BOOK OF ABSTRACTS
FOR FIRST INTERNATIONAL CONFERENCE ON LOGIC AND RELATIVITY: HONORING ISTVÁN NÉMETI'S 70TH BIRTHDAY

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EVIDENCE DYNAMICS IN NEIGHBORHOOD LOGICS

Johan van Benthem

The intuitive notion of evidence sits somewhere in between syntax and semantics. We explore new neighborhood logics for representing evidence and its changes over time, at a level of grain that connects with many areas of logical semantics. Technically, we study richer modal languages for this setting than the usual ones, explore their logics, as well as their links with binary plausibility models, and finally, we also connect with the priority graphs of Andréka, Ryan & Schobbens.

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THE RELATIVITY AND UNIVERSALITY OF LOGIC

Jean-Yves Béziau

First I will make the difference between logic as reasoning and logic as theory of reasoning. I will express this difference as Logic vs logic. I will then describe how this distinction appears in the history of logic, the different ways to conceive logic and to talk about it (from syllogistic to mathematical logic, through the art of thinking, formal logic, metamathematics, symbolic logic). In view of this distinction I will discuss the evolution of logic, its relativity and its universality.

Description versus Computation, and Levels of Abstraction

S. Barry Cooper

Twentieth century physics challenged basic assumptions of the scientific paradigm established by Isaac Newton and his contemporaries. There were features of the new theories which did not fit comfortably into what scientists had come to expect in the way of of computation and prediction. At the same time the nature of computation was clarified by a pioneering group of logicians in a way which pointed to essential limitations to our computational reach. Subsequently, two key elements of the logical analysis - the computational richness of information, and the duality of program and data - were developed in quite divergent ways. In this talk we look at basic issues of

computation versus description; of information versus process; and of the role of higher type computation in reconciling different approaches to understanding the real world.

LOGIC, THEORY OF RELATIVITY AND TIME MACHINE

Alexander K. Guts.

Axiomatic theory of relativity in Russia. What are logics which should be used for creation of the axiomatic theory of relativity? Is it possible to construct the intuitionistical general theory of relativity and what are consequences of such theory? What is construction of time machine: impossibility of the Thorn's time machine and use of 4-dimensional wormholes for creation of a time machine.

ON THE RELATIONSHIP BETWEEN SPACETIME SINGULARITIES, HOLES, AND EXTENSIONS

John B. Manchak

We consider three spacetime conditions of interest: geodesic completeness, hole-freeness, and inextendibility. How are these three conditions related? Here, we review what is known and contribute a few (minor) results of our own.

GANDY'S THESIS IN THE LIGHT OF RELATIVISTIC COMPUTATION

Philip Welch

In the symposium honouring Kleene's 70th Birthday, Robin Gandy outlined a thesis to complement Turing's thesis. Gandy was at pains on several occasions to point out that Turing asserted, indeed demonstrated, that what is calculable by a human computor is a computable by a Turing Machine. Gandy gave a small number of principles by which one could assert that any mechanism satisfying them would also calculate precisely those functions computed by a TM.

We revisit this paper and discuss Gandy's principles in the light of relativistic models of computation.

A PROLEGOMENON TO A QUANTUM-INFORMATION-THEORETIC COMPLEMENT TO A GENERAL-RELATIVISTIC IMPLEMENTATION OF A BEYOND-TURING COMPUTER

Christian Wüthrich

There exists a growing literature on the so-called physical Church-Turing thesis in a relativistic spacetime setting. The physical Church-Turing thesis is the conjecture that no computing device that is physically realizable (even in principle) can exceed the computational barriers of a Turing machine. By suggesting a concrete implementation of a beyond-Turing computer in a spacetime setting, István Németi and his collaborators Gábor Etesi and Gyula Dávid have shown how an appreciation of the physical Church-Turing thesis necessitates the confluence of mathematical, computational, physical, and indeed cosmological ideas. In this talk, I will honour István's seventieth birthday, as well as his longstanding interest in, and his seminal contributions to, this field going back to as early as 1987 by offering a prolegomenon to how the concrete implementation in

proposed by Németi and collaborators may or may not be complemented by a quantum-information-theoretic communication protocol between the computing device and the logician who sets the beyond-Turing computer a task such as determining the consistency of Zermelo-Fraenkel set theory. This suggests that even the foundations of quantum theory and, ultimately, quantum gravity may play an important role in determining the validity of the physical Church-Turing thesis.

HORN BELIEF CONTRACTION: REMAINDERS, ENVELOPES AND COMPLEXITY

Kira Adaricheva, Robert Sloan, Balázs Szörényi and György Turán

Making computers capable of commonsense reasoning is a basic problem of artificial intelligence that seems to be hoplessly complicated even nowadays. Its theoretical aspects and certain subproblems are heavily investigated though. One such important subproblem is belief revision: how to change a knowledge basis when receiving information that contradicts our previous knowledge. Usually it is also required to save as much of the old useful knowledge as possible. The mathematical theory of this topic is based on the axiomatic approach by Alchourron, Makinson and Gardenfors for belief contraction.

Traditionally belief revision has been based on full propositional logic. However, reasoning with full propositional knowledge bases is computationally hard, whereas reasoning with Horn knowledge bases is fast. In the past several years, there has been considerable work in belief revision theory on developing a theory of belief contraction for knowledge represented in Horn form.

Our main focus here is the computational complexity of belief contraction, and, in particular, of various methods and approaches suggested in the literature. This is a natural and important question, especially in connection with one of the primary motivations for considering Horn representation: efficiency.

The problems considered lead to questions about Horn envelopes, introduced earlier in the context of knowledge compilation. This work gives a syntactic characterization of the remainders of a Horn belief set with respect to a consequence to be contracted, as the Horn envelopes of the belief set and an elementary conjunction corresponding to a truth assignment satisfying a certain explicitly given formula. This gives an efficient algorithm to generate all remainders, each represented by a truth assignment.

On the negative side, examples are given of Horn belief sets and consequences where Horn formulas representing the result of contraction, based either on remainders or on weak remainders, must have exponential size for almost all possible choice functions (i.e., different possible choices of partial meet contraction). Therefore using the Horn framework for belief contraction does not by itself give us computational efficiency. Further work is required to explore the possibilities for efficient belief change methods.

