

Programme

Physics

September 26 will be arrival day, with an informal gathering and drinks in the evening 8pm.

Venue: <u>h-bar, basement of Sherfield Building, Imperial College</u>. Sherfield building is 1 20 on <u>this map</u>.

Talks will take place on the weekend of September 27/28, lecture room: Huxley 311, Department of Physics,

Imperial College London. Huxley building is number 13 on *this map*.

The conference dinner will take place at the <u>Rembrandt Hotel</u>, 11 Thurloe Place, Lonc 2RS, on

Saturday, September 27, from 19:00. If you registered for the dinner, please pay £25 u registration on

Saturday from 8:15 or during the coffee break at 10:45.

Schedule (minor changes still possible)

Friday, Sep 26

Time	Content	Remarks
20:00—ca. 22:30	Informal gathering and drinks, h-bar, Sherfield Building, Imperial College	All pay for themselves

Saturday, Sep 27 – all talks in Huxley 311

Time	Content	Remarks

8:15—9:00	Registration	Please pay £25 if you registered for the conference dinner
9:00-9:15	Welcome	
9:15-10:00	Michael Duff, "Yang-Mills origin of gravitational symmetries"	
10:00—10:45	Peter Knight, "Quantum Rulers – Joint Measurement of Non-commuting Variables and Observing Uncertainty Relations"	
10:45—11:15	Registration, coffee/tea break	Please pay £25 if you registered for the conference dinner
11:15—12:00	Roger Penrose, "Twistor non-locality and EPR effects"	
12:00—12:45	Julian Barbour, "Typical Universes and their Entropy"	
12:45—14:15	Lunch break	South Kensington station area or Gloucester Road, all pay for themselves
14:15—15:00	Lee Smolin (via video link), "Time, causality and law in a cosmological context"	
15:00—15:45	Carlo Rovelli, "Chris, here is a hope for a quantum gravity effect we might be able to see: Planck stars"	
15:45—16:15	Coffee/tea break	16:00 talk by Tom Kibble (by invitation only)
16:15—18:30	Free time/museum?	
18:30	Meeting back at Imperial, walking to restaurant	
19:00—ca. 21:30	Conference dinner at Rembrandt hotel	

Sunday, Sep 28 – all talks in Huxley 311

Time	Content	Remark
9:15-10:00	Sarben Sarkar, "Signatures of CPT	
	violation in mesons and neutrinos"	
10:00-10:45	Tim Palmer, "Bell's Conspiracy,	
	Schrödinger's Black Cat and	
	Global Invariant Sets"	
10:45—11:15	Coffee/tea break	
11:15-12:00	Andreas Döring, "Topos, Ou	
	Topos? Some Progress and Some	
	Partial Truths"	
12:00—12:45	Renate Loll	

12:45—14:15	Lunch break	South Kensington station area or Gloucester Road, all pay for themselves
14:15—15:00	Jonathan Halliwell, "Negative Probabilities, Fine's Theorem and Quantum Histories"	
15:00—15:30	Coffee/tea break	
15:30—16:15	Steve Weinstein, "Degrees of Freedom"	
16:15—17:00	Stanley Deser (via video link), "Massive Gravities, or how I got tenure by destroying Isham's models"	
17:00—17:15	Closing remarks by Chris	

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Abstracts:

Julian Barbour, Oxford: Typical Universes and their Entropy

It is shown in ArXiv:1409.0917 (PRL 26/09/14; JB, T Koslowski, and F Mercati) that a gravitation arrow of time arises solely by virtue of the law of gravity and does not require any special initial condition. Building on the methods of that paper, we have created a framework of gravitational statistical mechanics for dynamically closed universes. It allows us to define an entropy of the universe and establish the nature of typical universes. I will explain the basic ideas and surprising conclusions of our theory using the Newtonian N-body problem. General relativity shares the key structural features that underlie N-body theory, so our results should extend to Einstein gravity.

Stanley Deser, Brandeis: Massive Gravities, or how I got tenure by destroying Isham's models

Andreas Döring, Erlangen: Topos, Ou Topos? Some Progress and Some Partial Truths

I will present aspects of my joint work with Chris between 2006 and 2011 on the topos approach to the formulation of physical theories, emphasising how radically the topos approach departs from established theories and theory-making. I will then present some recent developments and pose the question: is there hope that this approach will actually lead to some progress in foundations, or will topos-based physics stay a utopia?

Michael Duff, Imperial: Yang-Mills origin of gravitational symmetries

By regarding gravity as the convolution of left and right Yang-Mills theories, we derive in linearised approximation the gravitational symmetries of general covariance, p-form gauge invariance, local Lorentz invariance and local supersymmetry from the flat space Yang-Mills symmetries of local gauge invariance and global super-Poincare. Turning to global symmetries we give a division algebra R,C,H,O description of Yang-Mills with N(L/R) = 1,2,4,8 and hence, by tensoring left and right multiplets, a Freudenthal magic square RR, CR, CC, HR, HC, HH, OR, OO OH, OO description of N=N(L)+N(R) supergravity.

