Abstracts

Antonio Acin

The Institute of Photonic Sciences ICFO, Spain

Quantum non-locality: a resource for information processing

Alain Aspect

Institut d'Optique, Palaiseau, France

From Einstein's intuition to quantum bits: a new quantum age

Public Lecture

In 1935, with co-authors Podolsky and Rosen, Einstein discovered a weird quantum situation, where particles in a pair are so strongly correlated that Schrödinger called them "entangled". By analyzing that situation, Einstein concluded that the quantum formalism was incomplete. Niels Bohr immediately opposed that conclusion, and the debate lasted until the death of these two giants of physics.

In 1964, John Bell discovered that it is possible to settle the debate experimentally, by testing the famous "Bell's inequalities", and to show directly that the revolutionary concept of entanglement is indeed a reality.

Based on that concept, a new field of research has emerged, quantum information, where one uses quantum bits, the so-called "qubits", to encode the information and process it. Entanglement between qubits enables conceptually new methods for processing and transmitting information. Large-scale practical implementation of such concepts might revolutionize our society, as did the laser, the transistor and integrated circuits, some of the most striking fruits of the first quantum revolution, which began with the 20th century. To cite only one example of these new concepts, quantum cryptography will allow us to guarantee an absolute privacy of communications, based the most fundamental laws of quantum mechanics.

Markus Aspelmeyer

University of Vienna, Austria

Entanglement in massive systems: what do we learn?

Mary Bell

John Bell's widow, our special guest of honor

Reinhold Bertlmann

University of Vienna, Austria

Magic Moments with John Bell: Collaboration and Friendship

Hans Briegel

University of Innsbruck & Austrian Academy of Sciences, Austria

Projective simulation for quantum learning

Caslav Brukner

Austrian Academy of Sciences & University of Vienna, Austria

Can quantum-mechanical description of causal relations be considered complete?

Dagmar Bruß, Michael Epping, Hermann Kampermann

Universität Düsseldorf, Germany

Designing Bell Inequalities via Tsirelson bounds

We introduce an analytical method to find an upper bound on the quantum value of a Bell-type inequality, i.e. a generalised Tsirelson bound.

We derive a criterion for tightness of this bound, and explain how our method helps to design new Bell inequalities. Certain modifications of the correlation coefficients are shown to leave the Tsirelson bound invariant, while changing the classical bound. This allows to optimise Bell inequalities with respect to the amount of their possible violation.

Jeffrey Bub

University of Maryland, USA

Whose Information? Information About What?

The idea that information might be the key to understanding quantum mechanics is often met with the Bell's dismissive comment: Information? Whose information? Information about what? But we don't ask these questions about a USB flash drive. A 64 GB drive is an information storage device with a certain capacity, and whose information or information about what is irrelevant. I present a case for regarding quantum mechanics as about the structure of information in a similar sense to which the theory of relativity is about the structure of spacetime.

Adan Cabello

Universidad de Sevilla, Spain

Quantum correlations: where, how and why

In quantum theory, correlations between outcomes of jointly measurable observables violate certain Bell and noncontextuality inequalities up to certain limits. Here we report some recent results that answer three important questions: Which inequalities are violated? Which violations are possible? Why these limits?