REDUCING FIRST-ORDER LOGIC TO A SIMPLE PROPOSITIONAL LOGIC, TO [S5,S5,S5]

Hajnal Andréka.

I report on recent joint results with Istvan Nemeti.

Our main result is that first-order logic (FOL from now on) can be recursively translated into a very simple and weak propositional modal logic, into [S5,S5,S5], which is

classical propositional logic with three commuting S5 modalities. This logical system [S5,S5,S5] is equivalent to the equational theory of Boolean algebras (BA's) with three commuting complemented closure operators, i.e., to that of diagonal-free 3-dimensional cylindric algebras (Df_3's). This strenghtens Tarski's main result in the book: Tarski, A. and Givant, S. R., Formalizing Set Theory without variables, AMS, 1987, which is basically reduction of Set Theory to the equational theory of relation algebras (RA's). The strengthening is twofold: (i) we reduce the whole of FOL and not only Set Theory, and (ii) we reduce to the equational theory of the much simpler class Df_3. The heart, and most tedious part of the proof is interpreting RA in Df_3.

There are many consequences of the above reducibility, I list some:

(1) Free finitely generated K-algebras are not atomic, where K may be either one of Df_3, RDf_3, CA_3, RCA_3.
(2) Multimodal propositional logic $[S5, S5, S5]$ as well as three-variable restricted fragment of FOL (L_3) without equality have Gödel's incompleteness property.
(3) The Turing-degree of the set of valid FOL-formulas is the same as that of the equations valid in Df_3.
(4) We get a new, partial Hilbert-style completeness theorem for the three-variable fragment L_3 of FOL, as follows. There is a decidable subset F of the three-variable FOL-formulas and a computable translation function tr mapping L_3-formulas to F with the following properties: (a) any formula of L_3 is valid if and only if its tr-translation is valid. (b) A formula in F is valid if and only if it can be derived from the axioms of a usual Hilbert-style proof-system for FOL with the axiom schemes restricted to L_3, by using Modus Ponens and Generalization.

The equational theory of the class of BA's with 2 commuting complemented closure operators is decidable, the equational theory of the class of BA's with finitely many, not necessarily commuting complemented closure operators is decidable, thus FOL cannot be recursively reduced to the equational theories of these classes. So, our reducibility result seems best possible from these points of view. On the other hand, we do not know whether the equational theory of BA's with three commuting, not necessarily complemented, closure operators is decidable or not.

AN AXIOMATIC FOUNDATION OF RELATIVISTIC SPACETIME

Thomas Benda

Axiomatizations of the General Theory of Relativity have occasionally been conducted to achieve precision and clarification of underlying concepts. Rigorous and inspiring work towards that aim based on first-order logic has been performed by Professor Németi and his working group (see references). A complementary approach (Benda 2008) constructs the relativistic spacetime manifold ab initio in a theory ST, which is a conservative extension of Zermelo's Z with urelemente, interpreted as worldlines. The present work contains a few modifications and continues towards the construction of a metric, from where the Einstein tensor is readily built.

For a longer abstract, please see attached PDF file.

CONSTRUCTIBILITY AND SPACE-TIME

David Bendaniel

We pursue an approach in which space-time is relational and its differential properties fulfill the strict requirements of Einstein-Weyl causality. Space-time is developed from a set theoretical foundation for a constructible mathematics. The foundation proposed is the axioms of Zermelo-Frankel (ZF) but without the power set axiom, with the axiom schema of subsets removed from the axioms of regularity and replacement and with an axiom of countable constructibility. Four arithmetic axioms are also adjoined; these formulae are contained in ZF but must be added here as axioms. All sets of finite natural numbers in this theory are finite and hence definable. The real numbers are countable, as in other constructible theories. We first show that this constructible approach actually provides some functions of a real variable which are of bounded variation and locally homeomorphic. These functions are composed of pieces that are fundamentally relational. Eigenfunctions governing physical fields can then be effectively obtained. Furthermore, using a null integral of the Lagrange density of a field over a compactified space, we produce a nonlinear sigma model. The Schrodinger equation follows directly from a sui generis proof in this theory of the discreteness of the space-like and time-like terms of the model. This result therefore also infers that quantum mechanics in this relational space-time framework can be considered conceptually cumulative with prior physics.

INTERPRETATIONS OF THE GROWTH OF KNOWLEDGE IN DYNAMIC LEARNING SITUATIONS

András Benedek

Motto: "If you have an idea and I have an idea and we exchange these ideas, then will each of us have two ideas...?" (After G.B. Show.)

1. Introduction

In the intersection of various logic approaches to problems of the 'growth of knowledge' one finds the thesis that knowledge does grow as a result of collaboration and information exchange. Empirical studies of research networks underline the need for more exact definitions of 'growth of knowledge' in group settings and an analysis of the alternative approaches to the fusion of logic models that describe the dynamics of information exchange in observational or quasi-empirical learning situations.

2. Conceptions of 'growth' and reflexive knowledge

Several different uses of the term of 'growth' can be identified with respect to knowledge, including individual level as well as collective level notions. The main alternatives are critically reviewed to assess their strengths and weaknesses with respect to the description of the dynamics of information exchange. Leaving behind various conceptions of individual and "objective" knowledge I point to the importance not only of shared views (mutual knowledge), but reflection on, and awareness of what the others know. Various conceptions of social and group knowledge can be defined and the interpretation of growth in these contexts is a challenging precondition of exact interpretations of the growth of knowledge. Recently Gierasimczuk (2009) reviewed how inductive inferences can be modelled in dynamic epistemic logic (DEL) and dynamic doxastic logic (DDL).

There are several conditions for common and distributed knowledge that can be introduced in these contexts. Characterizing the alternatives in DEL and DDL the results call for further research on temporal frames.

