessions. There were also five sessions of contributed talks. The ASL hosted an evening welcoming reception on the first day of the meeting.

A conference banquet was held on March 29th, at which the Karp and Shoenfield prizes were awarded. Zlil Sela was presented with the 2008 Karp Prize. The Shoenfield Prize for a book was shared by John P. Burgess for *Fixing Frege* and David E. Marker for *Model Theory: an Introduction*. Bohuslav Balcar and Thomas Jech shared the Shoenfield Prize for an article for their paper, "Weak distributivity, a problem of Von Neumann and the mystery of measurability."

The members of the Program Committee were Chris Laskowski (Chair), Joseph Miller, Toniann Pitassi, Erich Reck, and Martin Zeman. The members of the Local Organizing Committee were Aldo Antonelli (Chair), Paul Eklof, Matthew Foreman, Penelope Maddy, Kai Wehmeier, and Martin Zeman. There were 116 registered participants at the meeting, including 37 graduate students. Generous financial support was provided by the University of California, Irvine, the National Science Foundation, and the Association for Symbolic Logic.

The Nineteenth Gödel Lecturer was W. Hugh Woodin (University of California, Berkeley). The work of the Karp prize winner, Zlil Sela, was presented by Eliyahu Rips (Hebrew University). Akihiro Kanamori (Boston University) talked on the legacy of Paul Cohen, and Saharon Shelah (Hebrew University) gave a lecture in honor of Paul Eklof. The other hour-long invited addresses were:

Sam Buss (University of California, San Diego (USA)), *Resolution search algorithms, learning, and propositional proof systems*.

Stephen Cook (University of Toronto (Canada)), *Bounded reverse mathematics*.

José Ferreirós (University of Sevilla (Spain)), *Hilbert, logicism, and mathematical existence*.

Andy Lewis (University of Leeds (UK)), *On the degree spectrum of a* Π^0_1 *class*.

David Marker (University of Illinois, Chicago (USA)), *Complex exponentiation and pseudoexponentiation*.

Theodore Slaman (University California, Berkeley (USA)), *Effective randomness relative to continuous measures*.

Jamie Tappenden (University of Michigan (USA)), *Riemann-Dedekind methodology and nineteenth century logic*.

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Monica VanDieren (Robert Morris University (USA)), *Stability in abstract elementary classes*.

There were six special sessions (with organizers in parentheses): Computability theory and computable mathematics (A. Montalban), Logic and Early Analytic Philosophy (E. Reck), Logic and Logical Empiricism (E. Reck), Model Theory (C. Laskowski), Set-theoretic Algebra (M. Zeman), and Set Theory (M. Zeman). These included a total of 31 speakers, each of whom gave a 25-minute talk.

Abstracts of the invited talks and the contributed talks (given in person or by title) by members of the Association for Symbolic Logic follow.

For the Program Committee
CHRIS LASKOWSKI

Abstract of 19th Annual Gödel Lecture

► W. HUGH WOODIN, *The Continuum Hypothesis, the Ω Conjecture, and the inner model problem for one supercompact cardinal*.
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The Ω *Conjecture* is a key element of an argument that the *Continuum Hypothesis* is false, based on notions of simplicity. While this application is certainly debatable, there is a much stronger argument that if the Ω *Conjecture* is true then the *Continuum Hypothesis* must have an answer. In brief, the Ω *Conjecture* rules out a *multiverse* conception of truth in Set Theory which is based on the *generic multiverse*.

The Ω *Conjecture* is invariant under passing from the universe of sets to a generic extension of the universe of sets, and so it is reasonable to expect that if the Ω *Conjecture* is false then it must be refuted by some large cardinal hypothesis. The search for candidates for such a large cardinal hypothesis leads to the inner model problem since subject to fairly general criteria, if the inner model problem can be solved for a particular large cardinal hypothesis then that large cardinal hypothesis cannot refute the Ω *Conjecture*.

Again subject to fairly general criteria for a successful inner model construction, the entire inner model program can now be reduced to the case of exactly one supercompact cardinal. If this one case can be solved then one obtains an ultimate generalization of Gödel's, *Axiom of Constructibility*, and one also obtains that no (known) large cardinal hypothesis can refute the Ω *Conjecture*.

I shall survey how the inner model problem for one supercompact cardinal has emerged as the critical case, the connections with the Ω *Conjecture*, and the connections to transfinite generalizations of the *Axiom of Determinacy*.

My emphasis will be less on the technical details and more on what I think are the key foundational issues.

Abstract of Special Lecture in honor of Paul Eklof

► SAHARON SHELAH, *Incompactness in singular cardinals*.
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We prove the consistency of: λ is strong limit singular and for some properties of Abelian groups which are a relative of free, the compactness in singular fails. This is a consequence of an axiom consistent with GCH and saying something for every regular cardinal.

Abstract of Special Lecture on the life and work of Paul Cohen

► AKIHIRO KANAMORI, *Cohen and set theory*.
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I give a description and analysis of Cohen's work in set theory, put in historical perspective.

Abstracts of invited plenary talks

► STEPHEN COOK, *Bounded reverse mathematics*.
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We study the computational complexity of the concepts which need to be defined in order to prove theorems of interest in computer science. For example most polynomial time algorithms can be proved correct using only polynomial time concepts. However an apparent exception is any polynomial time prime recognition algorithm, where a polytime correctness proof would yield a polytime factorization algorithm (probably cracking the RSA encryption scheme). We associate a theory of bounded arithmetic with each major complexity class, starting with the base theory for AC0 reasoning and going up to a theory for polynomial time, and give interesting examples of theorems and their complexity along the way.

► JOSÉ FERREIRÓS, *Hilbert, logicism, and mathematical existence*.
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The talk will deal with David Hilbert's early foundational views, especially those corresponding to the 1890s, which can be analyzed anew on the basis of previously unpublished sources. We shall consider evidence that Hilbert was a logicist at the time, following upon Dedekind's footsteps in his understanding of pure mathematics. This insight makes it possible to throw new light on the shape and evolution of Hilbert's foundational ideas, including his early contributions to the foundations of geometry and the real number system, and his ideas about mathematical existence and consistency. The result is a picture in which differences from the 1920s Hilbert Programme are underscored.

Focusing particularly on Hilbert's paper "On the number concept", which axiomatized the real number system, we shall deal with the following points:

(i) the role of logicistic assumptions in Hilbert's early axiomatics (particularly his completeness axiom)

(ii) how the context of Dedekind-style logicism, plus Cantor's work on the paradoxes, clarifies the emergence of Hilbert's principle that mathematical existence reduces to consistency

(iii) the deep differences in Hilbert's ideas about consistency proofs before and after 1904—as before 1903 he never thought about syntactic consistency proofs.

[1] M. Hallett, W. Sieg, W. Ewald, and U. Majer, editors, ***David Hilbert's Lectures on Foundations***, vol. 1 and 2, Berlin, Springer, 2004 and forthcoming.

► ANDY LEWIS, *On the degree spectrum of a Π^0_1 class*.
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We consider the degree spectra of Π^0_1 classes ordered by inclusion. While many known theorems can be seen to relate, this is a structure which has not been studied explicitly in the previous literature, and its analysis leads to a number of interesting phenomena relating to the study of Π^0_1 classes which are worthy of independent interest.

