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1 Abstracts

Mantık ve Bilginin Aydınlığında Sonlu Boyutlu Morley Öbekleri

Tuna Altınel

In my talks, I will try to touch upon various aspects of current research on groups of finite Morley rank while trying to stay close to the same common theme: *genericity*. The notion of a *generic set*, as well as that of a *generic type*, plays a major role in the model theory of groups. In the context of groups of finite Morley rank, this is even more visible in that generics are well-defined and their basic properties are as expected. They are the appropriate indicators of whether a definable set is "large".

Research on groups of finite Morley rank has been mostly centered around *the classification of the infinite simple* ones following the lead of the Cherlin–Zil'ber conjecture. This conjecture states that an infinite simple group of finite Morley rank is a linear algebraic group over an algebraically closed field.

The statement of the Cherlin–Zil'ber conjecture and the good behavior of generics in groups of finite Morley rank naturally led researchers to attempt to understand similarities between generic elements in groups of finite Morley rank and those in algebraic groups. It turned out that this is a difficult question. Indeed, for a considerable period of time, techniques from finite group theory overshadowed methods based on genericity arguments.

During the last five years, the situation has changed and the research activity has reached a new equilibrium. This started with attempts to substitute genericity arguments for various conjugacy theorems well-known in finite group theory and missing in the context of groups of finite Morley rank. It has so evolved that it has been possible to make major progress in the analysis of simple groups of finite Morley rank using genericity arguments and to prove genericity theorems using results about classification obtained following the lead of finite group theory. Along the way, some rather old open problems have been solved. The theory of groups of finite Morley rank has reached a new level of maturity.

In my first talk, I will introduce the basics of the subject and prove some old results about genericity. In my second talk, I will go over recent advances that use or are about generic elements. In my final talk, I will go over parts of the current work and mention some open problems.

I strongly suggest to the interested participants to listen to Alexandre Borovik's talk. . . and visit Lyon.

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Motivic Iwahori-Hecke algebras

Nir Avni

We will define Iwahori Hecke algebras for SL_2 over algebraically closed valuation fields using motivic integration to replace the Haar measure and study its structure.

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A Conjecture on Intersections with Tori in positive characteristic

Martin Bays

We show that Zilber's Conjecture on Intersections with Tori (the CIT) is equivalent to a Schanuel-type predimension inequality regarding raising to non-standard integer powers in algebraically closed fields of characteristic zero. We consider the analogous predimension inequality for positive characteristic, and the corresponding algebraic statement. This provides us with a candidate for a positive characteristic version of the CIT.

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Manin maps and the Schanuel conjecture

D. Bertrand

Let (F, ∂) be a differential field with an algebraically closed constant field C of characteristic 0, let E be the universal vectorial extension of a semi-abelian variety G defined over C, and let $\partial \ell n$ be the logarithmic derivative map on E. Let further y be a section of $E(F)$, whose projection to G generates G modulo constant sections. We prove the following generalization of the theorem of Ax (see also J. Kirby) on the functional Schanuel conjecture: *let x satisfy $\partial \ell n(y) = \partial(x)$; then $tr.deg_C C(x, y) \geq dim E + 1$.* We also discuss extensions of this theorem (and obstructions to such extensions) when G is not isoconstant. The proofs are based on the study of Manin maps, or rather, of their continuations to the full cohomology of G, and we take opportunity of this talk to clarify the role of such continuations.

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[1] Schanuel's conjecture for non-isoconstant elliptic curves over function fields, submitted to the MAA 2005 Cambridge Proceedings

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Permutation groups of finite Morley rank

Alexandre Borovik

Joint work with Gregory Cherlin

Surprisingly, not much known about algebraic groups viewed as permutation groups (in their rational actions). The talk will survey some recent results in this area, proved in the wider context of groups of finite Morley rank. Here is a sample result:

Theorem. *If a group G of finite Morley rank acts definably, faithfully and primitively on set of Morley rank n, then the Morley rank of G is bounded by a function of n.*

(Easy examples, in the category of algebraic groups, show that the "primitiveness" assumption cannot be dropped.)