3. Dynamic logic and topological models of information exchange

Models in the spirit of Logics of Communication and Change (van Benthem et al. 2006) are capable of a compositional analysis of complex communication scenarios such as announcements to subgroups, or private and secret massaging. Making such models an integral part of the assessment of the growth of knowledge in science or research networks may provide new assessment paradigms for empirical research. (Apt-Witzel-Zvesper 2009) Based on dynamic-models one can analyze multi-agent scenarios, such as revealing individuals' information shared in a particular subgroup, or giving particular roles to different performers in a group. Following the line of McKinsey and Tarski's (1944) paper on the algebra of topology there are several geometric approaches to represent the dynamics of merging information for distributed knowledge (van Benthem-Sarenac, 2004). I reconsider some alternative frameworks for the description of the product and fusion of information spaces of groups of learners in information exchange scenarios and analyze their possibilities for defining the concept of the growth of group knowledge in these settings.

4. Models of distributed knowledge in groups and networks

The process of seeking and interpreting assessment of evidence where researchers are to tell how they need to go further, naturally introduced exchange of information between peers about their knowledge. In these situations distribution of knowledge may depend on rationality conditions that guarantee the existence of a "wise man" who represents the cumulative knowledge of the group. I present some alternatives on the preconditions of no-wise-man distributions. The point is that crucial issues depend on the underlying protocols that govern information exchange in social groups and networks. The results show that we need non-monotonic approaches to the problem of the comparison of the efficiency of networking scenarios based on sharing and representing information about knowledge states.

5. In conclusion

Analysis of conceptions of growth in a composite framework of dynamic epistemic logic, knowledge networks and topologics can provide new models and insights for the interpretation of growth of knowledge based communication protocols and scenarios in social networks. Making the protocols dependent on the assessment of the knowledge states of subgroups can be shown to have tremendous effects to the performance of the whole group that is sharing information according to different models of information exchange scenarios. A networking scenario may determine not only the efficiency of information exchange but the very nature of group knowledge that it produces.

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ON VARIETIES OF ALGEBRAS OF RELATIONS

Dmitry Bredikhin

In the investigation of algebras of relations, one of the most important problem is to study their identities [1, 2]. For any set F of operations on binary relations, let $R\{F\}$ be the class of algebras whose elements are binary relations and whose operations are members of F, and let $Var\{F\}$ be the variety generated by $R\{F\}$.

We shall consider the following binary primitive-positive [3] operation on relations $*$ which is defined as follows:

$$f * g = \{(x, y) : \exists z \ \ (x, z) \in f \wedge (z, x) \in g\} \tag{1}$$

for any binary relations f and g.

The following theorem gives a basis of identities for the variety $Var*$.

Theorem. An algebra (A, ffl) of the type (2) belongs to the variety Var* if and only if the following identities hold:

$$(xy)y = xy, (xy)(xy) = xy, ((xx)y)z = ((xx)z)y, \tag{2}$$

$$(xx)(yz) = (xx)(zy), (x(yy))(zz) = x((yy)(zz)). \tag{3}$$

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CORRESPONDENCE BETWEEN DESCRIPTION LOGIC AND ALGEBRAIC LOGIC

Sándor Csizmazia

The problem of the correspondence between description logic and modal logic is solved and its results are widely used. A correspondence is given in this work between description logic and algebraic logic. The ground is to enlarge the variety of the possible tools of the automated reasoning with algebraic instruments too.

FAREWELL TO CAUSALITY?

György Darvas

Foundations of QED were elaborated (Dirac, 1928, 1929, 1951, 1962) with the precondition that the theory should be causal. Causality meant that "... the wave function at any time determines the wave function at any later time". The latter, simultaneously with the requirement of Lorentz invariance of the theory, involved the requirement of invariance under time-reflection. A few years following the first publication of the theory, the first paradoxes were made themselves apparent, followed later by others (EPR, Aharonov-Bohm, Bell). Since causality was a prerequisite of the theory, causal paradoxes could not be explained in the framework of QED (Darvas, 2009). Causality in the above sense works in flat space-time. This is not the case in real non-classical physical situations. Theories, like GTR, QED, assume non-Euclidean geometry. Invariance of the infinitesimal arc-length under reflection is ambiguous in curved spaces. It is the case already in constant curvature spaces, it holds more strongly in Riemannian geometry, and gets much more apparent in Finsler geometries, where the curvature changes not only point by point, but also according to direction in each point. One cannot disregard even the last cases in gauge theories. When reflection of a segment is ambiguous (that means a segment reflected in a point out of its line has a bundle of infinitely many parallel mirror segments) unambiguity of reflection gets damaged. So does causality.

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COMPUTABILITY: THE HIDDEN FACE OF GRAVITY

Gábor Etesi

In this short talk we shall look at the old problem of the strong cosmic censorship from a new angle allowing us to make a contact with an apparently very different discipline of science namely computability theory and the Church–Turing thesis. This leads on the one hand to a simple proof of a variant of the strong cosmic censor conjecture attributed to Geroch–Horowitz and Penrose but first formulated by Wald as well as on the other hand to a natural but sofar hidden connection between the strong cosmic censorship scenario and the Church–Turing thesis revealing an unexpected conceptual depth beneath both conjectures.

A NEW REPRESENTATION THEORY: REPRESENTING CYLINDRIC-LIKE ALGEBRAS BY RELATIVIZED SET ALGEBRAS

Miklós Ferenczi

The topic of the submission is: how to represent certain cylindric-like algebras by relativized set algebras.