► DAVID MARKER, *Complex exponentiation and pseudoexponentiation*.
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Wilkie proved that definable sets in the real field with exponentiation have many of the good topological and geometric properties of semialgebraic sets. If one looks at the complex numbers the situation is much more complicated as you can define the integers. There is some hope for an interesting model theory. I will discuss an abstract approach to complex exponentiation due to Zilber and some partial results in this program.

► THEODORE SLAMAN, *Effective randomness relative to continuous measures*.
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We will discuss joint work with Jan Reimann on the question, "For which reals x does there exist a measure m such that x is effectively random relative to m?" We will review what is known about the general question.

We give several conditions on x equivalent to there being continuous measure which makes x random. We show that for all but countably many reals x these conditions apply, so there is a continuous measure which makes x random. There is a meta-mathematical aspect of this investigation. As one requires higher arithmetic levels in the degree of randomness, one must make use of more iterates of the power set of the continuum. We will then focus on questions of 1-randomness and those x's which are recursive in $0'$.

► MONICA VANDIEREN, *Stability in Abstract Elementary Classes*.
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An Abstract Elementary Class is a semantic generalization of various infinitary logics. In the past several years following proofs of versions of Morley's Theorem for abstract elementary classes, this area has received increased attention. We will provide an overview of recent advances in the development of analogs of stability and superstability in abstract elementary classes.

Abstracts of invited talks in the Special Session on Computability Theory and Computable Mathematics

► ROD DOWNEY, *Adjacencies in computable linear orderings*.
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We investigate the degree spectrum of the adjacency relation in a computable linear ordering. This is a natural relation in an ordering, and whilst some existential results are known, few universal ones are. We prove that coding is always possible. That is, if a linear ordering

L has a computable copy with adjanceny relation R having (c.e.) degree $\boldsymbol{a}$, and $\boldsymbol{b} > \boldsymbol{a}$ is a c.e. degree then L has a computable copy where R has degree $\boldsymbol{b}$.

The construction has a number of interesting features not hitherto found in computable algebra. In particular at no stage of the construction do we have a partial isomorphism, the isomorphism only being visible down the true path of the construction.

Joint work with Guohua Wu (Nanyang University of Technology) and Steffen Lempp (University of Wisconsin, Madison).

► E. FOKINA, J. F. KNIGHT, C. MAHER, A. MELNIKOV, AND S. QUINN, *Rank homogeneous trees and classes of Ulm type*.

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Friedman and Stanley [6] considered classes of countable structures, closed under isomorphism, and Borel transformations from one class to another which are one-to-one on isomorphism types. They located some familiar classes of structures under the resulting reducibility, $\leq_B$. The class *UG* of undirected graphs is on top, along with trees, linear orderings, fields of any desired characteristic, and 2-step nilpotent groups. Friedman and Stanley showed that the class of Abelian p-groups, and the broader class of Abelian torsion groups, do not lie on top. They asked about the class *TFAG* of torsion free Abelian groups. Hjorth [7] showed that the isomorphism relation is not Borel.

In [1], the setting of Friedman and Stanley is varied so that the classes include finite structures, and the transformations are Turing computable. The resulting reducibility, denoted by $\leq_{tc}$, is a refinement of $\leq_B$. Applying a result from [8], we show the following.

THEOREM. *Suppose that K contains a pair of structures $\mathcal{A}, \mathcal{B}$ such that $\omega_1^{\mathcal{A}} = \omega_1^{\mathcal{B}} = \omega_1^{CK}$, $\mathcal{A}, \mathcal{B}$ satisfy the same computable infinitary sentences, and $\mathcal{A} \not\cong \mathcal{B}$, while K' contains no such pair. Then $K \not\leq_{tc} K'$.*

Using this, we can show that the class of Abelian p-groups, or Abelian torsion groups, do not lie on top under $\leq_{tc}$. We may add the class *RHT* of "rank homogeneous" trees, which was introduced in [3].

COROLLARY. *$UG \not\leq_{tc} RHT$.*

The class *RHT* has some interesting features. It contains a computable structure of Scott rank ω_1^{CK}, where AG_p does not. There are rank-preserving Turing computable transformations from *RHT* to some other classes [2], showing that these classes contain computable structures of Scott rank ω_1^{CK}. We can give a rank preserving Turing computable transformation from *RHT* to the class of Boolean algebras. For the class *TFAG*, Downey and Montalban [5] recently showed that the isomorphism relation is complete Σ_1^1, and that the set of pairs of computable indices for isomorphic members of *TFAG* is m-complete Σ_1^1. We can show that $RHT \leq_{tc} TFAG$.

[1] W. CALVERT, D. CUMMINS, J. F. KNIGHT, and S. MILLER, *Comparing classes of finite structures*, ***Algebra and Logic***, vol. 43 (2004), pp. 365–373.

[2] W. CALVERT, S. S. GONCHAROV, and J. F. KNIGHT, *Computable structures of Scott rank ω_1^{CK} in familiar classes*, ***Advances in Logic***, Contemporary Mathematics, (Gao, Jackson, and Zhang, editors) pp. 43–66.

[3] W. CALVERT, J. F. KNIGHT, and J. MILLAR, *Computable trees of Scott rank ω_1^{CK}, and computable approximation*, ***The Journal of Symbolic Logic***, vol. 71 (2006), pp. 283–298.

[4] R. CAMERLO and S. GAO, *The completeness of the isomorphism relation for countable Boolean algebras*, ***Transactions of the American Mathematical Society***, vol. 353 (2000), pp. 491–518.

[5] R. DOWNEY and A. MONTALBAN, *The isomorphism problem for torsion-free Abelian groups is analytic complete*, pre-print.

[6] H. Friedman and L. Stanley, *A Borel reducibility theory for classes of countable structures*, ***The Journal of Symbolic Logic***, vol. 54 (1989), pp. 894–914.

[7] G. Hjorth, *The isomorphism relation on countable torsion-free Abelian groups*, ***Fundamenta Mathematicae***, vol. 175 (2002), pp. 241–257.

[8] J. F. Knight, S. Miller (Quinn), and M. Vanden Boom, *Turing computable embeddings*, ***The Journal of Symbolic Logic***, vol. 73 (2007), pp. 901–918.

[This talk was not given; it was presented by title.]

► VALENTINA S. HARIZANOV, *Effective categoricity of equivalence structures and abelian p-groups*.
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We investigate effectively categorical and relatively effectively categorical computable equivalence structures and abelian p-groups. A computable structure $\mathcal{A}$ is Δ^0_α *categorical* if for every computable isomorphic copy $\mathcal{B}$ of $\mathcal{A}$, there is a Δ^0_α isomorphism from $\mathcal{A}$ onto $\mathcal{B}$. For example, we establish that a computable equivalence structure $\mathcal{S}$ is computably (Δ^0_1) categorical if and only if $\mathcal{S}$ has only finitely many finite equivalence classes, or $\mathcal{S}$ has only finitely many infinite classes, bounded character, and at most one finite k such that there are infinitely many classes of size k. Goncharov and Smith previously characterized computably categorical abelian p-groups.