The talk will include a discussion of a number of open problems.

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Minimal connected simple groups of odd type and Pruefer-rank 1

Adrien Deloro

The Cherlin–Zilber conjecture states that simple infinite groups of finite Morley rank are algebraic groups over algebraically closed fields.

In order to perform an inductive approach, one has to deal with *minimal connected simple* groups, that is simple groups whose proper definable connected subgroups are all solvable.

The only minimal connected simple algebraic group is PSL_2, but nothing so strong can be asserted in the finite Morley rank context.

"Non-tame" recognition of PSL_2 will be discussed, in contrast to the so-called "tameness" hypothesis.

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Compact domination for groups definable in linear o-minimal structures.

Pantelis E. Eleftheriou

Let $\mathcal{M}$ be a saturated ordered vector space over an ordered division ring. We show that the Compact Domination Conjecture from [1] is true in this context. Namely, let G be a definably compact, definably connected group, definable in $\mathcal{M}$. Then G is compactly dominated by $(G/G^{00}, \mathbf{m}, \pi)$, where $\mathbf{m}$ is the Haar measure on G/G^{00} and π is the canonical homomorphism from G onto G/G^{00}. Intuitively, compact domination means that π is a kind of intrinsic 'standard part map'.

References

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Reconstructing Affine and Projective Schemes from Serre Subcategories

Grigory Garkusha

Joint work with Mike Prest

We show how to reconstruct affine and projective schemes from appropriate abelian categories, using properties of the Ziegler and Zariski topologies.

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G-compactness and groups

Jakub Gismatullin

Lascar described E_{KP} as a composition of E_L and the topological closure of E_L ([1]). We generalize this result to some other pairs of equivalence relations.

Motivated by an attempt to construct a new example of a non-G-compact theory, we consider the following example from [2]. Assume G is a group definable in a structure M. We define a structure M' consisting of M and X as two sorts, where X is an affine copy of G and in M' we have the structure of M and the action of G on X. We prove that the Lascar group of M' is a semi-direct product of the Lascar group of M and G/G_L. We discuss the relationship between G-compactness of M and M'. This example may yield new examples of non-G-compact theories.

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When are bi-embeddable abelian groups isomorphic?

John Goodrick

In [1], Irving Kaplansky asked:

Question. *If G and H are abelian groups such that G is a direct summand of H and H is a direct summand of G, are G and H necessarily isomorphic?*

Instead of direct summands, we consider the weaker relation of "embeddable as a pure subgroup." We consider abelian groups as models in the pure group language with only the symbol $+$. Standard results show that if $f : G \to H$ and $g : H \to G$ are pure embeddings then they are elementary embeddings. The answer to the analogue of Kaplansky's question for pure embeddings is "no," but we can prove the following related result:

Theorem. *Let $(G, +)$ be an abelian group. The following are equivalent:*

1. *If H_1 and H_2 are elementarily equivalent to G and elementarily (or purely) bi-embeddable, then $H_1 \cong H_2$;*

2. *There is a countable set I of direct-sum-indecomposable groups such that any group elementarily equivalent to G is isomorphic to a direct sum of groups in I;*

3. $\mathrm{Th}(G)$ *is totally transcendental.*

(The equivalence of 2 and 3 is probably not new, but their equivalence with 1 does seem to be.)

In this talk we will explain this result and how it grew out of attempts to understand what the condition "elementary bi-embeddability implies isomorphism" means for arbitrary first-order theories. We note that once we allow larger languages than $\{+\}$, even the question of which weakly minimal groups have this property seems difficult.