THE EPISTEMOLOGICAL SIGNIFICANCE OF REDUCING THE RELATIVITY THEORIES TO ZERMELO-FRANKEL SET THEORY

Michele Friend

There are three elements to the paper. One is the project of Andréka, Madarász, Németi, Székely and others. The second is Molinini's philosophical work on the nature of mathematical explanations. The third is my pluralist approach to mathematics. Looking at the elements separately: Andréka, Madarász, Németi, Székely and others, reduce special and general relativity to Zermelo-Fraenkel set theory (ZF). That is, they add some definitions and axioms to ZF and derive, in the language of set theory the "laws" of relativity theory. They go beyond this, and derive many other results as well. We can think of these results as "theorems" or "predictions" of the relativity theories. Molinini takes a pluralist approach to the notion of mathematical explanation for physical phenomena. What he means by 'pluralism' is that "What counts as a good explanation can vary from case to case, and we cannot design a single model able to capture all of these instances." (Molinini 2010, 16). What makes cases different are (a) the intellectual tools and (b) the conceptual resources provided by different mathematical theories. An intellectual tool is: "an ability to reason while used in the practice of explaining." (Molinini 2010, 352). A conceptual resource is "a concept which permits the use of our intellectual tools in a particular situation." (Molinini 2010, 352). Conceptual resources in mathematics give us mathematical concepts which allow us to analyse or see a physical situation in a certain way. We then use mathematics, as a tool to reason over that situation. If we are pluralists in mathematics, then we do not accept that there is a foundation to mathematics in the sense of giving us the ontology, essence and absolute truths of mathematics. Rather, there are a number of mathematical theories which crosscheck each other. It is the crosschecking, along with the rigour of the proofs, which gives mathematics stability and objectivity. Central theories in mathematics, such as ZF, play a very prominent role in this crosschecking through proof. Putting the elements together: there is a philosophical literature on topic of mathematical explanations for physical phenomena. This paper adds to this, but in a novel way. I use the work of Andréka, Madarász, Németi, Székely and others as an example of mathematical explanation for whole physical theories, not just isolated phenomena. The interesting question concerns the epistemological significance of the explanation. I use the account of Molinini to start the analysis and give solid sense of the epistemological significance as an explanation of relativity theories. However, I then deepen the analysis to address the significance in terms of the particular mathematical theory they use. I shall assume a pluralist philosophy of mathematics. It turns out that the 'reduction' of relativity theories to ZF not only tells us something about the physical theory, it also tells us something about ZF, and its relationship to other areas of mathematics.

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various logics, which does not depend on the specific characteristics of individual logics.

PROOF VERIFICATION AND PROOF DISCOVERY FOR RELATIVITY

Naveen Sundar Govindarajulu and Selmer Bringsjord

We report upon progress in producing machine verified and machine generated proofs for theorems in relativity. We present proofs for a simple theorem, Theorem Neat. We describe work in progress to tackle reasoning using the field axioms and proving of more interesting theorems in physics, specifically Theorem NFTLIO.

WHAT EXACTLY DOES THE SPECIAL RELATIVITY PRINCIPLE ASSERT?

Márton Gömöri and László E. Szabó

In its standard formulation, the special principle of relativity is the assertion that "All the laws of physics take the same form in any inertial frame of reference." This is usually regarded as a simple and clear statement. However, in trying to unpack the precise meaning of this sentence one encounters several obvious questions about how the very general—and vaguely used—concepts, such as "physical law", "of the same form", "a physical law in an inertial frame of reference", etc. should be understand.

Our aim in this paper is to make all these conceptual plugins to the relativity principle explicit and to formalize them as generally as possible. To achieve this, we develop a mathematical language in which all the necessary conceptual components can be precisely formulated.

Usually the requirement of covariance of the physical equations is considered as synonymous with the relativity principle. However, it will be clear from the formalism presented that covariance is not enough for the relativity principle; in fact, they are logically independent.

We will see that one of the above mentioned conceptual plugins, the "physical system in motion", is crucial to the physical content of the relativity principle. We will argue that this concept cannot be regarded as a priori determined by the Lorentz boost. It must reflect something from the physical behavior of the concrete physical system in question.

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1. WHAT IS PHYSICALLY POSSIBLE?

Balázs Gyenis

Spacetimes featuring hypercomputation scenarios are physically possible according to general relativity. What do we mean by this claim?

A physical theory, broadly speaking, identifies two components in a representation of the world: a component which the theory proclaims to be fixed and a component which the theory may allow to vary. The modal character of the theory rises from associating the fixed component with the necessary and the variable component with the accidental. The mathematical structure of the physical theory is suggestive of the space of mathematically admissible alternatives to the variable component, and we take these alternatives to represent the physical possibilities. It is in this sense we take solutions of a fundamental differential equation to represent physically possible scenarios: we represent arrangements of facts by means of a differential equation and its solution, proclaim that the differential equation is the fixed component – the law – and that the solution is the variable component, and proceed to view other compatible variable components – other solutions of the same differential equation – as representations of other physical possibilities.

In the talk we identify three assumptions behind our usual assessment of physical possibility: (a) that differential equations are the appropriate mathematical representations of the fixed component, (b) that solutions of a differential equation are the appropriate mathematical representations of the variable component, and that (c) mathematical compatibility of these two components is a sufficient condition for a plausible notion of physical possibility. We claim that all three assumptions can be challenged to the effect that the physicist mantra, according to which only well posed problems yield representations of physically realistic systems, becomes vindicated. If this conclusion holds in the framework of general relativity it sheds doubt upon the physical possibility of hypercomputing, time traveling etc. scenarios which can not be formulated as solutions of a well posed problem, and does so without the usual ad hoccery involved in directly imposing reasonableness or epistemic accessibility conditions on the space of solutions.

GENERIC AUTOMORPHISMS

Zalán Gyenis and Gábor Sági

An automorphism of a structure is called generic if its conjugacy class is co-meagre in the product topology of the automorphism group. In this talk we survey some results about generic automorphisms with an emphasis on its applications in Hrushovski's type theorems, as well as present some new developments concerning the (consistency of the) existence of generic automorphisms in certain structures.

THE TENSE LOGIC OF TWO DIMENSIONAL MINKOWSKI SPACETIME

Robin Hirsch and Mark Reynolds

We consider Minkowski space-time, the set of all point-events of space-time under the relation of causal accessibility. That is, u can access v if an electromagnetic signal could be sent from u to v.

We use Prior's tense language of F and P representing (reflexive) causal accessibility and its converse relation.

It is not known if this logic is decidable or even axiomatisable and this has been an open problem for decades.

Related earlier work by Rob Goldblatt showed that the dimension of the Minkowski frame can affect such properties of the tense logic.

We make a small step forward by proving that the set of valid formulas over two-dimensional Minkowski space-time is decidable.

