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RESEARCH CONFERENCES

ESF Mathematics Conference in Partnership with EMS and ERCOM

Model Theory

The Banach Center, Będlewo • Poland
9-14 August 2009

Chair: **Ludomir Newelski,** Uniwersytet Wrocławski, PL
ESF Rapporteur: **Manuel de León Rodríguez**, CSIC, ES

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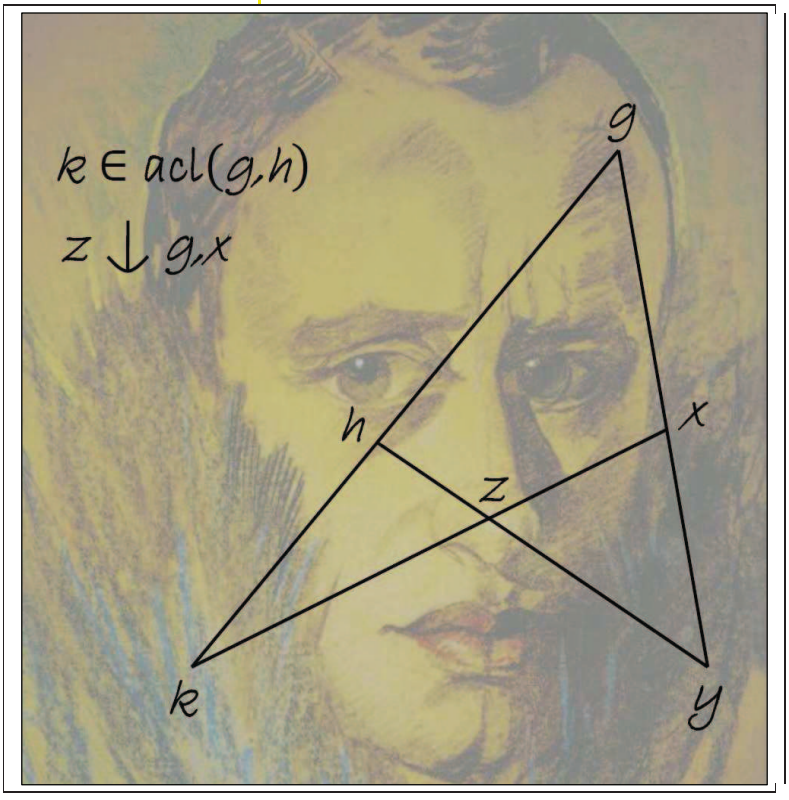

Conference Highlights

Please provide a brief summary of the conference and its highlights in non-specialist terms (especially for highly technical subjects) for communication and publicity purposes. (ca. 400-500 words)

The conference was held in the Mathematical Conference Center in Będlewo, Poland, in the period of 9-14 August 2009. The meeting was attended by 83 participants, mostly from Europe and USA, but also from Columbia, Canada and South Korea. It gathered several top specialists from model theory as well as many junior researchers and graduate students. The young participants were the majority of all participants.

The scientific program consisted of 14 long and 12 short talks and a poster session, consisting of 19 posters presented by young participants. The invited speakers were carefully selected by the Program Committee from among the experienced top researchers in the area and also from the promising junior researchers, taking adequate care of geographical and gender balance. The long talks were devoted to recent important developments in model theory. The short talks and the posters provided an opportunity for the younger participants to present results of their research.

The program of the conference covered all the main parts of model theory. Out of 14 long talks, 3 were devoted to pure model theory, 3 to o-minimality, 2 to groups of finite Morley rank, 1 to algebraic model theory and 3 to applications of model theory in algebra and computer science. 2 final talks were given by Ehud Hrushovski and Anand Pillay, the outstanding figures in model theory. Their excellent talks covered broad spectrum of issues and were pointing directions for further development of model theory as an important part of contemporary mathematics. Another outstanding speaker who attended the conference was Lou van den Dries, one of the founders of o-minimality. He gave one of the o-minimality talks. The short talks and the posters in the poster session covered more subjects of contemporary model theory, including additionally model theory of metric spaces, abstract elementary classes and finite model theory. So the scope of the conference covered practically all the subjects of contemporary model theory.

The conference was concluded by Forward Look Session. In this session a brief summary of the talks of the conference was presented. Also, there were some questions and discussion. There were also some announcements of future conferences in model theory to be held in 2010.

The goals of the conference were successfully realized. The participants, particularly the young ones, could learn about the important developments in model theory. The setting of the conference, remote from large cities, and the accommodation of the participants in a single compound facilitated interactions between them, discussions during the free time and social events.