John Clauser

J. F. Clauser & Associates, USA

Some Bell's Theorem Test Loopholes added in last 36 years

The Clauser, Horne, Shimony Holt (CHSH) 1969 paper provided the first experimentally testable Bell inequality. It specified an experimental protocol in which the polarization analyzers are inserted or removed, and associated coincidence rates are then measured. The Clauser-Horne (CH) 1974 paper first showed that "Objective Local Theories" are constrained by Bell inequalities. These theories were later renamed "Theories of Local Realism" by Clauser and Shimony (CS) in 1978. CH offered the first experimentally testable loophole-free Bell inequality, wherein analyzers need not be removed, but coincidence rates are compared with singles rates. Christensen *et. al* in 2013 first tested the loophole free CH inequality. CH also offered a test protocol using analyzer removal, along with a plausible "no-enhancement" assumption, whereupon the CH inequality reduces to the CHSH inequality, and only coincidence rates are measured. The (first) experimental test by Freedman and Clauser in 1972 of a Bell inequality used the CHSH/CH analyzer-removal protocol and violated the CHSH inequality by 5 std. dev. with no background subtraction. It was a 2-channel experiment. It left open the "locality loophole". Since then, experiments with higher count rates have additionally required subtracting the accidental coincidence background rate, thereby introducing an additional loophole, that was criticized by Marshall *et. al* in 1983. Since the FC experiment needed no background subtraction, it is not subject to their loophole. CS in 1978 noted that 4-channel ("Bell's configuration") experiments can be (similarly to CH) loophole free, if and only if the coincidence rates are "normalized" to an "event-ready" heralding rate. Aspect *et. al* in 1982 performed the first 4-channel experiment using active analyzer switching, thereby closing the locality loophole. However, they did not use CHSH/CH protocol, nor did they use event-ready heralding rate normalization. Instead, they added a new loophole by normalizing their coincidence rates to the sum of the 4 possible coincidence rates. Their method and inequality is still referred to (erroneously) as testing the CHSH inequality. (At the first Vienna Quantum Unspeakables Conference, I criticized this loophole and the associated misquotation.) Since then, passive beam-splitters have been used to replace Aspect *et. al*'s active analyzer switches, whereby 8-channel experiments are created, and additional loopholes thereby created. In 2011, Gerhardt *et. al* criticized these added loopholes and showed that they allow an experimental "faking" of a violation of a Bell's Inequality. Note that the 1972 FC experiment is not subject to their criticism either.

Nicolas Gisin

Université de Genève, Switzerland

Quantum correlations in Newtonian space and time: faster than light communication or nonlocality

Experimental violations of Bell inequalities using space-like separated measurements precludes the explanation of quantum correlations through causal influences propagating at subluminal speed. Yet, "everything looks as if the two parties somehow communicate behind the scene". We investigate the assumption that they do so at a speed faster than light, though finite. Such an assumption doesn't respect the spirit of Einstein relativity. However, it is not crystal clear that such "communication behind the scene" would contradict relativity. Indeed, one could imagine that this communication remains for ever hidden to humans, i.e. that it could not be controlled by humans, only Nature exploits it to produce correlations that can't be explained by usual common causes. To define faster than light hidden communication requires a universal privileged reference frame in which

this faster than light speed is defined. Again, such a universal privileged frame is not in the spirit of relativity, but it is also clearly not in contradiction: for example the reference frame in which the cosmic microwave background radiation is isotropic defines such a privileged frame. Hence, a priori, a hidden communication explanation is not more surprising than nonlocality.

We prove that for any finite speed, such models predict correlations that can be exploited for faster-than-light communication. This superluminal communication doesn't require access to any hidden physical quantities, but only the manipulation of measurement devices at the level of our present-day description of quantum experiments. Consequently, all possible explanations of quantum correlations that satisfy the principle of continuity, which states that everything propagates gradually and continuously through space and time, or in other words, all combination of local common causes and direct causes that reproduce quantum correlations, lead to faster than light communication, which can be exploited by humans, at least in principle. Accordingly, either there is superluminal communication or the conclusion that Nature is nonlocal (i.e. discontinuous) is unavoidable.

1. Jean-Daniel Bancal, Stefano Pironio, Antonio Acin, Yeong-Cherng Liang, Valerio Scarani and Nicolas Gisin, Quantum non-locality based on finite-speed causal influences leads to superluminal signalling, Nature Physics, 8, 867-70, 2012.

2. N. Gisin, arXiv:1210.7308

3. Tomer Jack Barnea, Jean-Daniel Bancal, Yeong-Cherng Liang, Nicolas Gisin, A tripartite quantum state violating the hidden influence constraints, PRA 88, 022123, 2013

Marissa Giustina

University of Vienna & Austrian Academy of Sciences, Austria

Bell violation with entangled photons, free of the fair-sampling assumption

The experimental violation of a Bell inequality forces one to abandon a local realistic worldview (in which physical influences are limited to light speed and measurement outcomes are defined, at least probabilistically, prior to measurement). Although Bell's inequality has already been tested in a number of experiments, a true test of local realism has tighter constraints: the nonlocal behavior must be demonstrated in such a way that no local realistic theory can take advantage of implicit experimental assumptions to explain the outcome. We have used photons and high-efficiency superconducting detectors to violate a Bell inequality closing the "fair-sampling loophole," i.e. without assuming that the sample of measured photons accurately represents the entire ensemble. This experiment marks an important step toward a truly definitive test, however a number of nontrivial improvements will be necessary to simultaneously close the most relevant loopholes, which also include "locality" and "freedom-of-choice."