CLASSIFICATION OF ABSORBENT-CONTINUOUS, SHARP FLE-ALGEBRAS ON WEAKLY REAL CHAINS

Sándor Jenei and Franco Montagna

FLe-algebras are algebraic models of the substructural logic FLe. The classification of absorbent-continuous, sharp FLe-algebras over weakly real chains is given: The algebra is determined by its negative cone, and the related cone operation can only be chosen from a certain subclass of BL-algebras. It is shown that absorbent-continuity is the most relaxed version of the naturally ordered condition under which the classification theorem holds. The classification theorem does not hold if the algebra is not sharp.

AN INFINITESIMALLY SUPERLUMINAL NEUTRINO IS LEFT-HANDED, CONSERVES LEPTON NUMBER AND SOLVES THE AUTOBAHN PARADOX

Ulrich Jentschura and Benedikt Wundt

Consider a gedanken experiment in which a massive left-handed neutrino, traveling on an autobahn at a speed of v=0.999c is overtaken by a tuned-up Cagiva V-Raptor 1000 traveling at a speed of 0.999999c. The biker, looking back, would see a right-handed neutrino. This "autobahn paradox" implies that a massive subluminal (tardyonic) neutrino necessarily has to be a Majorana particle, i.e, equal to its own antiparticle. In turn, this would require us to assign the same lepton number to charged leptons and antileptons, essentially voiding the concept of lepton number. By contrast, an infinitesimally superluminal (tachyonic) neutrino is not equal to its own antiparticle and allows us to assign proper lepton number, just as if the neutrino were a Weyl particle. Furthermore, if Lorentz symmetry holds, then an infinitesimally tachyonic neutrino remains superluminal upon Lorentz transformation, which implies that it is impossible to overtake it in a gedanken experiment. Consistently, right-handed neutrino and left-handed antineutrino states have recently been shown to acquire negative norm under the assumption of an ever-so-slightly tachyonic neutrino, and it would thus not be necessary to invoke a seesaw mechanism. An infinitesimally superluminal neutrino does not necessarily violate causality, as has been discussed in the literature. This paper is devoted to an illustrative discussion on a scenario which could unfold if the observation of neutrinoless double beta decay is not confirmed. In this case, an infinitesimally superluminal neutrino could appear to solve at least as many problems as it raises.

STRONGLY REPRESENTABLE ATOM STRUCTURES

Mohamed Khaled and Tarek Sayed Ahmed

In this article, we study various notions on atom structures of algebras. We introduce three classes for every type, and show that these are distinct if and only if the dimension is > 2. We extensively use graphs and games as introduced in algebraic logic by Hirsch and Hodkinson. Our algebras contain various reducts of quasi polyadic equality algebras.

APPROXIMATING THE TWO-VARIABLE FRAGMENT OF CLASSICAL PREDICATE LOGIC WITH PROPOSITIONAL MODAL LOGICS: A SURVEY OF RECENT RESULTS

Ági Kurucz

It is well-known in algebraic logic that 'trouble' starts from $n \geq 3$. Just to list a few cases: Both the n-variable fragment of predicate logic, and the equational theory of its algebraic counterpart, representable cylindric algebras of dimension n (RCA_n) are undecidable for $n \geq 3$, and decidable for $n < 3$. Also, RCA_n has a finitely axiomatisable equational theory for $n < 3$, which becomes nonfinitely axiomatisable for $n \geq 3$. In our talk we survey recent results in many-dimensional modal logic, showing that from a certain perspective there can be a lot of 'trouble' in dimension 2 already.

A CENTURY OF AXIOMATIC SYSTEMS FOR ORDINAL APPROACHES TO SPECIAL RELATIVITY THEORY

Koen Lefever

This article presents an introductory overview of the history of axiomatic systems for the ordinal approach to special relativity.

Those axiomatic systems are based on the observation by Robb in the early twentieth century that axiomatic systems for Minkowski time-space can be constructed from a single causal or temporal order relation.

Depending on what the designers of the axiomatic systems are interested in, we get different results. Axiomatic systems can be of first or second order. If they are of first order, they may use an axiom scheme to generate an infinite set of axioms. Some systems are decidable, others are categorical. Some systems contain a metric, others don't. A comparison between the different systems is being made.

THE EXISTENCE OF SUPERLUMINAL PARTICLES IS INDEPENDENT OF RELATIVISTIC DYNAMICS

Judit Madarász and Gergely Székely

We show that the existence of FTL (faster than light) particles is independent of Einstein's special relativistic dynamics. Thus, the existence of FTL particles does not contradict relativity theory.

To prove our statement, we formalize Einstein's special relativistic dynamics in mathematical logic. We present a first-order logic axiom system SRdyn that contains the formalized versions of Einstein's original postulates and axioms that were implicitly assumed by Einstein. Thus the axiom system SRdyn is a formalized version of Einstein's original special relativistic dynamics.

We prove our statement by constructing two models of SRdyn such that there are FTL particles in one model and there is no FTL particle in the other one. This situation is analogous to the independence of the continuum hypothesis of ZFC set theory.

We also show how the relativistic masses of FTL particles change from one reference frame to the other. This result gives new predictions on the relativistic masses of FTL particles. It turns out that by increasing the speed of an FTL particle both the relativistic mass and linear momentum decrease.

SRdyn can be extended such that the existence of an FTL particle remains independent, but the new axiom system together with the statement that there is no FTL particle (or together with the statement that there are FTL particles) forms a complete theory. This situation is analogous to the independence of Euclid's postulate of parallels of the rest of his axioms.

OUR BELOVED LEON HENKIN

María Manzano

Leon Henkin was born in 1921 in New York, in particular in Brooklyn, in the heart of a Jewish family that originally came from Russia. He died at the beginning of November in 2006. He was an extraordinary logician, and excellent teacher, a dedicated professor and an exceptional person overall. Henkin was an extraordinary insightful professor in the clarity of his expositions and was well loved by his students, who on his last day of class in the academic years would applause his efforts with great emotion. He was also very aware that we are beings immersed in the crucible of history from which we find it hard to escape. The reason I am presenting this paper here is because Henkin acts as an emotional bond between Istvan and me. Henkin was the first person to introduce Istvan's and Hajnal's work to me. It was during his trip to Europe in 1982, and in particular after his visit to Yugoslavia, were he met Hajnal Andreka and Istvan Nemeti, from Budapest.