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The real field with two small multiplicative groups

Ayhan Günaydın

Paper [1] studies the field $\mathbb{R}$ of real numbers with a subgroup G of $\mathbb{R}^{>0}$ satisfying a certain smallness condition, called the Mann property. In this talk, I consider $\mathbb{R}$ with two subgroups A, G of $\mathbb{R}^{>0}$ satisfying the Mann property with $G \subseteq A$. Roughly, I classify structures (R, A, G) up to elementary equivalence, where R is a real closed field and A, G are subgroups of $R^{>0}$ satisfying the Mann property with $G \subseteq A$, for example $(\mathbb{R}, 2^{\mathbb{Z}} \cdot 3^{\mathbb{Z}}, 2^{\mathbb{Z}})$.

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Measures on perfect PAC fields with pro-cyclic Galois group

Immanuel Halupczok

It is well known (see e.g. [1]) that for pseudo-finite fields, one has a "measure" on definable sets with some nice properties like being finitely additive and satisfying some kind of "Fubini theorem". In [2], Hrushovski asks whether one can get a similar measure (but with somewhat weaker properties) in the case of perfect PAC fields with bounded Galois group. I give an answer if one removes the Fubini theorem and instead only requires that the measure is invariant under definable bijections: The answer is yes for pro-cyclic Galois groups and no otherwise. In fact, for pro-cyclic Galois groups, under suitable conditions, one even gets uniqueness. (This is a new result even in the case of pseudo-finite fields, as up to now, uniqueness was only known using Fubini.)

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Definable groupoids

Ehud Hrushovski

A *concerete groupoid* is a definable set Ob, a family of definable sets $(X(a) : a \in Ob)$, and a definable family of bijections between the various sets $X(a)$, closed under compositions and inverses.

Given a definable set C (with the induced structure) and a definable set P internal to it, one can define a *liaison groupoid*: $\{X(a) : a \in O\}$ is a definable family of definable sets over P, each parameterically isomorphic to P; the bijections are defined in such a way that for any fixed $a \in O$, the bijections $X(a) \to X(a)$ form a group isomorphic to $Aut(P/C)$.

This construction generalizes the liaison group, but contains more information; indeed in a precise sense, all the information regarding P over C.

I'll discuss this and a couple of applications: to (generalized) Grothendieck groups, and a new proof of a theorem of Cluckers–Denef on p-adic orbits.

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The zero set property in certain o-minimal structures

Gareth Jones

I will show that in certain o-minimal expansions of the real exponential field, every closed definable set is the zero set of an infinitely differentiable definable function. The proof requires piecewise bounds on the derivatives (of all orders) of definable functions, and I will explain how these are obtained. This is joint work with Alex Wilkie.

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Hilbert 16, Riemann Mapping Theorem, Dirichlet problem and o-minimality

Tobias Kaiser

We consider the following three concepts:

1. Poincaré map:
The Poincaré map "counts" the number of limit cycles (converging to a polycycle) of a polynomial vector field on the real plane.
Used by Y. Ilyashenko in his proof of Hilbert 16, part 2 (1992).

2. Riemann Mapping Theorem:
A proper simply connected domain in $\mathbb{C}$ can be mapped biholomorphically on the unit ball.

3. Dirichlet problem:
Let $\Omega \subset \mathbb{R}^n$ be a (bounded) domain and let $g \in C(\partial\Omega)$. Find a function $u \in C^2(\Omega) \cap C^0(\overline{\Omega})$ which solves the following boundary value problem of the elliptic PDE given by the Laplacian

$$\Delta u = 0 \text{ in } \Omega,\ u = g \text{ on } \partial\Omega\,,$$

$$\Delta := \frac{\partial^2}{\partial x_1^2} + \ldots + \frac{\partial^2}{\partial x_n^2}\,.$$

We impose the following conditions

1. The vertices of the polycycle are hyperbolic saddles.
2. The simply connected domain is globally semianalytic
3. We work on the real plane ($n = 2$) and Ω and g are semianalytic

Then we can show that the Poincaré map, the Riemann map and the Dirichlet solution are definable in a common o-minimal structure, if in 1. the ratios of the eigenvalues of the hyperbolic saddles and if in 2. and 3. the angles of the domain of singular boundary points divided by π are irrational.

