Quantum Mechanics, vacuum, particles, Gödel-Cohen Incompleteness and the Universe

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Abstract – **What is the origin of Quantum Mechanics (QM)? Is it an ultimate principle of Physics or a property of standard particles generated at a more fundamental level?**

In the last case, a spinorial space-time with two complex coordinates instead of the standard four real ones can play an important role in the foundations of QM.

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Similarly, if the vacuum is made of preons and the vacuum preons are superluminal just as the speed of light is much larger than that of sound, quantum entanglement appears as a natural property for standard particles and Bell's theorem does not apply to this new situation.

A vacuum made of superluminal preons can also influence black hole dynamics, including new quantum effects and new forms of radiation. LIGO and VIRGO data can potentially be sensitive to such an interaction.

Can the Gödel-Cohen incompleteness be avoided for a suitable formulation of the Quantum Physics of standard particles, if these particles are actually excitations of a preonic vacuum? After reviewing the present situation for conventional Quantum Mechanics, we attempt to answer this question considering implications for both Particle Physics and Cosmology.

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John Stewart BELL

Belfast 1928

–

Geneva 1990

John Bell
taught us
what is,
and what is not,
Quantum
Mechanics

BELL'S THEOREM

BASIC CONTENT : **Theories with local hidden variables cannot reproduce all the predictions of Quantum Mechanics**

In his book *Speakable and Unspeakable in Quantum Mechanics*, **Cambridge University Press, 1987, p. 65, commenting on a hidden variable approach to Quantum Mechanics considered by Georges Lochak, John Bell writes explicitly:**

… if his extension is local it will not agree with quantum mechanics, and if it agrees with quantum mechanics it will not be local.

John Bell, in *On the Einstein Podolsky Rosen Paradox*, *Physics* 1 (3), 195 (1964) :

In a theory in which parameters are added to quantum mechanics to determine the results of individual measurements, without changing the statistical predictions, there must be a mechanism whereby the setting of one measuring device can influence the reading of another instrument, however remote. Moreover, the signal involved must propagate instantaneously, so that such a theory could not be Lorentz invariant.

Actually, the signal propagation can also be superluminal.

POSSIBLE INGREDIENTS OF A NEW APPROACH TO QUANTUM MECHANICS

I – VACUUM STRUCTURE AND DYNAMICS

STANDARD PARTICLES AS VACUUM EXCITATIONS

THE PHYSICAL VACUUM AND STANDARD QUANTUM FIELD THEORY

In standard quantum field theory (SQFT), standard particles are "elementary" and the associated quantum fields can condense in vacuum. In this way, vacuum acquires an internal structure.

But SQFT does not describe an intrinsic internal structure of vacuum pre-existent to standard particles and of which such particles would be excitations.

BEYOND SQFT =>
A PREONIC VACUUM STRUCTURE ?

See, for instance, my previous ICNFP papers

IF STANDARD PARTICLES ARE VACUUM EXCITATIONS, LIKE PHONONS AND SOLITONS IN CONDENSED MATTER, THE CONSTITUENTS OF VACUUM CAN NATURALLY HAVE

A CRITICAL SPEED MUCH LARGER THAN THE SPEED OF LIGHT c JUST AS c IS MUCH LARGER THAN THE SPEED OF SOUND

=>THE SUPERBRADYON HYPOTHESIS

(L. Gonzalez-Mestres, arXiv:astro-ph/9505117, 1995, and subsequent papers)

SUPERBRADYONS (SUPERLUMINAL PREONS) WOULD BE THE CONSTITUENTS OF THE PHYSICAL VACUUM

THEN, STANDARD RELATIVITY AND QUANTUM MECHANICS WOULD NO LONGER BE ULTIMATE FUNDAMENTAL PRINCIPLES

CAN SUPERBRADYONS PROPAGATE AS FREE PARTICLES IN OUR UNIVERSE?