HENKIN ON COMPLETENESS

María Manzano and Enrique Alonso

The Completeness of Formal Systems is the title of the thesis that Henkin presented at Princenton in 1947, under the guiadance of Alonzo Church. His renowned results on completeness for both type theory and first order logic are part of his thesis. It is interesting to note that he obtained the proof of completeness of first order logic readapting the argument found for the theory of types. It is surprising that the first-order proof of completeness that Henkin explained in class was not his own but was developed by using Herbrand's theorem and the completeness of propositional logic. "Since we use the completeness of sentential logic in our proof, we effectively reduce the completeness problem for first order logic to that of sentential logic." We conclude this paper by pointing two of the many influences of his completeness proofs, one is the completeness of basic hybrid type theory and the other is in correspondence theory, as developed in [Manzano 1996].

STARTING FROM THE SCENARIO EUCLID - BOLYAI - EINSTEIN

Solomon Marcus

I show that the logical scenario of the emergence of non- Euclidean geometries, including their impact on Relativity theory, is repeated in the 20th century by some axioms of Set Theory.

THOUGHT EXPERIMENTS AS SEMANTIC ARGUMENTS

Péter Mekis

In the last couple of decades, there has been an intensive debate concerning the epistemological status of thought experiments. Whether in science or in philosophy, thought experiments apparently provide important new knowledge in spite of being entirely a priori, and thus they pose a serious challenge to empiricism. Some authors argue that the new knowledge in question is based on mental processes of a quasi-observational nature (where the objects of quasi- observation may be either abstract laws or one's own mental representations). Others say that a thought experiment's experimental scenario plays a merely rhetorical role, and it is in fact a popular way of putting forward a deductive argument. My suggestion is that a great deal of thought experiments function as semantic arguments concerning the satisfiability and categoricity of scien- tific or philosophical theories. Thus they, being about theories, differ genuinely from arguments within theories, but their explanation requires no appeal to the cognitive apparatus of the experimenter.

[More detailed abstract in the pdf document.]

RESIDUATED ALGEBRAS OF BINARY RELATIONS AND POSITIVE FRAGMENTS OF RELEVANCE LOGIC

Szabolcs Mikulás

The aim of this paper is to apply some results obtained jointly with Hajnal Andreka and Istvan Nemeti about finite axiomatizability of Tarski's representable relation algebras in the context of completeness of fragments of relevance logic.

ON THE NOTION OF POSSIBILITY IN RELATIVITY THEORY

Attila Molnár

The Logic and Theory of Relativity group lead by Andréka, H. and Németi, I. developed several axiom systems for relativity theory to investigate it within mathematical logic.

One of the simplest and most commonly used axiom system is an axiom system of kinematics, the so-called SpecRel. Although this axiom system is very simple, it implies all the main predictions (theorems) of relativity theory. However, as it is proposed by the group in many articles, sometimes the classical first-order logic framework of SpecRel does not seem to be sufficient to give back the appropriate physical meaning. For example, the main axiom of SpecRel, the axiom which is about the possibility of sending out light signals, states that there could be a photon which crosses certain points. This "could be" indicates some kind of notion of possibility, which is barely accessible from a classical first-order logic. According to the classical logic, an entity either exists somewhere, or does not exist somewhere. There are no options such as "it does not exist there but it is possible to exists there" or "does not exist there and it could never ever happen that it exists there."

This problem becomes more serious when we try to expand the system SpecRel by certain dynamical axioms (to get SpecRelDyn). For example, we would like to postulate that for every observer, everywhere any kind of possible collision is realizable. It is worth to investigate this type of axioms, because this way leads to an experimental understanding of the notion of possibility.

We will investigate axiom systems of special relativity based on modal logic, which is the standard tool for formally handle dynamical notions – such as performing an experiment, for instance "send out a light signal" or "realize a collision". Modal logic is a logic containing classical logic and an operator to manage formally the notion of possibility. For us it means the possibility of the existence of a light signal in certain points and the possibility of the existence of bodies making collisions.

Our axiom systems will be built with the following goals:

(1) Give a plausible but formal notion of possibility based on the informal explanations of the classical SpecRel and SpecRelDyn.
(2) Save the theorems and the ideas of their proofs from SpecRel and SpecRelDyn.
(3) Make space for notions unavailable in SpecRelDyn, e.g., an operational notion of mass.

LOGIC, UNIVERSAL SYMMETRY AND THEORIES OF EVERYTHING

Ranjit Nair

The formula of the special and general theories of relativity, brought to light a fundamental principle, which we call the universality of symmetry. According to this principle, the symmetry group of the space-time manifold must be identical to the dynamical symmetry group of the physical fields on the manifold. This paper seeks to explore the program of unifying the forces of nature pursued by successor theories, which involve additional compactified dimensions, the forerunner of which was the Kaluza-Klein theory. In its evolved contemporary avatars, the theories of everything bring together the very small and the very large program unites the very large and the very small, cosmology

with microphysics. An 'axiomatization' of such theories must be regarded as a valuable tool in establishing their consistency, quite apart from the question of empirical support

GENERAL RELATIVISTIC COMPUTING - COMPUTING WITH WORM-HOLES

Péter Németi

I present joint work with Hajnal Andréka, István Nemeti and Gergely Székely.

Newtonian absolute time is built into the notion of a Turing Machine, and this is reflected in the physical-Church-Turing thesis which states that there is no way to build physical devices by which we could compute a non-Turing computable function. General relativity (GR) states that there is no such thing as absolute time, it makes is possible to manipulate time. This gives a hope to design thought-experiments in GR spacetimes via which we could compute functions which are not Turing-computable. Indeed, in [1] such a thought-experiment was designed, and the details were computed, in the spacetime of a rotating black hole. By such an experiment we can decide any recursively enumerable set, and Philip Welch showed that the limit when using the spacetime of a rotating black hole is deciding Δ_2-sets.