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Algebraic integration

David Kazhdan

Let $\underline{X}, \underline{Y}$ be smooth algebraic varieties over a local field $F, X = \underline{X}(F), Y = \underline{Y}(F)$ and ω be a top form on $\underline{Y}$. We will fix a non-trivial additive character $\psi : F \to \mathbb{C}^\star$. The to any $f \in \Gamma(\underline{X} \times \underline{Y}, \mathcal{O})$ we can associate a linear operator $A_f : \mathbb{C}_0^\infty(Y) \to \mathbb{C}^\infty(X)$ by

$$A_f(a)(x) := \int_{y \in Y} \psi(f(x,y))a(y)|\omega|$$

where $|\omega|$ is the measure on Y associated to the top-form ω.

An algebraic approach for the study of algebraic approach for the study of operators of the form A_f exists only in the case when the field F is finite. We discuss examples which suggest the existence of an [yet unknown] algebraic approach.

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Algebraic versions of the P = NP problem

Pascal Koiran

The talk will be devoted to the P versus NP problem in two algebraic models of computation: Valiant's model, which deals with evaluation of polynomials, and the Blum-Shub-Smale model, which deals with decision problem over the ordered field of the real numbers of other structures. I will show that P = NP over the real numbers would follow from the hypothesis that certain polynomial evaluation tasks are easy.

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Ax-Schanuel conditions in arbitrary characteristic

Piotr Kowalski

Theorems of Ax [1, 2] give Schanuel-like conditions on the differential equation of $\exp : \mathbb{C} \to \mathbb{C}^*$ and more generally $\exp : Lie(A) \to A$ for A semi-abelian (see also [3] and [4]). There are two problems with extending these results to the positive characteristic case – the exponential map does not exist (even as a formal map) and the notion of a derivation is not good enough. Nevertheless, we formulate an Ax-Schanuel condition in arbitrary characteristic using Hasse derivations and arbitrary "nowhere algebraic" formal group isomorphisms.

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The Model theory of some infinite dimensional representations of $sl_2(K)$

Sonia L'Innocente

This a joint work with Ivo Herzog [2].

This report aims at illustrating some results of a joint work with Ivo Herzog [2], devoted to a model theoretic investigation of the so called pseudo-finite dimensional representations of $sl_2(K)$, the Lie algebra of trace zero 2×2 matrices over an algebraically closed field K of characteristic zero. They were introduced by [1] as infinite dimensional representations such that they satisfy every first-order sentence of the theory of finite dimensional representations of $sl_2(K)$.

It is known that its endomorphism ring is a field extension K_V of K, so we want to characterize all elements of this field K_V. Here some intriguing connections with exponentiation arise. We also discuss some open problems in this framework.

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Local geometry of definable p-adic sets

François Loeser

Motivated by the study of arc spaces, we define local densities for definable p-adic sets in analogy with the complex and real cases. We also construct analogues of tangent cones and show that local densities can be computed on a suitable tangent cone "with multiplicities". Finally, we explain how local densities of a definable subset of dimension d can be retrieved by averaging local densities of projections onto d-dimensional linear spaces. This is joint work with Raf Cluckers and Georges Comte.

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Small skew fields

Cédric Milliet

J. Wedderburn showed in 1905 that finite fields are commutative. As for infinite fields, we know that superstable [CS] and supersimple [PSW] ones are commutative. In their proof, G. Cherlin and S. Shelah use the fact that a superstable field is algebraically closed. F. Wagner showed that an infinite small field is algebraically closed [Wag], and asked whether a small field should be commutative. We shall answer this question positively in non-zero characteristic.