A computable structure $\mathcal{A}$ is *relatively* Δ^0_α *categorical* if for every $\mathcal{B}$ isomorphic to $\mathcal{A}$, there is an isomorphism that is Δ^0_α relative to the atomic diagram of $\mathcal{B}$. It is known that $\mathcal{A}$ is relatively Δ^0_α categorical if and only iff $\mathcal{A}$ has a formally Σ^0_α Scott family or, equivalently, $\mathcal{A}$ has a computably enumerable Scott family of computable Σ_α formulas. We show that all computable equivalence structures are relatively Δ^0_3 categorical. We further investigate which computable equivalence structures and abelian p-groups are Δ^0_2 categorical and relatively Δ^0_2 categorical. This is joint work with Wesley Calvert, Doug Cenzer, and Andrei Morozov.

[1] W. Calvert, D. Cenzer, V. Harizanov, and A. Morozov, *Effective categoricity of equivalence structures*, ***Annals of Pure and Applied Logic***, vol. 141 (2006), pp. 61–78.

[2] ———, *Effective categoricity of abelian p-groups*, submitted.

► ASHER KACH, *Embeddings of computable linear orders*.
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In this talk, we'll investigate what the existence of a classical embedding between computable linear orders implies about the complexity (from a computability viewpoint) of such embeddings. Specifically, we'll demonstrate the existence of a computable non-scattered linear order having no computable presentation into which the rationals computably embed; and the existence of a computable non-well-ordered linear order having no computable presentation into which the negative integers computably embed. As time permits, we'll sharpen these results by increasing the minimal complexity of any embedding. This work is joint with Joe Miller.

► BJORN KJOS-HANSSEN, *Infinite subsets of random sets of integers*.
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There is an infinite subset of a Martin-Löf random set of integers that does not compute any Martin-Löf random set. In fact, each recursively bounded diagonally non-recursive function computes an infinite subset of a Martin-Löf random set of integers. The proof involves some probability theory developed in the 1990s primarily by R. Lyons and Y. Peres.

► ALBERTO MARCONE, *The reverse mathematics of Fraïssé's conjecture for finite Hausdorff rank*.
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Fraïssé's conjecture (proved by Laver in 1971) states that the set of countable linear orders is well-quasi-ordered under embeddability. Computing the proof-theoretic strength of this statement is a long-standing open problem in reverse mathematics. We consider the restriction of Fraïssé's conjecture to linear orders of finite Hausdorff rank. It turns out that this statement is provable in $ACA_0^+ + \varphi_2(0)$ *is well-ordered* and, over RCA_0, implies $ACA_0' + \varphi_2(0)$ *is well-ordered.* Here $\varphi_2(0)$ is the first fixed point of the epsilon-function.

This is joint work with A. Montalbán.

► JEFF REMMEL, *A reflection on a theorem of Kozen: universal languages and the power of diagonalization*.
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Diagonalization is a powerful technique in recursion theory and in computational complexity. The limits of diagonal arguments are not clear. On the one hand, people argue that the existence of oracles which give different relativizations for separations of complexity classes such as the existence of oracle A and B such that $P^A = NP^A$ and $P^B \neq NP^B$ means that such separations cannot be resolved by diagonalization arguments. On the other hand, it is not clear that all diagonalization arguments necessarily relativize. In fact, in 1980, Kozen proved a theorem which states that if any two complexity classes can be separated, then they can be separated by a diagonalization argument assuming the classes have certain natural closure properties. In 2003, Nash, Impagliazzo and Remmel proposed a definition of "separation by strong diagonalization" in which to separate class $\mathcal{A}$ from $\mathcal{B} \subseteq \mathcal{A}$, a proof is required that $\mathcal{A}$ contains a *universal language* for $\mathcal{B}$. In contrast to the kind of "separation by weak diagonalization" that is implicit in Kozen's theorem, there are complexity classes that cannot be separated by strong diagonalization. We will talk about some recent extensions of the work of Nash, Impagliazzo and Remmel which shows that there are interesting formalizations of diagonalizations that lie between the notion of weak diagonalization implicit in Kozen's theorem and strong diagonalization.

This is joint work with Alan Nash and Russell Impagliazzo.

► REED SOLOMON, *Computable complexity of trivial strongly minimal models*.
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There are numerous results in computable model theory about the complexity of the countable models of an uncountably categorical theory. In these results, one typically constructs a trivial strongly minimal theory in which some of the countable models are computable while others are not. However, the noncomputable models are usually computable from $0'$. In this talk, we give an example of a trivial strongly minimal theory in which the prime model is computable and each nonprime model codes $0''$.

This work is joint with Bakh Khoussainov, Chris Laskowski and Steffen Lempp.

Abstracts of invited talks in the Special Session on Logic and Early Analytic Philosophy

► DANIELLE MACBETH, *Reasoning in Frege's Begriffsschrift*.
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Over the course of the nineteenth century mathematical practice was transformed as constructive algebraic problem solving techniques gave way to the practice of proving theorems from the contents of concepts (by reason alone) that remains the norm today. Near the end of that century Frege developed a strange two-dimensional notation in order to render such reasoning fully rigorous; the goal was to express the contents of concepts in a way that would enable gap-free proofs involving those contents. Begriffsschrift was designed, in other words, as a special purpose instrument that would do for the new mathematical practice of reasoning from concepts essentially what the positional Arabic numeration system had done for calculating with numbers. My aim is to clarify the way this goal is achieved in Frege's Begriffsschrift notation.

► CHRISTOPHER PINCOCK, *Russell's propositional functions: A case study in the metaphysical basis of logic*.
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Propositional functions are at the center of Russell's logic in Principia Mathematica and so any attempt to evaluate the success of his logicist project must take a stand on their status. More generally, it is important to determine how logical systems might depend on or imply a commitment to metaphysical entities. Two main options have been developed to make sense of Russell's propositional functions: (1) propositional functions exist, but they are not universals and (2) propositional functions do not exist. Linsky argues in favor of (1) by claiming that propositional functions are metaphysically dependent on propositions, which are in turn metaphysically dependent on universals and particulars. Landini and Stevens reject (1) and support (2) based on their contention that Russell's metaphysics precludes relationships of metaphysical dependence. I argue that (1) is defensible because the principles that Landini and Stevens appeal to, like the doctrine of the unrestricted variable, are consistent with some dependencies.

► KAI WEHMEIER, *Frege, Russell, and Wittgenstein on the logic of identity*.
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Frege famously opens "Über Sinn und Bedeutung" with the observation that "Equality gives rise to challenging questions which are not altogether easy to answer," and immediately proceeds to ask, "Is it a relation?" Similarly, in section 64 of The Principles of Mathematics, Russell remarks, "The question whether identity is or is not a relation, and even whether there is such a concept at all, is not easy to answer." And in Tractatus 5.5301, Wittgenstein boldly asserts, "That identity is not a relation between objects is obvious." In my talk, I will offer various formulations of the basic problem that I take Frege, Russell, and Wittgenstein to be concerned with, discuss their reactions to it, and attempt an evaluation of the problem and its proposed solutions from a contemporary point of view.