In the talk I want to present a thought-experiment based on the spacetime of a Lorentzian worm-hole by which we can decide about any recursively enumerable set whether it is infinite or not. I will present the concrete details, and check some realisticity issues. We conjecture that any Σ_n set can be decided by using n wormholes, for any integer n. It may even be the case that we can decide any Σ_n set with using only two wormholes. The new setting has advantages and disadvantages over the rotating-black-hole based computer. Advantages are, besides being more powerful, that the size of the computer may be kept small, and the programmer and the computer may stay close to each other, there is no need for a long journey on behalf of the programmer.

New physical theories predict that there are stable worm-holes, and astrophysicist Igor Novikov conjectures that actually some of the celestial bodies thought now of being black holes are, instead, worm-holes. The Russian experiment Millimetron scheduled for 2014 will make mesurements to decide about two candidates whether they are worm-holes or not.

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ON PRESERVATION THEOREMS BY CATEGORY THEORY

Bertalan Pécsi

We present a categorical form of certain preservation theorems (preservation of positive/existential formulas under surjective/injective homomorphisms, and preservation under reduced products), following the research path initiated by Németi-Andréka-Sain.

RELATIVITY AND MODAL LOGIC MEET HAUSDORFF

Tomasz Placek

I construct generalized (non-Hausdorff) manifolds that have the maximal Hausdorff sub-manifolds, to be identified with GR spacetimes.

ON THE DIFFERENT FORMS OF THE ELECTROMAGNETIC EQUATIONS IN A UNIFORM MEDIUM, AN ALTERNATIVE TO THE MINKOWSKI THEORY

Victor Mikchaylovich Red'Kov and Elena Mikchaylovna Ovsiyuk

Two known, alternative to each other, forms of presenting the Maxwell electromagnetic equations in a moving uniform medium are investigated and discussed. Approach commonly used after Minkowski is based on the two tensors; relationships between them change their form at Lorentz transformations and have the form of the Minkowski equations, depending upon a 4-velocity of the moving medium under an inertial reference frame. In this approach, the wave equation for electromagnetic 4-potential has a form that involves explicitly this 4-velocity vector of a moving medium. So, the electrodynamics by Minkowski implies the absolute nature of the mechanical motion.

An alternative formalism (Rosen's and others) may be developed in the new variables, when the Maxwell equations can be written in terms of a single tensor. This form of the the Maxwell's equations exhibits symmetry under modified Lorentz transformations in which everywhere instead of the vacuum speed of light c is used the speed of light in the medium c' less than c. In virtue of this symmetry we might consider such a formulation of the Maxwell theory in the medium as invariant under the mechanical motion of the reference frame; at this the velocity transition must be done with the use of modified Lorentz formulas. Transition to 4-potential leads to a simple wave equation that does not contain any additional 4-velocity parameter, so this form of the electrodynamics presumes a relative nature of the mechanical motion; also this equation describes waves propagating in space with the light velocity kc, which is invariant under modified Lorentz formulas.

In connection with these two theoretical schemes, a point of principle must be stressed: it might seem reasonable to perform Poincaré-Einstein clock synchronization in the uniform medias with the help of real light signals influenced by the medium, which leads us to the modified Lorentz symmetry.

Similar approach is developed for a spin 1/2 particle obeying the Dirac equation in a uniform medium.

NEAT EMBEDDINGS AS ADJOINT SITUATIONS

Tarek Sayed Ahmed

Looking at the opeartion of forming neat α reducts as a functor, with α and infinite ordinal, we investigate when such a functor obtained by truncating to ω dimensions, has a right adjoint. We show that the neat reduct functor for representable cylindric algebras does not have a right adjoint, so that it is not invertible, while that for polyadic algebras is strongly invertible, in fact it is an equivalence. We relate this categorical result to several amalgamation properties for classes of representable algebras.

A COMPLETENESS THEOREM VIA ALGEBRAIC LOGIC

Dorit Ben Shalom

This paper is yet another attempt for an intuitive axiomatization of first order logic. Using the de Bruijn index, it offers an independent axiomatization. Simple, countable, locally-finite corresponding algebras are shown to be representable.

A UNIFIED FIELD THEORY

Amr Sidahmed

In this paper, we present a unifying perspective of several results proved recently by the author. The main contribution is yet another unification of gravity and electromagnetism. The main novelty in this paper is the extension of classical absolute parallelism (AP-space) formulated on the base manifold of dimension $n \geq 3$ to the tangent bundle, a manifold of dimension $2n$. This new geometry is much richer and wider than classical AP-geometry. In fact, this geometry combines within its structure the simplicity of classical AP-geometry and the richness and depth of the geometry of the tangent bundle. In this more general context, our unified field theory is constructed. This may have future theoretical and practical applications that could shed light on central concepts of gravity and electromagnetism, and possibly other interactions. Finally, the extra degrees of freedom existing in our geometry, and hence in our unified field theory, may have affinity with string theory.

MOVING IN A LONELY UNIVERSE

Mike Stannett

Consider a Universe containing only a single pointlike self-observing particle. Given the lack of other entities relative to which its position and velocity can be assessed, what, if anything, does it mean to say that this particle occupies a particular location in spacetime, or that it is capable of motion? We consider this and related questions, and ask whether the particle's self-observations can consistently generate the appearance of a richly populated Universe governed by mathematical laws of motion, like the one we see around us.

DOES BRANCHING EXPLAIN FLOW OF TIME OR IS IT THE OTHER WAY AROUND?

Petr Švarný

This paper explores the semantical issues and possibilities of two temporal branching structures, Branching Space-time (BST) and Branching Continuations (BCont). These structures present a possible way how to treat quantum and relativistic phenomena at the same time. They might also help to formalize and understand what it means that there is a flow of time. The paper focuses on the introduction of notions derived from the idea of a generalized flow of time into the branching structures. The main idea is to use world lines as a tool for the ordering of events and that allows us to construct a valuation for the given branching structures. Thereafter the paper explores how this enrichment influences branching models and how they present a possibility to capture

some essential ideas connected to the flow of time, for example the question of becoming vs. indexicals.

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DOES THE RELATIVITY PRINCIPLE HOLD FOR ALL SITUATIONS IN RELATIVISTIC PHYSICS?