The conference served well as a device for dissemination of the latest research results in model theory and for integration of the model-theoretic community. Several participants expressed their view that this meeting was the main event in model theory in 2009.

☒ I hereby authorize ESF – and the conference partners to use the information contained in the above section on 'Conference Highlights' in their communication on the scheme.

Scientific Report

Executive Summary

(2 pages max)

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Scientific Content of the Conference

(1 page min.)

- *Summary of the conference sessions focusing on the scientific highlights*
- *Assessment of the results and their potential impact on future research or applications*

The scientific program of the conference consisted of 14 long and 12 short talks, and a poster session, consisting of 19 posters presented by young participants. The talks were delivered in 13 sessions. The 14. session was Forward Look Session.

Monday, 10 August. 4 sessions.

On Monday the long talks were given by David Evans, Ziv Shami, Chris Laskowski and Margarita Otero and the short talks by Krzysztof Krupiński, Alex Usvyatsov, Jakub Gismatullin and Philipp Hieronymi. Evans presented an exposition of an important recent paper by Hrushovski (still unpublished) on categorical approach to amalgamation properties in model theory. This paper provides a new research perspective in model theory. Shami described a proof of his recent result that every countable unidimensional simple theory with elimination of hyperimaginaries is supersimple. This generalizes an earlier result of Hrushovski from his Ph.D. Thesis, on superstability of unidimensional simple theories. The approach of Shami includes novel aplication of topological methods and Baire categoricity in simple theories. Laskowski preesented an exposition of a paper being prepared by himself, together with Elisabeth Bouscaren and Bradd Hart, describing the structure of models of classifiable theories. These results were obtained in

early 90's by Hrushovski, who sketched the proofs then. Now this material is finally written down. This is a completion of the Shelah classification program in the case of countable theories. Otero was speaking of the topological structure of groups definable in o-minimal structures. This subject became important due to conjectures of Pillay on infinitesimals in such groups, and the subsequent results of Hrushovski, Peterzil, Pillay and others. An essential part of the talk was an exposition of definable homotopy in the o-minimal setting.

The short talks on Monday were devoted to model theory of Polish spaces (Krupiński), model theory of metric spaces (stable types in Banach spaces, Usvyatsov), model-theoretic connected components in groups (Gismatullin) and definability of integers in expansions of the real field (o-minimality, Hieronymi).

Tuesday, 11 August. 2 sessions and a poster session (excursion in the afternoon).

On Tuesday the long talks were given by Lou van den Dries and Jean-Philippe Rolin and the short talks by Jana Mařikova and Tamara Servi. Both long talks were about o-minimality. Van den Dries is one of the founders of o-minimality. Rolin works in real-algebraic geometry, where o-minimality has found important applications. The talk of van den Dries was devoted to invariant measures on groups with chain conditions, while the talk of Rolin was about real summation process and o-minimality. The talk of van den Dries was of more logical nature, while the talk of Rolin was more analytic.

The shorter talks on Tuesday were devoted to non-standard models of o-minimal expansions of the reals, expanded by the standard part mapping (Mařikova) and to decidabbility issues of the theory of a real field with a generic power function (Servi). The latter talk was related to Schanuel conjecture.

In the poster session 19 posters were presented. The posters covered a wide spectrum of subjects, including abstract elementary classes, model theory of metric spaces, o-minimality, valuation theory, pure and algebraic model theory, finite model theory. An interesting poster was displayed by Hill Cameron, who proposed a very original and promising model-theoretic approach to finite model theory.

Wednesday, 12 August. 4 sessions.

On Wednesday the long talks were delivered by Mario Edmundo, Katrin Tent, Jeffrey Burdges and Eric Jaligot and the short ones by Martin Bays, Misha Gavrilovich, Maryanthe Malliaris and Giuseppina Terzo. Edmundo gave a talk about definable o-minimal homotopy. He is the most competent person for this task, since he initiated the investigation of homotopy and homology in the o-minimal context. Tent was speaking on recent joint results with Martin Ziegler, on determining whether some reals (like e) are periods (that is, integrals of some rational functions over some semi-algebraic sets). They have introduced a related notion of a low number, with connotations in computability theory. This research has model-theoretic flavor and may be important in number theory. Burdges and Jaligot gave a survey of results towards a proof of Cherlin-Zilber conjecture on simple groups of finite Morley rank. This conjecture, formulated over 20 years ago, stemmed a lot of research on groups of finite Morley rank. The talk of Burdges was more technical, while the talk of Jaligot more expository.