Abstracts of invited talks in the Special Session on Logic and Logical Empiricism

► SAM HILLIER, *Carnap's principle of tolerance deflated*.
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Carnap's famous principle of tolerance is usually seen as a substantial claim about the nature of logic, an endorsement of logical pluralism or of the conventionality of logical truth. I think this way of understanding the principle of tolerance is mistaken, and in its place I offer a new, deflated interpretation. That is, instead of viewing tolerance as a substantial metaphysical claim, I argue that it is better seen as a methodological maxim that guides Carnap's unique vision of a logic-based philosophy of science. Doing any more than this, inflating the principle of tolerance, leads to mistakes elsewhere in the overall picture of Carnap's philosophy, and should therefore be avoided.

► DIRK SCHLIMM, *Moritz Pasch: A nineteenth century logical empiricist*.
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When Hans Hahn reviewed the second edition of Pasch's "Vorlesungen über neuere Geometrie" (1882) in 1921, he noted their remarkable historical influence and that they were well known to everybody with an interest in geometry (e.g., they are taken into consideration in Carnap's dissertation "Der Raum", 1922). Nowadays Pasch is remembered—if at all—only for his axiomatization of the order relation and "Pasch's axiom", i.e., as a precursor of Hilbert's seminal "Foundations of Geometry" (1899). What is less known is that in his lectures on projective geometry Pasch held two views that later became cornerstones of logical empiricism, namely that our knowledge rests (a) on empirical origins and (b) on purely logical deductions. In this paper, Pasch's axiomatic approach to geometry and his views on the nature of geometry are critically discussed, with particular focus on the tension between his strong empiricism, aimed as providing an epistemological basis for geometry, and his goal to provide a rigorous mathematical foundation of geometry. In addition, an attempt is made to assess the influence of this work on further developments.

► RICHARD ZACH, *Carnap's logic in the 1930s*.
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Rudolf Carnap's conception of logic underwent a significant change in the 1930s. He moved away from the approach he took in the 1920s, in works such as the ***Abriss der Logistik*** (1929) and his project of "general axiomatics", which was in large part an adaptation of ***Principia Mathematica***, via his syntactic approach in the ***Logical Syntax of Language*** (1934), towards a semantic conception of logic from the beginning of the 1940s. This change was partly prompted by Gödel's incompleteness results and considerations related to it. In response, Carnap contributed significant results and conceptual innovations which parallel some of Gödel's own of the time as well as Tarski's. These contributions are interesting not only in their own right and for the influence they had on Gödel and Tarski, but they form an important part of Carnap's developing views on the "logic" in "logical empiricism".

Abstracts of invited talks in the Special Session on Model Theory

► JOHN T. BALDWIN, *Necessity of the VWGCH*.
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We discuss the conjecture that the following statement is relatively consistent with ZFC. Suppose κ is a regular cardinal with $\kappa^{<\kappa} = \kappa$. Then, there is a complete sentence ψ of $L_{\omega_1,\omega}$ such that ψ is categorical in every $\lambda < \kappa$ but has 2^κ models of cardinality κ and no models of cardinality $> \kappa$. Call the assertion $2^{\aleph_n} < 2^{\aleph_{n+1}}$ for $n < \omega$, the very weak generalized continuum hypothesis. (VWGCH). The conjecture implies Shelah's theorem proved from VWGCH, categoricity of an $L_{\omega_1,\omega}$ sentence up to $\aleph_\omega$ implies categoricity in all powers, is not provable in ZFC.

► JOHN BALDWIN, ALEXEI KOLESNIKOV, AND SAHARON SHELAH, *The amalgamation spectrum*.
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Amalgamation property is one of the key assumptions in many of the categoricity transfer results for abstract elementary classes. However, very little is known about the property itself. For example, Rami Grossberg asked whether there is a Hanf number for amalgamation.

As a first step, we study disjoint amalgamation property. In particular, we determine that for any ordinal α, there is an AEC that has disjoint amalgamation up to $\aleph_{|\alpha|+\alpha}$ but fails disjoint amalgamation eventually. I will summarize the results and state some open problems.

► ALFRED DOLICH, *On generic expansions of ordered structures*.
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Given a theory T eliminating $\exists^\infty$ Chatzidakis and Pillay in [1] show the existence of a model completion, T_P for T in a language expanded by a new unary predicate P. We consider T_P for theories T which expand that of dense linear orderings. Such theories provide good examples of well-behaved ordered theories which are not o-minimal. We study what conditions are necessary to guarantee that desirable properties of T persist in T_P.

[1] Zoé Chatzidakis and Anand Pillay, *Generic structures and simple theories*, ***Annals of Pure and Applied Logic***, vol. 95 (1998), pp. 71–92.

[This talk was not given; it was presented by title.]

► JOHN GOODRICK, *Dp-minimal structures and ordered groups*.
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Dp-minimality is an analogue of weak minimality in the context of dependent theories (or theories with NIP). If T is a weakly o-minimal theory then it is dp-minimal, but there are dp-minimal densely ordered groups that are not weakly o-minimal. In the context of dp-minimal densely ordered groups, we prove a slightly weaker version of the local monotonicity theorem from [1]: every definable unary function is a union of finitely many continuous locally monotonic functions. We will discuss the proof of this theorem and some of its consequences.

[1] Dugald Macpherson, David Marker, and Charles Steinhorn, *Weakly o-minimal structures and real closed fields*, ***Transactions of the American Mathematical Society***, vol. 352 (2000), no. 12, pp. 5435–5483.

► MARTIN KOERWIEN, *Omega-stability and Borel reducibility*.
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The descriptive set theoretic notion of *Borel reducibility* is of great interest to model theorists because it can be used to measure the complexity of the classification problem for countable models of an $L_{\omega_1\omega}$ axiomatizable theory.

Most of the research and interesting examples in that area are concerned with theories that are typically not first order axiomatizable, such as *essentially countable* theories, and little is known about the first order case so far.

We propose a first approach to the first order setting by considering the model theoretically "best behaved" theories, namely ω-stable theories, which allows us to use strong tools like tree decompositions of models.

It turns out that a "countable version" of Shelah's notion of *depth* is to some extent related to the notion of Borel reducibility, and we try to find out how deep this relationship is and where it fails.

► DAVID LIPPEL, *Some facts about tropical amoebas via model theory*.
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Let X be a semi-algebraic subset of $(\mathbb{R}_{>0})^n$. For $h > 0$, let $\mathcal{A}_h(X)$ be the image of X under the transformation $(x_1, \ldots, x_n) \mapsto (h \log(x_1), \ldots, h \log(x_n))$. When $n = 2$, we can think of $\mathcal{A}_h(X)$ as the result of graphing X on (scaled) logarithmic graph paper. Now, let $\mathcal{A}_0(X) = \lim_{h \to 0^+} \mathcal{A}_h(X)$, and call $\mathcal{A}_0(X)$ the *tropical amoeba* of X. I will discuss how to prove some basic properties of tropical amoebas using model theory. This is joint work with Matthias Aschenbrenner and Sergei Starchenko.

Abstracts of invited talks in the Special Session on Set-theoretic Algebra

► IVO HERZOG, *Hereditary pure torsion classes*.
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Let R be an associative ring with identity. A subcategory T of left R-modules is called a hereditary pure torsion class if it is closed under (1) arbitrary direct sums; (2) pure-extensions; (3) pure submodules; and (4) pure-epimorphic images. Using a pure variation of the Eklof–Trlifaj Theorem on how to make Ext vanish, we prove (jointly with P. A. Guil Asensio and P. Rothmaler) the existence of T-pure-injective preenvelopes. Then we note that the endomorphism ring of a T-pure-injective module is cotorsion, which allows us to deduce the existence of T-pure-injective envelopes. This observation also yields a theory of purity for T analogous to the theory of purity that I developed with Guil Asensio for the category of flat left R-modules.