AN OPEN QUESTION

Assuming this is the case, they are expected (contrary to tachyons) to spontaneously emit Cherenkov-like radiation in vacuum in the form of standard particles until they reach a speed close to *c*.

BUT THEY WOULD IN ANY CASE BE ABLE TRAVEL AT SUPERLUMINAL SPEED INSIDE THE VACUUM STRUCTURE => SUPERLUMINAL SIGNALS WOULD BE ABLE TO PROPAGATE

AS SUPERBRADYONS WOULD NOT BE STANDARD PARTICLES,

WE EXPECT THE DIRECT COUPLING OF A SINGLE SUPERBRADYON TO STANDARD INTERACTIONS TO BE WEAKER THAN THAT OF STANDARD MATTER

BUT IF THE PHYSICAL VACUUM IS MADE OF SUPERBRADYONS,

THE TRANSMISSION OF SIGNALS AND INFORMATION FROM STANDARD MATTER WILL BE A COLLECTIVE EFFECT AND CAN BE AMPLIFIED AS SUCH

SUPERLUMINAL SIGNALS PROPAGATING IN A SUPERBRADYONIC VACUUM

=> A NATURAL EXPLANATION FOR QUANTUM ENTANGLEMENT

Assume that the critical speed of superbradyons inside vacuum is $c_s \sim 10^6 c$ just as c is $\sim 10^6$ times larger than the speed of sound => can explain data from Bernien, Hensen et al.

$$1.3 \text{ Km} / c_s \sim 4 \times 10^{-12} \text{ s}$$

Experiments on entanglement can lead to bounds on c_s and even, possibly, determine it

Experimental loophole-free violation of a Bell inequality using entangled electron spins separated by 1.3 km

B. Hensen, H. Bernien, A.E. Dréau, A. Reiserer, N. Kalb, M.S. Blok, J. Ruitenberg, R.F.L. Vermeulen, R.N. Schouten, C. Abellán, W. Amaya, V. Pruneri, M. W. Mitchell, M. Markham, D.J. Twitchen, D. Elkouss, S. Wehner, T.H. Taminiau, R. Hanson (Submitted on 24 Aug 2015)

For more than 80 years, the counterintuitive predictions of quantum theory have stimulated debate about the nature of reality. In his seminal work, John Bell proved that no theory of nature that obeys locality and realism can reproduce all the predictions of quantum theory. Bell showed that in any local realist theory the correlations between distant measurements satisfy an inequality and, moreover, that this inequality can be violated according to quantum theory.

This provided a recipe for experimental tests of the fundamental principles underlying the laws of nature. In the past decades, numerous ingenious Bell inequality tests have been reported. However, because of experimental limitations, all experiments to date required additional assumptions to obtain a contradiction with local realism, resulting in loopholes. Here we report on a Bell experiment that is free of any such additional assumption and thus directly tests the principles underlying Bell's inequality. We employ an event-ready scheme that enables the generation of high-fidelity entanglement between distant electron spins. Efficient spin readout avoids the fair sampling assumption (detection loophole), while the use of fast random basis selection and readout combined with **a spatial separation of 1.3 km** ensure the required locality conditions. We perform 245 trials testing the CHSH-Bell inequality $S \leq 2$ and find $S = 2.42 \pm 0.20$. A null hypothesis test yields a probability of $p = 0.0039$ that a local-realist model for space-like separated sites produces data with a violation at least as large as observed, even when allowing for memory in the devices. This result rules out large classes of local realist theories, and paves the way for implementing device-independent quantum-secure communication and randomness certification.

II – SPACE-TIME STRUCTURE

SPACE-TIME, THE UNIVERSE AND PARTICLE PROPERTIES

=> THE SPINORIAL SPACE-TIME

FIRST INGREDIENT OF A NEW FORMULATION OF QUANTUM MECHANICS : SUPERLUMINAL SIGNALS IN THE SUPERBRADYONIC VACUUM

BUT WHAT ABOUT SPACE-TIME ?