Short talks on Wednesday were devoted to covers of elliptic curves and excellence (Bays), an analogy of Shelah's theory of possible cofinalities (PCF set theory) and categorical homotopy theory (Gavrilovich), new combinatorial characterizations of several fundamental stability properties of model theory (Malliaris) and rings with exponentiation (Terzo). The talk of Bays was related to a research program of Boris Zil'ber on model-theoretic description of the field of complex numbers with exponentiation. Terzo reported results of her joint work with Angus Macintyre.

Thursday, 13 August. 3 sessions and Forward Look Session.

The long talks on Thursday were given by Janos A. Makowsky, Thomas Scanlon, Ehud Hrushovski and Anand Pillay, while the shirt ones by Fares Malouf and Juan Diego Caycedo. Makowsky gave a talk on connections between algorithmic graph theory and countably categorical structures in model theory. Makowsky is a famous specialist in theoretical computer science. His talk may create a new important research link between model theory and computer science. Scanlon gave a beautiful talk on algebraic dynamics. He showed how certain results from algebraic dynamics may be proved by skillfully interpreting them within the field of p-adic numbers. He attributed this method already to Skolem. Hrushovski gave a beautiful and insightful talk on generating some special subgroups in definable groups, subgroups stabilizing in a way certain subsets of the group. This is a far-reaching generalization of his own results on these issues in stable and simple structures, fundamental in model theory. He sketched a broad mathematical perspective for possible applications of these model-theoretic ideas. Pillay gave a talk on generalizing several basic stability-theoretic notions to new unstable contexts, mainly to theories with NIP.

The short talks on Thursday were defining groups in C-minimal structures (Malouf) and on the model-theoretic problems related to the field of complex numbers with exponentiation (Caycedo). The talk of Malouf was particularly interesting, his results are a natural counterpart of earlier results of similar nature in o-minimality (Starchenko, Peterzil) and stability (Hrushovski). Finding definable groups in various model-theoretic contexts is an important thread in model theory.

Forward Look

(1 page min.)

- *Assessment of the results*
- *Contribution to the future direction of the field – identification of issues in the 5-10 years & timeframe*
- *Identification of emerging topics*

Model theory is a branch of mathematical logic dealing with mathematical structures (models). It was created in the 40's and 50's of the last century by Abraham Robinson and Alfred Tarski (whose portrait served as a background for the conference poster). In the several decades of its development model theory gradually was broadening its scope, using more and more advanced techniques and finding connections and applications to classical mathematics, mainly algebra, algebraic geometry, real algebraic geometry and analysis.

Thus model theory is traditionally divided into pure and applied parts. In turn, applied model theory splits further into algebraic model theory, dealing with model-theoretic properties of concrete algebraic structures, and o-minimality theory, dealing with model-theoretic properties of the ordered field of reals and its expansions, essential for connections with real algebraic geometry. All these research directions were represented in the talks at the conference. The talks were given by outstanding specialists, ensuring the highest scientific quality.

The talks and other scientific activities of the conference were fully in line with the general direction of development of model theory described above. It became clear that for its further development model theory on one hand side needs to develop its pure part, investigating the general logical properties of mathematical structures, and on the other hand side it should strengthen applications in classical mathematics. The interaction between model theory other branches of mathematics is essential for recognition of model theory as an established an important part of mathematics.

The community of model theorists is open to new ideas coming from other parts of mathematics. Hence there were some invited speakers from outside model theory and there were talks on connections and applications of model theory to new areas of mathematics. Notably, there were talks by Janos A. Makowsky (connections with algorithmic graph theory), Katrin Tent (connections with number theory) and Jean-Philippe Rolin (connections with real algebraic geometry).

Maybe the most important from the talks on the conference was the talk by Ehud Hrushovski. He

sketched a broad mathematical perspective for considering and applying model-theoretic ideas. He showed how model theory provides a common denominator, common roots for ideas appearing in various branches of mathematics. This talk gave an exciting outlook for future development of model theory. Other talks also were providing new problems and opening new research perspectives in model theory.

It seems that the talks and other scientific activities of the conference indicate that in the future in model theory, besides the existing research topics, there may occur new applications and connections with computer science and particularly with finite model theory. Finite model theory still lacks a unifying general structure theory. This may be provided by model theory.

▪ Is there a need for a foresight-type initiative?

Several participants considered this meeting the most important event in model theory in 2009. There are many meetings in model theory that specialize in particular parts of model theory. This was the only meeting devoted to model theory as a whole. Certainly there is a need for organizing similar events in the future.

Atmosphere and Infrastructure

▪ The reaction of the participants to the location and the organization, including networking, and any other relevant comments

The participants in general favorably evaluated the location and organization of the conference. There were some minor critical comments regarding the shape of the lecture room (it was long and relatively narrow, so that two screens were used, one in front and one in the middle of the room) .