► JAN TRLIFAJ, *The roots of Ext*.
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If $\mathcal{C}$ is a class of modules then the modules M such that $\mathrm{Ext}^1(M, C) = 0$ for each $C \in \mathcal{C}$ are called the *roots of Ext for* $\mathcal{C}$. These roots are ubiquitous in module and representation theory. They include projective, flat, and Baer modules, for example, and they are closely related to tilting and cotilting modules.

A basic technique of the structure theory of the roots consists in building filtrations whose consecutive factors are small roots of the same kind. This is the *deconstruction* of the roots. For example, the classical Kaplansky structure theorem for projective modules is a particular case of deconstruction where $\mathcal{C}$ is the class of all modules.

In my talk, I will introduce filtrations of modules, their basic properties (the Eklof and Hill lemmas), and explain how set–theoretic methods developed by Shelah, Eklof et al., are used for deconstruction with countably, and even finitely, generated root factors; [1], [3], [4], [5].

The roots of Ext naturally yield examples of abstract elementary classes (AEC's) in the sense of Shelah. I will finish by a recent result saying that the AEC's of the roots induced by tilting and cotilting modules are always of finite character in the sense of Hyttinen and Kesälä; [2], [6].

[1] L. ANGELERI HÜGEL, S. BAZZONI, and D. HERBERA, *A solution to the Baer splitting problem*, to appear in ***Transactions of the American Mathematical Society***.

[2] J. T. BALDWIN, P. C. EKLOF, and J. TRLIFAJ, $^{\perp}N$ *as an abstract elementary class*, ***Annals of Pure and Applied Logic***, vol. 149 (2007), pp. 25–39.

[3] P. C. EKLOF and A. H. MEKLER, ***Almost free modules***, Revised ed., North-Holland Mathematics Library, Elsevier, Amsterdam, 2002.

[4] R. GÖBEL and J. TRLIFAJ, ***Approximations and endomorphism algebras of modules***, W. de Gruyter, GEM 41, Berlin 2006.

[5] J. ŠAROCH and J. ŠŤOVÍČEK, *The countable telescope conjecture*, preprint (2007).

[6] J. TRLIFAJ, *Abstract elementary classes induced by tilting and cotilting modules have finite character*, preprint (2007).

Abstracts of invited talks in the Special Session on Set Theory

► ANDRES CAICEDO, *The extent of squares under* MRP.
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I present some recent results on the theory of the *Mapping Reflection Principle*, MRP, due to Moore, Sharon, Magidor, and to joint work with Veličković. MRP is a consequence of the Proper Forcing Axiom, PFA. It is well-known that PFA implies that the principles $\square(\kappa, \omega_1)$ and $\square_{\kappa,\omega_1}$ fail. We study the situation under MRP

► SEAN COX, *A covering theorem for the core model, with applications*.
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We prove a covering theorem for the core model below one strong cardinal. This theorem is used to find lower bounds for the consistency strength of several combinatorial principles on small regular cardinals.

Our theorem generalizes a theorem of Mitchell in two ways: by relaxing the smallness assumption on the universe, and by no longer requiring the ordinals of interest to be cardinals. We prove:

THEOREM 1. *Assume* 0-*pistol does not exist* (*i.e., in what follows, K is the core model for one strong cardinal*). *If $\gamma > \omega_2$, $cf^V(\gamma) < |\gamma|^V$, and γ is regular in K, then γ is measurable in K. Furthermore, if $cf^V(\gamma) > \omega$, then*:

1. *For every $\beta < cf^V(\gamma)$, all but nonstationarily many $\lambda < \gamma$ have order at least β in K.*
2. $o^K(\gamma) \geq cf^V(\gamma)$.

We apply this theorem to find lower bounds for the consistency strength of several combinatorial principles on small regular cardinals.

► STEPHEN JACKSON, *Some remarks about scales*.
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We revist the question of developing the analysis of scales and Suslin cardinals from just AD. Martin developed a technique for generating the next Suslin cardinal from AD, and we provide a fix for one of the scale arguments to show that all the appropriate pointclasses do have the scale property with one exception: the Σ_0 class immediately following an inductive-like pointclass. This leads to some questions about homogeneous trees which we formulate.

► J. R. STEEL, *The consistency strength of* $\mathsf{AD}_{\mathbb{R}}$.
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The $\mathsf{AD}_{\mathbb{R}}$ *hypothesis* is the assertion: there is an ordinal λ which is both a limit of Woodin cardinals, and of cardinals which are $< \lambda$-strong. It gets its name because Woodin showed around 15 years ago

THEOREM 0.1 (Woodin). *If the* ZFC *plus* $\mathsf{AD}_{\mathbb{R}}$*-hypothesis is consistent, then* ZF *plus* $\mathsf{AD}_{\mathbb{R}}$ *is consistent. Indeed, if* λ *witnesses the* $\mathsf{AD}_{\mathbb{R}}$ *hypothesis, then* $\mathsf{AD}_{\mathbb{R}}$ *holds in the derived model at* λ.

In the other direction, Wooding obtained from $\mathsf{AD}_{\mathbb{R}}$ a model in which OR is a limit of Woodins and $<$ OR stong cardinals (but Replacement fails; the order type of the strong cardinals is ω). We shall close the gap here:

THEOREM 0.2. *If* ZF *plus* $\mathsf{AD}_{\mathbb{R}}$ *is consistent, then* ZFC *plus the* $\mathsf{AD}_{\mathbb{R}}$*-hypothesis is consistent. Indeed, if* V *is the minimal model of* $\mathsf{AD}_{\mathbb{R}}$*, then in some generic extension of* V*, there is a proper class extender model* $\mathcal{M}$ *satisfying the* $\mathsf{AD}_{\mathbb{R}}$*-hypothesis, and such that* V *is a derived model of* $\mathcal{M}$.

Woodin also produced a consistency-strength upper bound for $\mathsf{AD}_{\mathbb{R}} + \mathsf{DC}$, and our work shows this bound is exact.

Technically speaking, our work is a refinement of a proof, due to Neeman and the author, of Woodin's theorem that the Mouse Set Conjecture holds in the minimal model of $\mathsf{AD}_{\mathbb{R}}+\mathsf{DC}$. See [1], especially section 14, where the consistency strength of AD^+ plus "All Π^2_1 sets are Susslin" is computed

[1] J. STEEL, *Derived models associated to mice*, to appear in the proceedings of the Singapore 2005 workshop, ***Computational prospects of infinity***, World Scientific.

Abstracts of contributed talks

► BROOKE ANDERSEN, *Comparing strong notions of reducibility*.
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We define a D-reduction procedure to be a Turing reduction procedure that is total on all recursively enumerable sets. This gives a (nontransitive) notion of reducibility between truth-table and Turing. Conditions are then added to guarantee transitivity, and the transitive notion is distinct from all other known reducibilities. We discuss our ongoing work comparing this reducibility with other notions of reducibility.