IS THERE A LINK BETWEEN QUANTUM MECHANICS AND THE SPACE-TIME STRUCTURE ?

IS THERE A RELATION BETWEEN COMPLEX QUANTUM WAVE FUNCTIONS AND POSSIBLE COMPLEX SPACE-TIME COORDINATES ?

ARE COMPLEX QUANTUM WAVE FUNCTIONS NATURAL EXPRESSIONS OF A COMPLEX SPACE-TIME LEADING VACUUM DYNAMICS?

HOW ARE FERMIONIC SPINORS GENERATED ?

AN EXAMPLE OF NEW SPACE-TIME : THE SPINORIAL SPACE-TIME (SST)

L. Gonzalez-Mestres, 1996-97

FERMIONS ARE NOT REPRESENTATIONS OF THE CONVENTIONAL SPACE ROTATION GROUP SO(3) BUT OF ITS COVERING GROUP SU(2)

=>Replace the standard four-dimensional space-time by a SU(2) spinorial one, so that spin-1/2 particles become representations of the actual group of space transformations.

=> Associate to each point of space-time in our Universe a cosmic spinor ξ (two components, two complex numbers) with a SU(2) group that contains the space rotations group SO(3).

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=> Extracting from a cosmic spinor ξ the scalar $|ξ|^2 = ξ^†ξ$ where the dagger stands for hermitic conjugate, a positive cosmic time $t = |ξ|$ can be defined which leads in particular to a naturally expanding universe, with an arrow of time.

=> The conventional space at cosmic time t_0 corresponds to the $|ξ| = t_0$ S^3 hypersphere from the four real numbers contained in the two SU(2) spinor components

PURELY GEOMETRIC EFFECTS => No matter, no critical speed, involved yet.

The definition of cosmic time is not unique :
t **can also be a different fonction of the spinor modulus |ξ| => f.i. *t* = |ξ|²**

This does not change the analysis that follows, and has no practical consequences

In such a spinorial space-time, comoving frames correspond to straight lines through the origin ξ = 0 that corresponds to the origin of cosmic time

Spatial distances at a given cosmic time must be measured on the constant time S³ hypersphere.

THE LUNDMARK- LEMAITRE – HUBBLE LAW CAN THEN EMERGE FROM PURE GEOMETRY

The SST automatically Leads to the Lemaître – Hubble law : $v / d = t_0^{-1}$ where : v = relative speed, d = spatial distance at constant t .

The Lundmark - Lemaître – Hubble constant turns out to be equal to the inverse of the age of the Universe. This "automatic" value obtained with such a simple, purely geometric, spinorial pattern is quite reasonable from a phenomenological point of view.

No gravitation, standard interactions… has yet been introduced => could the apparent acceleration of the expansion of our Universe be just a fluctuation due to the history of these "local" parameters that initially opposed to the expansion? (See my previous papers)

SST AND RELATIVITY

EVEN IF RELATIVITY WILL REMAIN AN ESSENTIAL PROPERTY OF STANDARD MATTER, IT IS NOT EXPECTED TO BE AN EXACT SYMMETRY IN THE SST

=> NOT REALLY PART OF THE BASIC GEOMETRY

RELATIVITY WILL IN PRINCIPLE BE VIOLATED AT VERY LOW DISTANCES AND ULTRA-HIGH ENERGIES (f.i. by preon dynamics)

SIMILARLY, GENERAL RELATIVITY IS NOT EXPECTED TO BE A DOMINANT FEATURE OF THE UNIVERSE AT THE LARGEST DISTANCE SCALES (IMPLICATIONS OF A POSSIBLE PRE-BIG BANG COSMOLOGY)

SST AND A POSSIBLE ORIGIN OF QUANTUM MECHANICS (MY ICNFP 2015 PAPER)

HAVING DEFINED THE COSMIC TIME IN THE SST AS $t = |\xi|$, HOW TO DEFINE, IN THE LIMIT OF VERY SMALL TIME AND DISTANCE SCALES, THE LOCAL TIME AND SPACE AROUND A POINT ξ_0 DIFFERENT FROM THE COSMIC ORIGIN ?