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G-compactness is not preserved

Rodrigo Peláez

I will briefly introduce the notion of G-compactness and present some of the main results obtained in [1], [2] and [3]. Then I'll Show a G-compact theory T such that for a specific set of parameters A, $T(A)$ is not G-compact, thus giving a negative answer to the question of wether G-compactness is preserved when enlarging the language by constant symbols.

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Differential fields

David Pierce

In a differential field, how can we tell whether all consistent systems of equations and inequations have solutions? Reviewing the history of answers to this question, I shall update the accounts in [P1, P2].

To begin with the Robinsonian beginnings, I remind or inform the reader-listener that: The class of substructures of models of a theory T is elementary, and its theory is $T_\forall$. The class of structures in which a structure $\mathfrak{M}$ embeds is elementary, and its theory is $\operatorname{diag}(\mathfrak{M})$. The class of models of T is closed under unions of chains if and only if $T = T_{\forall\exists}$ [R2, 3.4.7]. The theory T is called *model-complete* [R1] if $T \cup \operatorname{diag}(\mathfrak{M})$ is complete whenever $\mathfrak{M} \models T$. If $T \subseteq T^*$, and $T_\forall = {T^*}_\forall$, then T^* is the *model-completion* [R2] of T if $T^* \cup \operatorname{diag}(\mathfrak{M})$ is complete whenever $\mathfrak{M} \models T$; but T^* is merely the *model-companion* of T if T^* is model-complete. A *derivation* of a field K is an additive endormorphism D of K that respects the Leibniz rule, $D(x \cdot y) = Dx \cdot y + x \cdot Dy$. A *differential field* is a field equipped with one or more derivations, usually commuting.

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[GR] Nicolas Guzy and Cédric Rivière. Principle of differential lifting for theories of differential fields and Pierce–Pillay axiomatization. 20xx.

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First order theories without the independence property

Anand Pillay

The NIP (not the independence property) is a weaker property than stability, and there is a hope that analogues or versions of some of the structural results associated with stable theories can be proved for theories with NIP. I will give a rather ad hoc presentation of some results in this direction, under the three general themes (a) Types, (b) Groups, (c) Measures.

The talks will be heavily influenced by recent works of Shelah on the subject, such as [3], some older work of Keisler [2], and a recent paper by Hrushovski, Peterzil, and myself [1].

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Strongly minimal sets with a simple predicate are simple

Olivier Roche

Let K be a strongly minimal $\mathcal{L}$-structure, and $F \subseteq K$ be any infinite subset. We are interested in the study of the pair-structure (K, F) in the language $\mathcal{L}_{(K,F)} := \mathcal{L} \cup \{F\}$. We show that if F with the induced structure is simple, then so is (K, F). This answers a question of Bijan Afshordel, whom we thank for preliminary talks on this subject.

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Definable analytic functions

Masahiro Shiota

We have a big list of results on definable analytic functions and manifolds for $\langle \mathbf{R}, <, +, \cdot \rangle$. We show some of them for $\mathbf{R}_{\mathrm{an}}$ and a few ones for general O-minimal structure over $\mathbf{R}$ hold.

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Ordered o-ω-stable groups

Viktor Verbovskiy

An ordered structure M is said to be *o-stable in* λ if for any cut in M and for any subset A of M with $|A| \leq \lambda$ there are at most λ one-types over A, which are consistent with the cut. A theory is called *o-stable in* λ if any its model is.

An ordered structure M is said to be *strongly o-stable in* λ, if in addition any definable cut is rational.

Here I study as general theory of o-stability, as partial questions, concerning ordered groups which are strongly o-ω-stable.

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Die böse Farbe

Frank Wagner

I shall describe the construction of a bad field, i.e. a field of finite Morley rank with a predicate for a proper non-trivial connected multiplicative subgroup, in characteristic 0. This is done via a Hrushovski amalgamation process by collapsing Poizat's green field of Morley rank $\omega \cdot 2$.