► PAUL CORAZZA, *The Axiom Of Infinity and transformations* $V \to V$.
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We suggest a new approach for addressing the problem of establishing an axiomatic foundation for large cardinals. An axiom asserting the existence of a large cardinal can naturally be viewed as a strong Axiom of Infinity. However, it has not been clear on the basis of our knowledge of ω itself, or of generally agreed upon intuitions about the true nature of the mathematical universe, what the right strengthening of the Axiom of Infinity is—which large cardinals ought to be derivable? It was shown in the 1960s by Lawvere [2] that the existence of an infinite set is equivalent to the existence of a certain kind of structure-preserving transformation from V to itself, not isomorphic to the identity. We use Lawvere's transformation, rather than ω, as a starting point for a reasonably natural sequence of strengthenings and refinements, leading to a proposed strong Axiom of Infinity. A first refinement was discussed in Blass [1], showing that if the preservation properties of Lawvere's tranformation are strengthened to the point of requiring it to be an *exact functor*, such a transformation is provably equivalent to the existence of a measurable cardinal. We propose to push the preservation properties as far as possible, short of inconsistency. The resulting transformation $V \to V$ is strong enough to account for virtually all large cardinals, but is at the same time a natural generalization of an assertion about transformations $V \to V$ known to be equivalent to the Axiom of Infinity.

[1] A. Blass, *Exact functors and measurable cardinals*, ***Pacific Journal of Mathematics***, vol. 63 (1976), no. 2, pp. 335–346.

[2] W. Lawvere, *Adjointness in foundations*, ***Dialectica***, vol. 23 (1969), no. 23, pp. 281–296.

► CURTIS FRANKS, *Herbrand on arithmetization*.
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Jacques Herbrand intended for his proof-theoretical investigations to be a contribution to Hilbert's foundational program. However, in remarks and apologies he wrote between 1929 and 1931 he explicitly distanced himself from Hilbert's philosophical views and described his work as philosophically neutral. For that reason, unlike his purely technical achievements, the details of Herbrand's thought and the significance of his results for the philosophical goals of Hilbert's program are not well-known.

Herbrand saw his theorem as allowing an "arithmetization" of meta-theory of a sort quite different from arithmetization of syntax in the style of Gödel (e.g., in [1], p. 213). He also was apparently aware of this difference even before Gödel's announcement: he described what an arithmetization of syntax would be, explained that it was not the sort of arithmetization he had accomplished, and expressed hope that it would be possible ([2], p. 38). These two styles of arithmetization were both inspired by philosophical aspects of Hilbert's program, though by different aspects.

I shall explain the sense in which Herbrand intended his results as an arithmetization of meta-theory, distinguish this sort of arithmetization from Gödel's, and explain the relevance of each to Hilbert's philosophical views. The two styles of arithmetization are not alternative but rather complimentary to one another. To emphasize this I shall describe an investigation of meta-theory that utilizes both styles of arithmetization jointly and demonstrate some of its applications. Along the way I shall illustrate the uniqueness and utility of Herbrand's largely unknown philosphical views.

[1] Jacques Herbrand, *Note non signée sur a thèse de Herbrand*, in [3], pp. 209–214, 1931.

[2] ———, *Recherches sur la théorie de la démonstration*, in [3], pp. 35–153, 1930.

[3] ———, ***Écrits logiques***, (Jean van Heijenoort, editor), Presses Universitaires de France, Paris, 1968.

► HUNTER JOHNSON, *Linear growth in VC dimension*.
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Vapnik Chervonenkis dimension is a basic combinatorial notion with applications in machine learning, stability theory, and statistics. I explore what effect model theoretic structure has on the VC dimension of formulas, considered as parameterized families of sets, with respect to long disjunctions and conjunctions. If the growth in VC dimension is linear in the number of disjunctions, then the theory under consideration has a certain kind of good structure. I have found a general class of theories in which this structure obtains, as well as situations where it fails. I will discuss characterizing the phenomenon in terms of established classifications of structure.

► PETER KOEPKE, *A finestructural refinement of the J-hierarchy for extender models*.
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We interpolate successive levels J_α^E and $J_{\alpha+1}^E$ of JENSEN's J-hierarchy for the extender model L^E by an ω-sequence of intermediate levels

$$J_\alpha^E = F_{\omega\cdot\alpha}^E \subseteq F_{\omega\cdot\alpha+1}^E \subseteq F_{\omega\cdot\alpha+2}^E \subseteq \cdots \subseteq \bigcup_{n<\omega} F_{\omega\cdot\alpha+n}^E = J_{\alpha+1}^E.$$

Each F_γ^E is the underlying set of a structure $\mathcal{F}_\gamma^E = (F_\gamma^E, \in, E, \dots)$ containing a SKOLEM function and other basic constructible operations. The next level $F_{\gamma+1}^E$ consists of all subsets of F_γ^E which are definable *without quantifiers* over the structure $\mathcal{F}_\gamma^E$. The *fine hierarchy* $(\mathcal{F}_\gamma^E)_{\gamma\in\mathrm{Ord}}$ satisfies a strong condensation theorem and other finestructural laws. One can define *finestructural extensions* (ultrapowers) of $\mathcal{F}_\gamma^E$ by extenders in E. If all proper initial segments of $\mathcal{F}_\gamma^E$ are finestructurally sound then this inherits to the finestructural extension. Higher core model theory can be based on the new fine structure theory.

► G. MINTS, *Termination proof for epsilon substitution by bar induction*.
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A new termination proof for epsilon substitution method for the first order arithmetic is presented. Termination is established by bar induction on a decidable tree of sequences.

► JEFFREY ROLAND, *Remarks on governing maxims of set theory*.
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Call a maxim which guides or regulates the development of set theory, in the sense that decisions to accept or reject candidate set-theoretic axioms are made (at least in part) in accordance with the maxim, a *governing maxim of set theory*. Recent work on the methodological foundations of set theory, particularly as in [1], has brought the role of governing maxims of set theory to the fore, especially as regards the epistemology of set theory. In brief, the idea is the following. Taking for granted that we are justified in believing our current set-theoretic axioms, we identify the methods of current set-theoretic practice responsible for these beliefs. We then attempt to extract general guiding principles underlying these methods. These principles are governing maxims of set theory. Since following these maxims has produced justified beliefs concerning set-theoretic axioms up to now, we think that following them in novel cases will likely produce justified beliefs.

In these remarks, I consider a desideratum, *modal backwards compatibility* (MBC) that any satisfactory governing maxim of set theory should meet. After introducing and motivating MBC I formulate a method for determining whether or not a governing maxim satisfies it, utilizing a device I call *potential development trees* for set theory, and show that this method is correct, in the sense that the method ratifies all and only those maxims satisfying MBC.

[1] PENELOPE MADDY, ***Naturalism in mathematics***, Oxford University Press, 1997.

► WIM RUITENBURG, *A classical model theory for intuitionistic logic*.
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We present model-theoretic methods that use classical Kripke models of intuitionistic theories. Applications involve non-constructive proofs that all members of a nontrivial class of intuitionistic theories admit quantifier elimination. We define a notion of Kripke submodel that is a straightforward generalization of the classical notion of submodel, and define a notion of universal formula that generalizes the classical notion of universal formula.