ASSUME THAT, HAVING A PREONIC VACUUM, WE INTRODUCE LOCAL SPINORIAL COORDINATES SIMILAR TO THE COSMIC ONES THROUGH THE LOCAL SPINOR $\xi - \xi_0$ LEADING TO A LOCAL TIME $|\xi - \xi_0|$ => A CONTRADICTION ARISES AT VERY SMALL DISTANCES BETWEEN LOCAL AND COSMIC TIME => CONSEQUENCES FOR MATTER ?

If $\Psi(\xi - \xi_0)$ is the spinorial wave function from preon dynamics, centered at $\xi = \xi_0$, of a fermion in the local spinorial space-time, it may happen that $\Psi(\xi - \xi_0)$ is a solution of the basic equations leading preon dynamics, but its continuous propagation is not and is forbidden by dynamics.

Taking for the cosmic time associated to the fermion space-time position $t_0 = |\xi_0|$, the spinor $\xi - \xi_0$ spans over a continuous set of values of the cosmic time => In the SST with a preonic vacuum, particles are extended objects in both space and time

=> THIS CAN FORBID CONTINUOUS MOTION

FROM MY ICNFP 2015 POSTER ON QM

TIME

SPACE

SPACE
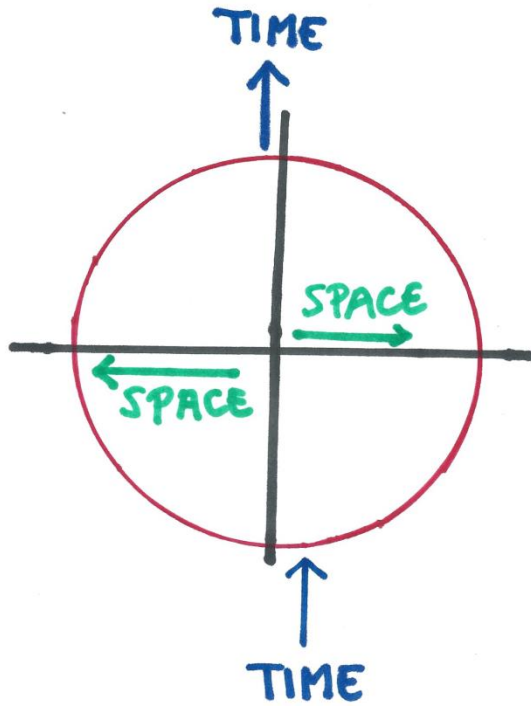
TIME

TIME

AN "EXTENDED" SPIN-1/2 PARTICLE IN THE SST ⟹ A WHOLE CONTINUUM OF VALUES OF TIME IS SIMULTANEOUSLY CONCERNED
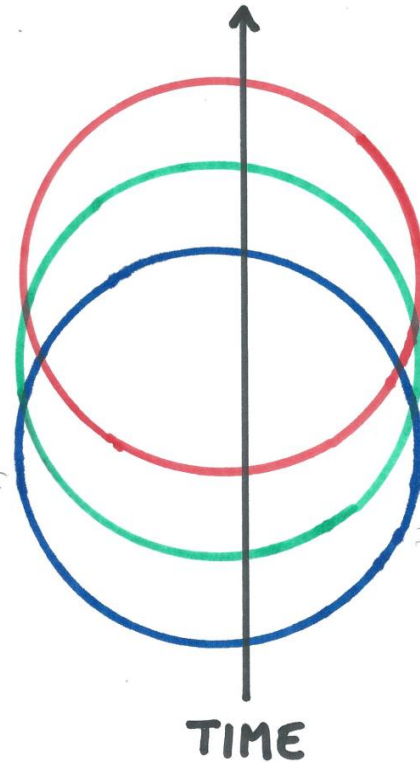
CONTINUOUS MOTION FORBIDDEN BY VACUUM DYNAMICS BECAUSE OF OVERLAP IN TIME?