László E. Szabó and Márton Gömöri

In its standard formulation, the special principle of relativity is the assertion that "All the laws of physics take the same form in any inertial frame of reference." Unpacking this short sentence, it turns out that the concept of "physical system co-moving with an inertial frame of reference" is crucial to the content of the relativity principle; without specifying the precise meaning of this concept the principle is simply meaningless. In this paper, we present arguments and examples which illustrate that there is no clear and unambiguous meaning of this concept, even in very simple situations in relativistic physics.

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TUTORIAL ON LOGICAL ANALYSIS OF RELATIVITY THEORIES

Gergely Székely

In this talk we will overview the axiomatic framework for relativity theories developed by our research school lead by Hajnal Andréka and István Németi.

Our school's general aims are to axiomatize relativity theories using simple, comprehensible and transparent basic assumptions (axioms); and to prove the surprising predictions (theorems) of relativity theories using a minimal number of convincing axioms. We are building a whole net-like hierarchy of axiom systems and logical connections between them. We not only axiomatize relativity theories, but also analyze their logical and conceptual structures and, in general, investigate them in various ways (using our logical framework as a starting point).

In physics the role of the axioms (the role of basic statements that we assume without proofs) is even more fundamental than in mathematics. That is why we aim to formulate natural, simple and convincing axioms. All the surprising or unusual statements should be provable as theorems and not assumed as axioms. For example, the statement "no observer can move faster than light" is a theorem in our approach and not an axiom.

We work within first-order logic for several reasons, e.g., because it can be viewed as a fragment of natural language with unambiguous syntax and semantics. Being a fragment of natural language is useful in our project because one of our aims is to make relativity theory accessible to a broad audience. Unambiguous syntax and semantics are

important for the same reason, because they make it possible for the reader to always know what is stated and what is not stated by the axioms. Therefore, they can use the axioms without being familiar with all the tacit assumptions and rules of thumb of physics (which one usually learns via many, many years of practice).

A novelty in our approach is that we try to keep the transition from special relativity to general relativity logically transparent and illuminating. We are going to "derive" the axioms of general relativity from those of special relativity in two natural steps. In the first step we extend special relativity of inertial observers to accelerated observers. In the second step we eliminate the difference between inertial and noninertial observers in the level of axioms. This second natural step provides a first-order logic axiomatization of general relativity suitable for further extensions and logical analysis.

Some of the questions we study to clarify the logical structure of relativity theories are:

- What is believed and why?
- Which axioms are responsible for certain predictions?
- What happens if we discard some axioms?
- Can we change the axioms and at what price?

Among others, logical analysis makes relativity theory modular: we can replace some axioms with other ones, and our logical machinery ensures that we can continue working in the modified theory. This modularity might come handy, e.g., when we want to extend general relativity and quantum theory to a unified theory of quantum gravity.

ON THE AXIOMATIZABILITY OF SOME FIRST-ORDER SPATIO-TEMPORAL THEORIES

Sándor Vályi

Spatio-temporal logic is a variant of branching temporal logic where one of the so-called causal relations on spacetime plays the role of a time flow. Allowing only rational numbers as space and time co-ordinates, we prove that a first-order spatio-temporal theory over this flow is recursively enumerable if and only if the dimension of spacetime does not exceed 2. The situation is somewhat different compared to the case of real co-ordinates, because we establish that even dimension 2 does not permit recursive enumerability in this case. The proof of the result on rational spacetime involves a more deeper portion of spacetime geometry than the corresponding, more evident result for the real co-ordinates.

THE CHARACTERIZATION OF NP WITHIN INTERVAL-VALUED COMPUTING

Sándor Vályi and Benedek Nagy

In [CiE2005], B. Nagy introduced a new computing paradigm, namely, interval-valued computing. It uses finite unions of subintervals of [0,1) as basic data processing unit (known as generalized intervals). While Turing machines are abstractions where the memory size can be arbitrarily extended in its length, this system assumes the unlimited density of data units. In [TCS2008], the notion of interval-valued computations was formalized. A computation is a sequence of operator applications on generalized intervals (interval-values). Operators are the usual Boolean ones, two shifts (left and right) and a

so-called product which works as zooming. A discrete language L is decidable by (linear, polynomial, etc.) interval-valued computation if and only if there is a classical logspace algorithm that for any input word w constructs an interval-valued computation (of a size that linearly, polynomially depends on the length of w) that ends with a nonempty interval-value if and only if w is in L. This tastes like Boolean network computing style but not on discrete bit sequences but on full interval-values. In the same paper we showed that QSAT (the language of true quantified Boolean formulae) can be decided by a linear interval-valued computation and that PSPACE coincides with tha languages decidable by a polynomial size restricted interval-valued computations where restricted means that product operator may occur only as product by [0,1/2).

In [VLL2007] we demonstrated the connections of this system to visual computing. In [PMD2011] and in an other paper (accepted for publication, presented on [DCM2012]), we defined the notion of computable function by interval-valued computing and showed two functions to be computable by polynomial length interval-valued computations which were interesting for the cryptography audience. The methods of these papers are relatively simple and a summarizing conclusion can be drawn: exactly languages in NP can be decided by a specific type of interval-valued computations, which is characterized by the following conditions:

- the computation starts with generation of all the posible witnesses
- and continues only with Boolean operators.

This observation is just the interval-valued counterpart of the characterization of NP by languages having polynomially checkable witnesses. The main purpose of t his talk is to acquaint this paradigm with the logic community.

A SPACE-TIME FORMALISM WITH NEGATIVE MASS TO DESCRIBE ANTIMATTER AND DARK ENERGY

Antoine van de Ven

A space-time formalism is proposed in which anti-matter has negative mass and moves forward in time but backwards in proper time. By redefining and generalizing relativistic expressions including relativistic energy, momentum and the stress energy tensor it is shown that it is agreement will all current experimental data. This theory predicts that anti-matter generates an anti-gravitational field. This would make anti-matter a candidate for dark energy, because it explains why no anti-matter stars would be able to form, so it is dark and distributed, and it can explain the expansion of the universe. It is predicted that anti-matter repels both matter and anti-matter, but because both follow geodesics, the strongest gravitational field will determine the direction of a particle. So this theory predicts that on Earth anti-matter particles will fall down, but that anti-matter will gravitationally repel other anti-matter. It is proposed to experimentally test this.