Daniel Greenberger

City College of New York, USA

Otfried Gühne

Universität Siegen, Germany

Analyzing multiparticle quantum states: problems and some solutions

Many experiments nowadays aim at the observation of quantum phenomena with several particles, such as trapped ions or polarized photons. In my talk I present results on three problems concerning the characterization of multiparticle quantum states. First, in many experiments one measures certain observables in order to determine the quantum state completely. The resulting state, however, has often unphysical properties (such as negative eigenvalues). This can be due to systematic errors, such as a misalignment of the measurement directions, or due to statistical fluctuations coming from the finite number of experiments. I will introduce a method to distinguish such statistical errors from systematic errors and apply the method to data obtained in a ion-trap experiment [1].

Second, if measurement data without systematic errors are given, the task remains to reconstruct a density matrix. I will show that the frequently used methods of maximum likelihood reconstruction and free least squares optimization lead to a systematic bias, underestimating the fidelity and overestimating the entanglement.

This is shown to be a fundamental problem for any state reconstruction scheme that results always in valid density operators [2].

Finally, if in an experiment the quantum state has been reconstructed properly, the question remains how to characterize its correlations.

I will introduce a method based on exponential families, which leads to a natural extension of the concept of multiparticle entanglement.

This approach can, for instance, be used to verify the presence of complex interactions in experiments for quantum simulation.

[1] T. Moroder et al., Phys. Rev. Lett. 110, 180401 (2013).

[2] C. Schwemmer et al., arXiv:1310.8465.

[3] S. Niekamp et al., J. Phys. A: Math. Theor. 46, 125301 (2013).

Beatrix Hiesmayr

University of Vienna, Austria

Testing Bell's Theorem in High Energy Physics

John Stewart Bell was known and hired as a "particle physicist" when he came up with his work on hidden parameters. The aim of this talk is to discuss whether his theorem can be brought back to those systems that do not build up ordinary matter and light. Indeed, entanglement can be witnessed, e.g., in flavour oscillating systems, in particular in the neutral kaon-antikaon system, BUT: Can an experimentally conclusive test be found proving the existence of correlations that are stronger than those allowed by classical physics?

The first thing to note is that it is not straightforwardly to apply his theorem to decaying two-state systems. From the theoretical point of view the findings [1] turned out to be surprising since a connection between the violation of Bell's theorem and the tiny violation of the CP symmetry (C..charge conjugation, P...parity) has been found. The broken CP symmetry, verified in various accelerator facility experiments, reveals a small difference of a world of matter and a world of antimatter. Moreover, this discovery of CP violation can be attributed to the unsolved problem why we live in a universe dominated by matter, a huge open problem in particle physics.

In the last part of the talk I show that the kaon-antikaon system is a unique laboratory to study foundations of quantum mechanics, e.g. for testing quantum eraser or decoherence models or collapse models [2].

[1] Hiesmayr et al., "Revealing Bell's Nonlocality for Unstable Systems in High Energy Physics", EPJ C , Vol. 72, 1856 (2012).

[2] Brahami et al., "Are collapse models testable with quantum oscillating systems? The case of neutrinos, mesons, chiral molecules", Nature:Scientific Reports 3, 1952 (2013).

Michael Horne

Stonehill College, USA

On Spatial Entanglement Wavefunctions

Simon B. Kochen

Princeton University, USA

Quantum Mechanics in a New Key

Barbara Kraus

The maximally entangled set of multipartite quantum states

Many applications of quantum information, such as quantum communication and quantum computation, rely on the possibility of several systems to be entangled. Thus, the qualification and quantification of entanglement is one of the central topics within quantum information. Due to the exponential growths of the dimension of the state-space (as a function of the number of considered systems), however, many very fundamental questions in this context are still unanswered.

In this talk I will focus on some aspects of multipartite entanglement.

I will show how the notion of maximally entangled bipartite systems can be generalized to the multipartite setting. In the multipartite case there does no longer exist a single state which is maximally entangled, but a whole set of states is required. The maximally entangled set for three and four qubit states will be presented and a simple characterization of them will be provided [1].

[1] J. I. de Vicente, C. Spee, B. Kraus, "The maximally entangled set of multipartite quantum states", Phys. Rev. Lett. 111, 110502 (2013).