IF CONTINUOUS MOTION IS FORBIDDEN AT VERY SMALL DISTANCE SCALES, DISCRETE MOTION WILL PRESENT RANDOM FEATURES POTENTIALLY LEADING TO A FEYNMAN-LIKE PATH INTEGRAL AT MACROSCOPIC SCALES

=> A SUPERBRADYONIC VACUUM WITH SST SPACE-TIME GEOMETRY CAN NATURALLY DE AT THE ORIGIN OF QUANTUM MECANICS

THE SITUATION DESCRIBED CAN POTENTIALLY BE GENERATED WITH ANY DYNAMICAL PATTERN IMPLYING A DEFINITION OF TIME AT VERY SMALL DISTANCES IN CONTRADICTION WITH THE MACROSCOPIC ONE OR NATURALLY INTRODUCING AN INTRINSIC TIME UNCERTAINTY => DESERVES FURTHER INVESTIGATION

THE SCENARIO JUST CONSIDERED VIOLATES CONVENTIONAL RELATIVITY AND QUANTUM MECHANICS AT VERY SMALL DISTANCES AND VERY HIGH ENERGY FOR STANDARD PARTICLES => HOW TO TEST SUCH VIOLATIONS ?

- Ultra-high energy cosmic rays (e.g. GZK ?, see my previous ICNFP papers) : the situation remains unclear => AUGER is preparing an upgrade

- SST predicts a privileged space direction for each comoving observer (see my previous ICNFP papers) : Planck may have seen a signature of this phenomenon, but its final results are not yet known.

http://arxiv.org/abs/1604.03637

The Pierre Auger Observatory Upgrade - Preliminary Design Report

The Pierre Auger Collaboration:

(Submitted on 13 Apr 2016)

The Pierre Auger Observatory has begun a major Upgrade of its already impressive capabilities, with an emphasis on improved mass composition determination using the surface detectors of the Observatory. Known as AugerPrime, the upgrade will include new 4 m² plastic scintillator detectors on top of all 1660 water-Cherenkov detectors, updated and more flexible surface detector electronics, a large array of buried muon detectors, and an extended duty cycle for operations of the fluorescence detectors. This Preliminary Design Report was produced by the Collaboration in April 2015 as an internal document and information for funding agencies. It outlines the scientific and technical case for AugerPrime. (…)

III – HOW TO TEST THE SUPERBRADYONIC VACUUM ?

(INCLUDING QUANTUM-MECHANICAL EFFECTS IN THIS CONTEXT)

A POSSIBLE NEW WAY AFTER LIGO – VIRGO RESULTS :

BLACK HOLES, GRAVITATIONAL WAVES, OTHER POSSIBLE WAVES…

Schwarszchild black hole of mass M :

$$ds^2 = -c^2 (1 - 2GM/c^2r) \, dt^2 - (1 - 2GM/c^2r)^{-1} \, dr^2 + r^2 (d\theta^2 + \sin^2\theta \, d\varphi^2)$$

G = gravitational constant, r = spatial radius, c = speed of light, t = time, θ and φ = standard angular variables.

In the presence of a superbradyonic vacuum, we expect the $r = 0$ singularity of the black hole to interact with vacuum structure and be replaced by a new dynamical configuration, including quantum effects => Can modify black hole dynamics and radiation => Observable by LIGO and VIRGO ?