This is joint work with Ben Ellison, Jon Fleischmann, and Dan McGinn.

► IOANNIS SOULDATOS, *Cardinals characterizable by Scott sentences*.
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We say that a Scott sentence *characterizes* κ, if it has a model of size κ, but not of size κ^+. From [1], [2] and [3] we know that for $\alpha < \omega_1$, $\aleph_\alpha$ and $\beth_\alpha$ are characterizable by a Scott sentence. We build upon these results to prove several closure properties of characterizable cardinals.

[1] J. E. Baumgartner, *The Hanf Number for complete $\mathcal{L}_{\omega_1,\omega}$ sentences (without GCH)*, ***The Journal of Symbolic Logic***, vol. 39 (1974), no. 3, pp. 575–578.

[2] G. Hjorth, *Knight's model, its automorphism group, and characterizing the uncountable cardinals*, ***Journal of Mathematical Logic***, vol. 2 (2002), no. 1, pp. 113–144.

[3] J. Malitz, *The Hanf Number for complete $\mathcal{L}_{\omega_1,\omega}$ sentences*, ***The syntax and semantics of infinitary languages***, Lecture Notes in Mathematics, vol. 72 (J. Barwise, editor), Springer-Verlag, Berlin and New York, 1968, pp. 168–181.

► M. C. STANLEY, *Outer model satisfiability*.
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There is no uniform (with respect to transitive standard models of ZFC) parameter-free first-order characterization of the family of subsets of ω_2 that have a closed unbounded subset in some ω_1 and ω_2 preserving outer model satisfying ZFC. Analogous results hold for certain other natural problems.

In contrast, *stationary* characterizes (even over H_{ω_2}) the subsets of ω_1 that have a club subset in an ω_1 preserving outer model.

If V is a standard transitive model of ZFC, say that W is an *outer model* if $W \supseteq V$, $W \cap \mathrm{OR} = V \cap \mathrm{OR}$, and W satisfies ZFC. Talk of outer models is inherently second-order. The least restrictive way to understand claims of outer model existence is to understand "V" in this abstract as itself countable in a larger ambient universe.

For present purposes, let

$$\mathrm{ZFC}^+ = \mathrm{ZFC} + \text{"every definable club class of ordinals contains a Ramsey cardinal"}.$$

Theorem. *There exists a parameter-free Π_2 formula* $\mathsf{good}(x)$ *in the language of set theory that, for regular uncountable κ, defines over H_κ, uniformly with respect to transitive standard models of* ZFC^+, *the family of first-order theories T in the language of set theory with parameters in H_κ that are satisfiable in some outer model*: *Let V be a standard transitive model of* ZFC^+.

1. *If $H_\kappa^V \models \mathsf{good}[T]$, then there exists an outer model of V that satisfies T.*
2. *If $H_\kappa^V \models \neg\mathsf{good}[T]$ and V is sufficiently non-minimal, then T is not satisfied in any outer model of V.*

The sufficient non-minimality requirement in item 2 is necessary. If "V" in the above theorem is actually V_δ, where δ is inaccessible in some longer standard model of ZFC, then V is sufficiently non-minimal.

► FRANKLIN D. TALL, *Useful models of set theory*.
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These models are obtained by forcing over a ground model containing a coherent Souslin tree S with partial orders that preserve S, and then forcing with S. For example one could start with L and then iterate CCC posets preserving S, and then force with S. The PFA or MM versions are most interesting, say starting with a ground model in which one has forced to add Cohen subsets of every regular cardinal, while preserving a supercompact. Quite a few consequences of PFA still hold, e.g., P-ideal dichotomy (Todorcevic, unpublished). On the other hand, the Cohen forcing plus the Souslin forcing yield consequences of $V = L$ that are important in general topology. The combination of PFA and $V = L$ consequences has led and is leading to the solution of a number of previous intractable problems in topology. As these models become better known the applications can be expected to branch out into other areas.

► SERGEI TUPAILO, **NF** *and indiscernibles in* **ZF**.
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We show how **NF** (Quine's "New Foundations") can be seen as a special non-standard model of **ZF**. First, we give a two-lines construction of a model of **NFU**. Then, we give a sufficient condition for [the famous open problem of] **NF** consistency. Finally, in the **ZF** language, we will present a much simplified Specker's refutation of **AC** in **NF** (= in that model of **ZF**).

[1] M. Boffa, ZFJ *and the consistency problem for* NF, ***Jahrbuch der Kurt Gödel Gesellschaft*** (Wien), pp. 102–106, 1988.

[2] M. Crabbé, *Typical ambiguity and the axiom of choice*, ***The Journal of Symbolic Logic***, vol. 49, pp. 1074–1078, 1984.

[3] ———, *On NFU*, ***Notre Dame Journal of Formal Logic***, vol. 33, pp. 112–119, 1992.

[4] E. P. Specker, *Typical ambiguity*, (E. Nagel, editor), ***Logic, methodology and philosophy of science***, Stanford University Press, pp. 116–123, 1962.

► DAN E. WILLARD, *On how self-justifying axiom systems are related to evolving logical formalisms*.
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An *Evolving Logical Formalism E* is a countable set of axiom systems $\alpha_1, \alpha_2, \alpha_3, \ldots$ such that

1. The union of these axiom systems (denoted as α^E) is a consistent system
2. Each of the $\alpha_1, \alpha_2, \alpha_3, \ldots$ are recursively defined axiom systems
3. The set of Gödel numbers of these sub-systems $\alpha_1, \alpha_2, \alpha_3, \ldots$ is the complement of a recursively enumerable set.

At an intuitive level, an Evolving Logical Formalism E can be viewed as representing the states of a Thinking Being T which changes which axiom system it employs as time progresses (and which allows T to make *temporary errors* provided that they are *always later corrected*).

It is relatively easy to devise such formalisms E where α^E can corroborate all the logically valid Π_1 and Σ_1 arithmetic sentences. In this talk, we seek to do more than this—and devise E so that its sub-states $\alpha_1, \alpha_2, \alpha_3, \ldots$ can additionally recognize their own consistency?

It turns out one can accomplish this feat in essentially each case where our previous research [1, 3, 4, 5] had constructed a self-justifying axiom system. For instance if we employ a language that treats addition as a total function but treats multiplication as a 3-way relation, then each α_i can recognize its self-consistency under semantic tableaux deduction. Likewise, if our language treats both addition and multiplication as 3-way relations (where neither addition nor multiplication are presumed to be total operations), then each α_i can be made to recognize its own Hilbert consistency.

Also in those cases where [2, 5, 6] had developed a generalization of the Second Incompleteness Theorem prohibiting self-justification from occurring, a similar restriction applies to E.

[1] D. Willard, *Self-verifying systems, the incompleteness theorem and tangibility*, ***The Journal of Symbolic Logic***, vol. 66 (2001), pp. 536–596.

[2] ———, *How to extend the semantic tableaux and cut-free versions of the second incompleteness theorem almost to Robinson's arithmetic Q*, ***The Journal of Symbolic Logic***, vol. 67 (2002), pp. 465–496.

[3] ———, *An exploration of the partial respects in which an axiom system recognizing solely addition as a total function can verify its own consistency*, ***The Journal of Symbolic Logic***, vol. 70 (2005), pp. 1171–1209.