Paul Kwiat

University of Illinois at Urbana-Champaign, USA

Xtreme Nonlocality

Jan-Åke Larsson, Marissa Giustina, Johannes Kofler, Bernhard Wittmann, Rupert Ursin, and Sven Ramelow

Linköpings universitet, Sweden

Bell violation with entangled photons, free of the coincidence-time loophole

In a local realist world view, physical properties are defined prior to and independent of measurement, and no physical influence can propagate faster than the speed of light. Proper experimental violation of a Bell inequality would show that the world cannot be described within local realism. Such experiments usually require additional assumptions that make them vulnerable to a number of "loopholes." A recent experiment [Giustina et al, Nature, 2013] violated a Bell inequality without being vulnerable to the detection (or fair-sampling) loophole, therefore not needing the fair-sampling assumption. Here we analyze the more subtle coincidence-time loophole, and propose and prove the validity of two different methods of data analysis that avoid it. Both methods are general and can be used both for pulsed and continuous-wave experiments.

We apply them to demonstrate that the experiment mentioned above violates local realism without being vulnerable to the coincidence-time loophole, therefore not needing the corresponding fair-coincidence assumption.

John M. Martinis

University of California Santa Barbara, USA

Superconducting Xmon qubits with gate fidelity at the surface code threshold

We have recently demonstrated a universal set of logic gates in a superconducting Xmon qubit that achieves an average single-qubit gate fidelity of 99.92% and a two-qubit gate fidelity up to 99.4%. This places Josephson quantum computing at the fault-tolerant threshold for surface code error correction. Our quantum processor is a first step towards the surface code, using five qubits arranged in a linear array with nearest-neighbor coupling. Using this device we have further demonstrated generation of the five-qubit Greenberger-Horne-Zeilinger (GHZ) state using the complete circuit and full set of gates, giving a state fidelity of 82% and a Bell state (2 qubit) fidelity of 99.5%. These results demonstrate that Josephson quantum computing is a high-fidelity technology, with a clear path to scaling up to large-scale, fault-tolerant quantum circuits.

David Mermin

Cornell University, USA

Putting the Scientist into the Science

Chris Fuchs and Ruediger Schack have developed a way to think generally about science, which resolves many of the conceptual puzzles in quantum mechanics that have vexed people for the past nine decades. They call it QBism. I shall speculate on how John Bell might have reacted to QBism, and I shall talk about the many ways in which QBism differs from the Copenhagen interpretation, which Bell evidently believed resolved no conceptual puzzles whatever. I shall try to make my remarks intelligible to people unacquainted with QBism, by phrasing what I say about both Bell and Copenhagen to serve as implicit definitions of what QBism is about.

Sven Ramelow

VCQ Vienna, Austria

On Closing Loopholes in Bell Experiments

Helmut Rauch

Institute of Atomic and Subatomic Physics, Austria

Search for hidden observables in neutron experiments

Neutrons are proper tools for testing basic laws of quantum physics since they are massive and can be handled and measured with high efficiency. Entangled spin-momentum states occur when neutrons enter a magnetic field. Proper post-selection experiments demonstrate coherence features of sub-ensembles even when the whole ensemble seems to have lost its coherence. Partial absorption and homodyne experiments will be described and it will be shown that distinct losses are unavoidable in any case of interaction. Coherence and decoherence are intrinsic features of quantum effects. Quantum contextuality as a new feature will be used to demonstrate entanglement of different degrees of freedom. This makes quantum phenomena stronger correlated than classical ones. Most experiments have been done with perfect neutron interferometers and some others by using ultra-cold neutrons and spin-echo systems [1,2]. Whether the Compton frequency and proper time effects can contribute to a more rational explanation of quantum effects will be discussed. An event by event based interpretation can also be brought into agreement with the experimental results [3]. The coupling and entanglement of various parameter spaces guide us to a more rational discussion of quantum effects.