Jonathan Halliwell, Imperial: Negative Probabilities, Fine's Theorem and Quantum Histories

Many situations in quantum theory and other areas of physics lead to quasi-probabilities which seem to be physically useful but can be negative. The interpretation of suchobjects is not at all clear. We argue that quasi-probabilities naturally fall into two qualitatively different types, according to whether their non-negative marginals can or cannot be matched to a non-negative probability. The former type, which we call viable, are qualitatively similar to true probabilities, but the latter type, which we call non-viable, may not have a sensible interpretation. Determining the existence of a probability matching given marginals is a non-trivial question in general. In simple examples, Fing theorem indicates that inequalities of the Bell and CHSH type provide criteria for its existence. The proof of Fine's theorem is briefly discussed. The results have consequences for the linear positivity condition of Goldstein and Page in the context of the histories approach to quantum theory. Althou it is a very weak condition for the assignment of probabilities it fails in some important cases when our results indicate that probabilities clearly exist.

This talk is based on the papers

J.J.Halliwell and J.M.Yearsley, Phys. Rev. A 87, 022114 (2013) J.J.Halliwell, Phys. Lett. A 378, 2945 (2014).

Peter Knight, Imperial: Quantum Rulers – Joint Measurement of Non-commuting Variables and Observing Uncertainty Relations

Renate Loll, Nijmegen: tba

Tim Palmer, Oxford: Bell's Conspiracy, Schrödinger's Black Cat and Global Invariant Sets

A locally causal hidden-variable theory of quantum physics need not be constrained by the Bell inequalities if this theory also partially violates the measurement independence condition. However violation can appear unphysical, with implausible conspiratorial correlations between the hidden-vor particles being measured and earlier determinants of instrumental settings. Motivated by global properties of the state space geometry associated with certain nonlinear dynamical systems, a nove explanation for such correlations is proposed. The explanation is based on the proposal that states physical reality lie precisely on a measure-zero dynamically invariant set in the state space of the the Cosmological Invariant Set Postulate. To illustrate the relevance of the concept of a global invariant

a simple analogy is considered where a massive object is propelled into a black hole depending on of a radioactive atom: if the global nature of the event horizon (a photonic invariant set) were not a this experiment might also suggest either implausible conspiracy or retrocausality between the ato supposed hidden variables and the size of the black hole at early times. A locally causal hidden-vae theory constrained by the Cosmological Invariant Set Postulate can violate the CHSH inequality we being conspiratorial, superdeterministic, fine-tuned or retrocausal, and the theory readily accommon the classical compatibilist notion of (experimenter) free will. Just as the application of global geon methods revolutionised our understanding of gravitational physics in the 1960s, here it is proposed global geometric methods in state space may fundamentally change our understanding of quantum and, by promoting a more synergistic relationship between quantum physics and cosmology, lead insights in the problem of unifying quantum and gravitational physics.

Roger Penrose, Oxford: Twistor non-locality and EPR effects

The twistor description of wavefunctions for individual massless particles is fundamentally non-lo given in terms of holomorphic 1st cohomology. This reflects a certain non-locality of individual que particles. For nearticles we have a twistor description in terms of holomorphic nth cohomology. To connection

between this and EPR effects will be explored.

Carlo Rovelli, Marseille: Chris, here is a hope for a quantum gravity effect we might be able to set stars

Where does the matter falling into a black hole go? Quantum gravity allows it to bounce around to density (at a radius much larger than Planckian) and the hole might quantum tunnel into a white he estimate of the tunnelling probability indicates that this is should happen *before* extensive Hawkin evaporation. Primordial black holes might be exploding now, producing signals we might be able If so, this could be an observable quantum gravitational phenomenon. measuring it would be the b to celebrate Chris.

Sarben Sarkar, King's College London: Signatures of CPT violation in mesons and neutrinos

Quantum gravity models based both on decoherence and string theory backgrounds are examined the context of experiments at meson factories and leptogenesis (and resultant baryogenesis). The lost CPT invariance is inherent in the proposals. Signatures in correlations of kaon pairs and oscillat properties of Majorana neutrinos are discussed.

Lee Smolin, Perimeter Institute: Time, causality and law in a cosmological context

Steven Weinstein, Waterloo: Degrees of Freedom

The statistical independence assumption in Bell's theorem (a.k.a. measurement independence) can of as the requirement that all degrees of freedom are local degrees of freedom. That is, there are n constraints. This suggests the possibility that quantum correlations might actually arise from correinitial

data encoded in such constraints. Such constraints, though unfamiliar to many, need not be arcanexotic.

I'll give three simple examples.

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