[4] ———, *On the available partial respects in which an axiomatization for real valued arithmetic can recognize its consistency*, ***The Journal of Symbolic Logic***, vol. 71 (2006), pp. 1189–1199.

[5] ———, *A generalization of the second incompleteness theorem and exceptions to it*, ***The Annals of Pure and Applied Logic***, vol. 141 (2006), pp. 472–496.

[6] ———, *Passive induction and a solution to a Paris–Wilkie open question*, ***The Annals of Pure and Applied Logic***, vol. 146 (2007), pp. 124–149.

Abstracts of talks presented by title

► PAUL BANKSTON, *Identifying a topological space via first order lattice information*.
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We explore the idea of identifying a topological space—within a class of related spaces—using only first order information about the closed set lattice of the space. It is an old result of C. W. Henson, et al., that the closed unit interval is identifiable within the class of metrizable spaces. When the first order information is restricted to sentences that are *base free*; i.e., stable under change of lattice base for any compact Hausdorff space, then no nondegenerate metrizable continuum, and no infinite scattered metrizable compactum, is identifiable within the class of compact metrizable spaces. However, any topological graph is identifiable within the smaller class of locally connected compact metrizable spaces.

► JOHN CORCORAN, *Iffication, preiffication, qualiffication, reiffication, and deiffication*.
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Roughly, *iffication* is the speech-act in which—by appending a suitable *if-clause*—the speaker qualifies a previous statement. The clause following *if* is called the *qualiffication*. In many cases, the intention is to retract part of the previous statement—called the *preiffication*. I can retract part of "I will buy three" by appending "if I have money". This initial study focuses on logical relations among propositional contents of speech-acts—not their full conversational implicatures, which will be treated elsewhere. The modified statement—called the *iffication*—is never stronger than the preiffication. A *degenerate* iffication is one logically equivalent to its preiffication. There are limiting cases of degenerate iffications. In one, the qualiffication is tautological, as "I will buy three if three is three". In another, the negation of the qualiffication implies the preiffication, as "I will buy three if I will not buy three". *Reiffication* is iffication of an iffication. "I will buy three if I have money" is reifficated by appending "if there are three left". *Deiffication* is the speech-act in which—by appending a suitable *and-clause*—the effect of an iffication is cancelled so that the result implies the preiffication. "I will buy three if I have money" is deifficated by appending "and I have money". All further examples come from standard (one-sorted, tenseless, non-modal) first-order arithmetic. All theorems are about first-order arithmetic propositions. An easy theorem, hinted above, is that an iffication is degenerate if and only if the negation of the qualiffication implies the preiffication. The iffication of a conjunction using one of the conjuncts as qualiffication need not imply the other conjunct: "Two is an even square if two is square" does not imply "Two is even".

► JOHN CORCORAN AND WAGNER SANZ, *Disbelief logic complements belief logic*.
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Consider two doxastic states *belief* and *disbelief*. Belief is taking a proposition to be true and disbelief taking it to be false. Judging also dichotomizes: *accepting* a proposition results in belief and *rejecting* in disbelief. Stating follows suit: *asserting* a proposition conveys belief and *denying* conveys disbelief. Traditional logic implicitly focused on logical relations and processes needed in expanding and organizing systems of beliefs. Deducing a conclusion from beliefs results in belief of the conclusion. Deduction presupposes consequence: one proposition is a consequence of a set of propositions if the latter logically implies the former. The role of consequence depends on its being *truth-preserving*: every consequence of a set of truths is true. This paper, which builds on previous work by the second author, explores roles of logic in expanding and organizing systems of disbeliefs. *Aducing* a conclusion from disbeliefs results in disbelief of the conclusion. *Aduction* presupposes *contrequence*: one proposition is a contrequence of a set of propositions if the set of negations or contradictory opposites of the latter logically implies that of the former. The role of contrequence depends on its being *falsity-preserving*: every contrequence of a set of falsehoods is false. A system of aductions that includes, for every contrequence of a given set, an aduction of the contrequence from the set is said to be *complete*. Historical and philosophical discussion is illustrated and enriched by presenting complete systems of aductions constructed by the second author. One such, a natural aduction system for Aristotelian categorical propositions, is based on a natural deduction system attributed to Aristotle by the first author and others.

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One of the less known characterizations of a Ramsey cardinal κ involves the existence of certain types of elementary embeddings for transitive sets of size κ satisfying a large fragment of ZFC. I will introduce new large cardinal axioms generalizing the Ramsey embeddings and show that they form a natural hierarchy between weakly compact cardinals and measurable cardinals. These axioms further our knowledge about the elementary embedding properties of smaller large cardinals, in particular those still consistent with $V = L$. I will discuss other interesting questions that remain about the exact placement of these cardinals within the large cardinal hierarchy.

► XUNWEI ZHOU, *Rule-based inference v. hypothetical inference*.
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In classical logic, rule-based inference and hypothetical inference are not distinguished, they are regarded as the same thing. In mutually-inversistic logic, however, they are regarded as different thing. To show you a geometry example, rule-based inference is described by

$$\frac{\Delta ABC \cong \Delta A'B'C'}{\therefore\ AB = A'B'}$$

where the general law $\Delta ABC \cong \Delta A'B'C' \rightarrow AB = A'B'$ is used as an inference rule, inferring the unknown fact $AB = A'B'$ from the known fact $\Delta ABC \cong \Delta A'B'C'$. Hypothetical inference is described by

$$\begin{array}{l} \Delta ABC \cong \Delta A'B'C \rightarrow AB = A'B' \\ \Delta ABC \cong \Delta A'B'C' \\ \hline \therefore\ AB = A'B' \end{array}$$

where the general law $\Delta ABC \cong \Delta A'B'C' \rightarrow AB = A'B'$ is used as a geometrical theorem, taken as the major premise, $\Delta ABC \cong \Delta A'B'C'$ is taken as the minor premise, inferring the conclusion $AB = A'B'$.

In mutually-inversistic logic, first level rule-based inference and second level rule-based inference are distinguished. First level rule-based inference infers fact, as the rule-based inference shown above. Second level rule-based inference infers empirical theorem or mathematical theorem, which is described by

$$\frac{\mathrm{int}(x) \rightarrow \mathrm{rat}(x)}{\therefore\ \neg\mathrm{rat}(x) \rightarrow \neg\mathrm{int}(x)}$$

where the contrapositive law is used as an inference rule, inferring the mathematical theorem $\neg\mathrm{rat}(x) \rightarrow \neg\mathrm{int}(x)$ from $\mathrm{int}(x) \rightarrow \mathrm{rat}(x)$. In mutually-inversistic logic, second level hypothetical inference is proposed, which is described by

$$\begin{array}{l} (P \rightarrow Q) \rightarrow (\neg Q \rightarrow \neg P) \\ \mathrm{int}(x) \rightarrow \mathrm{rat}(x) \\ \hline \therefore\ \neg\mathrm{rat}(x) \rightarrow \neg\mathrm{int}(x) \end{array}$$

where the contrapositive law is used as a logical theorem, taken as the major premise, $\mathrm{int}(x) \rightarrow \mathrm{rat}(x)$ is taken as the minor premise, inferring the conclusion $\neg\mathrm{rat}(x) \rightarrow \neg\mathrm{int}(x)$.