[1] H. Rauch, S.A. Werner, "Neutron Interferometry", Clarendon Press, Oxford 2000

[2] Y. Hasegawa, H. Rauch, New J. Physics 13 (2011) 115010

[3] H. De Raedt, K. Michielsen, Quantum Matter 1 (2012) 20

Renato Renner

ETH Zürich, Switzerland

The freedom of choice assumption and its implications

Terence Rudolph

Imperial College London, UK

My struggle to face up to un-reality

I am sadly irretrievably committed to the notion that there is an underpinning narrative about "what is really going on" at the microscopic scale. I don't care much if it is non-determiistic, not counterfactually definite, contextual, nonlocal, or involves leprechauns – as long as it doesn't require me to accept the failure of reductionism for realism itself. That is, I cannot accept that while there is clearly a realistic description of the macroscopic world (I am not a solipsist!), at some intermediate scale between me and my atomic friends realistic descriptions of any sort become impossible. In this talk I will try and outline the relationship between various no-go theorems for obtaining realistic descriptions, defend the notion that the quantum state should not be considered real, and try to explain a sort of "category mistake" that I think underpins most of our attempts at telling realistic stories.

Valerio Scarani

Centre for Quantum Technologies CQT, Singapore

A full state in a single number

Suppose that one could observe exactly the maximal violation of the CHSH inequality, S=2sqrt2, in a loophole-free Bell test. From this single number, without any a priori knowledge other than trusting that quantum theory is correct, one infers that the state being measured is the maximally entangled state of two qubits, and that the two measurements of each party are performed in complementary bases. This observation can be traced back to a work by Popescu and Rohrlich in 1992 (although the few privileged ones who can read operator algebra papers might have noticed it already in 1987, in the work of Summers and Werner). It is now called "self-testing" after the similar criterion put forward by Mayers and Yao in 1998.

Self-testing is the most impressive form of device-independent assessment: from the observed statistics, one does not just infer the performance of the system in a given specific task ("amount of randomness that can be extracted", "length of a cryptographic key"...), but the full structure of the state and measurements --- up to local isometries, of course.

After reviewing the basics of self-testing, I shall present two recent developments: (i) the proof of robustness of self-testing, that is, we can also say something is S is not exactly 2sqrt2; (ii) the generalization of self-testing beyond CHSH and Mayers-Yao, to other inequalities and criteria.

Robert Spekkens

Perimeter Institute for Theoretical Physics, Canada

On causal explanations of quantum correlations

Causal discovery algorithms take as their input facts about correlations among a set of observed variables, and they return as their output causal structures that can account for the correlations. I show that any causal explanation of certain quantum correlations--- those that violate a Bell inequality---must contradict a core principle of these algorithms, namely, that an observed statistical independence between variables should not be explained by fine-tuning of the causal parameters. The fine-tuning criticism applies to all of the standard attempts at causal explanations of Bell-inequality violations, such as superluminal causal influences, superdeterminism, and retrocausation. Nonetheless, I argue that by understanding the innovation of quantum theory to be an innovation to the theory of Bayesian inference, one can generalize the notion of a causal model and salvage a causal explanation of quantum correlations without fine-tuning.

Rupert Ursin

Austrian Academy of Sciences, Austria

Quantum Optics Experiments using Satellites

C. Erven, E. Meyer-Scott, K. Fisher, J. Lavoie, B. L. Higgins, Z. Yan, C. J. Pugh, J.-P. Bourgoin, R. Prevedel, L. K. Shalm, L. Richards, N. Gigov, R. Laflamme, **Gregor Weihs**, T. Jennewein and K. J. Resch

University of Innsbruck, Austria

A GHZ experiment under strict Einstein locality conditions

Quantum correlations are critical to our understanding of the quantum world, with far-reaching technological and fundamental impact. Many tests of Bell inequalities have studied pairs of correlated particles. However, interest in multi-particle quantum correlations is driving the experimental frontier to test larger systems. All violations to date require supplementary assumptions that open results to loopholes, the closing of which is one of the most important challenges in quantum science. Seminal experiments have closed some loopholes, but no experiment has closed locality loopholes with three or more particles. Here, we close both the locality and freedom-of-choice loopholes by distributing three-photon Greenberger–Horne–Zeilinger entangled states to independent observers. We measured a violation of Mermin's inequality with parameter 2.77+0.08, violating its classical bound by nine standard deviations. These results are a milestone in multi-party quantum communication and a significant advancement of the foundations of quantum mechanics.

[Erven et al., Nature Photonics, 2014, DOI: 10.1038/nphoton.2014.50]

Daniel Burchardt, Robert Gaarthof, Julian Hofmann, Norbert Ortegel, Kai Redeker, Markus Weber, Wenjamin Rosenfeld and **Harald Weinfurter**

Ludwig-Maximilians-Universität Munich, Germany

Heralded entanglement between distant atoms: Towards a loophole free test of Bell's inequality?