This is joint work with Andreas Baudisch, Martin Hils and Amador Martín Pizarro.

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Geometric properties of sets definable in weakly o-minimal structures

Roman Wencel

The main part of the talk will be devoted to the theory of topological dimension for sets definable in weakly o-minimal structures. I will also discuss the issue of cell decomposition in case of weakly o-minimal non-valuational expansions of ordered groups. A surprising application of the latter is a result saying that every weakly o-minimal expansion of the field of real algebraic numbers must be polynomially bounded.

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Black box recognition of finite groups and related group theoretic constructions

Şükrü Yalçınkaya

A *black box group* G is a finite group whose elements are encoded as 0-1 strings of uniform length and the group operations are performed by an oracle ('black box'). Given strings representing $g, h \in G$, the black box can compute the strings representing $g \cdot h$, g^{-1} and decide whether $g = h$. In problems naturally arising in computational group theory, some additional information is usually available, for example, the group can be given as a group of matrices over a finite field; another natural assumption is that we have an *order oracle* which determines the orders of elements.

In this context, a natural task is to find a probabilistic algorithm which determines the isomorphism type of the group G within given (arbitrarily small) probability of error. Under various mild assumptions, there are positive answers to this question in class of finite simple groups; for example, one can determine the isomorphism type of a finite simple group of Lie type with an order oracle [1]. I will present an algorithm which produces a non-trivial element, if any exists, from the p-core (or "unipotent radical") $O_p(G)$ of a black box group G where $G/O_p(G)$ is a finite (quasi)simple group of Lie type of odd characteristic p and I will talk on the construction of the Curtis-Tits system of root $(P)SL_2$-subgroups for the (quasi)simple part. The algorithm involves repeated constructions of centralizers of involutions [2] and properties of conjugacy classes in these groups.

References

[1] L. Babai, W. M. Kantor, P. P. Palfy, A. Seress, *Black-box recognition of finite simple groups of Lie type by statistics of element orders*, J. Group Theory 5, 2002, 383–401.

[2] A. V. Borovik, *Centralisers of involutions in black box groups*, Contemp. Math., 298, Amer. Math. Soc., Providence, RI, 2002, 7–20.

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Fusion of structures of finite Morley rank

Martin Ziegler

Let T_1 and T_2 be two countable complete theories in disjoint languages, of finite Morley rank, the same Morley degree, with definable Morley rank and degree. Let N be a common multiple of the ranks of T_1 and T_2. We show that $T_1 \cup T_2$ has a nice complete expansion of Morley rank N.

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3 Committees

Program committee: Ayşe Berkman, Zoé Chatzidakis, Gregory Cherlin, Angus Macintyre, Kobi Peterzil, Boris Zilber (chair)

Local organizing committee: Oleg Belegradek, Ayşe Berkman, Ali Nesin, David Pierce

Besides the addition of this text, the following changes have been made to the booklet since its distribution at the conference:

1. the places of Hrushovski and Loeser on the timetable have been switched;
2. the spelling of Günaydın's name has been corrected in the timetable;
3. the ligature in the email address of Toffalori has been removed (in the typewriter font, `toffalori` is better than `toﬀalori`);
4. page-numbers have been moved to the top;
5. people who did not come have been removed from the list of participants;
6. an email address on that list has been replaced with a web address.

4 Timetable

	Sunday	Monday	Tuesday
9.00	Pillay		
10.00	coffee		
10.30	Verbovskiy	Kaiser	Kazhda
11.30	Shiota	Wencel	Hrushovski
12.30	lunch		
14.30	Jones	Koiran	
15.30	coffee		
16.00	Günaydın	Pelaez	
16.30	Eleftheriou	Gismatullin	
17.00	Roche	L'Innocente	
17.30		Garkusha	
18.00	Reception		

	chairs		
A.M.	Zilber	Point	Toffalori
P.M.	Belegradek	Prest	