We report on the generation and analysis of heralded entanglement between spins of two single ^{87}Rb atoms trapped independently 20 meters apart. The data observed violate a Bell type entanglement without the detection loophole even for the large separation.

We discuss the progress towards further extending this experiment to also close the locality loophole. For that purpose the measurements, now taking about 20 ms only for the readout, have to be performed significantly faster. We developed a fast quantum random number generator determining the analysis direction and are currently implementing state dependent ionization and subsequent detection of the ionization fragments allowing to perform the whole measurement sequence within a microsecond. Together with extending the distance between the trapped atoms to about 400m this will enable the space like separation of the two observers.

Reinhard F. Werner

Leibniz Universität Hannover, Germany

Steering, and maybe why Einstein didn't go all the way to Bell's argument"

An important issue for Einstein in his debate with the mainstream quantum physicists was to criticize the idea that quantum states and wave functions could be considered as properties of single systems. The EPR paper was written to make this point. It determines, by the rules of quantum mechanics, the conditional state distribution on one side of a correlation experiment, which is obtained by the choice of a measuring device on the other. These state distributions are inconsistent with the existence of a prior distribution of pure states, for which Schrödinger coined the term "steering". In this way of looking at correlation experiments it is natural to try to resolve the inconsistency by allowing a finer description than the one given by wave functions. In modern terminology this would be the search for local hidden variables, shown to be inconsistent with quantum predictions only after Einstein's death by Bell.

A quantum state with the steering property is necessarily entangled, but need not violate any Bell inequality. In my 1989 paper showing that entangled states may have a classical model (thus violating no Bell inequality) I actually used a non-steering model, thus showing that the first inclusion is strict. Embarrassingly, the precise threshold for steering using general observables (not just projection valued ones) is still not known, even for qubits. I show what problem in spherical geometry needs to be solved to establish this threshold.

Andrew Whitaker

Queen's University Belfast, UK

John Bell and Quantum Information Theory

It is often taken for granted that the work of Bell on the foundations of quantum theory, and the theoretical and experimental investigations following from it, led on practically seamlessly to the theory and practice of quantum information theory. The idea is analyzed, together with a discussion of the contributions of others such as Richard Feynman, David Deutsch and Charles Bennett.

Andrew White

University of Queensland, Australia

Physics above and below the Bell horizon: re-examining quantum foundations and glimpsing the post-quantum world via photonics

Fifty years ago, John Bell laid down the foundation of the employment of many of us at this conference. His theorem not only made a testable prediction for quantum mechanics, but also provided a horizon which delineated quantum from post-quantum theories. In this talk I will shine some light on an old question which Bell's local-causality framework helped formulate: what is the nature of the wavefunction? We find that if there is some underlying reality to the wavefunction at all, the wavefunction must itself very likely be real if we want to maintain Bell's framework. I will then edge above the Bell horizon with two post-quantum phenomena: an experimental protocol which allows to create stronger-than-quantum correlations—and thus violate information causality; and a quantum simulation of closed-timelike curves.

Howard M. Wiseman

Griffith University, Australia

Causation and the Two Bell's Theorems of John Bell

Anton Zeilinger

University of Vienna & Austrian Academy of Sciences, Austria

New Dimensions for Entangled Photons

Marek Zukowski

Gdansk University, Poland

Non-locality? – It ain't necessarily so

Bell's theorem is 50 years old. Still there is a controversy about its implications. Much of it has its roots in confusion about the premises from which the theorem can be derived. Some claim that a derivation of a Bell's inequality requires just locality assumption, and nothing more.

Violations of Bell's inequality are then interpreted as ``nonlocality'' or ``quantum nonlocality''. We show that such claims are unfounded.

The assumptions behind Bell's inequalities require existence of hidden variables (or hidden causes, or hidden determinism, or realism, or counterfactual definiteness), locality, and freedom to choose measurement settings by the observers (the choice of settings is independent of other aspects of the experiment). Realism, oppositely to what is sometimes claimed, cannot be derived using quantum correlations and locality (plus the freedom). Local causality, the term used by Bell in his later works, is a form of local hidden variables. Inherently stochastic local hidden variable theories (that is with some fundamental finite irreducible stochasticity, which does not allow deterministic models of any measurement – even as only a mathematical tool) lead to different bounds, than the standard ones, of Bell inequalities.

If time allows some current results of Gdansk group will be flashed.