Properties of the Binary Black Hole Merger GW150914

The LIGO Scientific Collaboration, the Virgo Collaboration

On September 14, 2015, the Laser Interferometer Gravitational-wave Observatory (LIGO) detected a gravitational-wave transient (GW150914); we characterize the properties of the source and its parameters. The data around the time of the event were analyzed coherently across the LIGO network using a suite of accurate waveform models that describe gravitational waves from a compact binary system in general relativity. GW150914 was produced by a nearly equal mass binary black hole of $36+5-4 M_\odot$ and $29+4-4 M_\odot$; for each parameter we report the median value and the range of the 90% credible interval. The dimensionless spin magnitude of the more massive black hole is bound to be <0.7 (at 90% probability). The luminosity distance to the source is $410+160-180$ Mpc, corresponding to a redshift $0.09+0.03-0.04$ assuming standard cosmology. The source location is constrained to an annulus section of 610 deg2, primarily in the southern hemisphere. The binary merges into a black hole of $62+4-4 M_\odot$ and spin $0.67+0.05-0.07$. This black hole is significantly more massive than any other inferred from electromagnetic observations in the stellar-mass regime.

GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence

The LIGO Scientific Collaboration, the Virgo Collaboration

We report the observation of a gravitational-wave signal produced by the coalescence of two stellar-mass black holes. The signal, GW151226, was observed by the twin detectors of the Laser Interferometer Gravitational-Wave Observatory (LIGO) on December 26, 2015 at 03:38:53 UTC. The signal was initially identified within 70 s by an online matched-filter search targeting binary coalescences. Subsequent off-line analyses recovered GW151226 with a network signal-to-noise ratio of 13 and a significance greater than 5 σ. The signal persisted in the LIGO frequency band for approximately 1 s, increasing in frequency and amplitude over about 55 cycles from 35 to 450 Hz, and reached a peak gravitational strain of $3.4+0.7-0.9\times10-22$. The inferred source-frame initial black hole masses are $14.2+8.3-3.7 M\odot$ and $7.5+2.3-2.3 M\odot$ and the final black hole mass is $20.8+6.1-1.7 M\odot$. We find that at least one of the component black holes has spin greater than 0.2. This source is located at a luminosity distance of $440+180-190$ Mpc corresponding to a redshift $0.09+0.03-0.04$. All uncertainties define a 90 % credible interval. This second gravitational-wave observation provides improved constraints on stellar populations and on deviations from general relativity.

Black hole fireworks: quantum-gravity effects outside the horizon spark black to white hole tunneling

Hal M. Haggard, Carlo Rovelli

We show that there is a classical metric satisfying the Einstein equations outside a finite spacetime region where matter collapses into a black hole and then emerges from a white hole. We compute this metric explicitly. We show how **quantum theory determines** the (long) time for the process to happen. **A black hole can thus quantum-tunnel into a white hole**. For this to happen, quantum gravity should affect the metric also in a small region outside the horizon: we show that contrary to what is commonly assumed, this is not forbidden by causality or by the semiclassical approximation, because quantum effects can pile up over a long time. This scenario alters radically the discussion on the black hole information puzzle.

**NEW PHYSICS CAN INDEED
MODIFY BLACK HOLE DYNAMICS
AND PRODUCE OBSERVABLE EFFECTS**

**THE EFFECT CAN BE EVEN STRONGER
FOR A BLACK HOLE MERGER**

**STANDARD QUANTUM EFFECTS
ARE ALREADY KNOWN TO PRODUCE
HAWKING RADIATION,**

**BUT WHAT CAN HAPPEN
IN THE PRESENCE
OF A SUPERBRADYONIC VACUUM?**

A SIMPLE EXAMPLE OF A POSSIBLE SIGNATURE

Assume that, as a result of the interaction between the superbradyonic vacuum and the black hole (or black hole merger), some superbradyons can penetrate inside the black hole (or black hole merger) and leave it as free particles

=> a new form of black hole radiation

The Schwarszchild radius $R = 2GMc^{-2}$ associated to the observed black holes and black hole mergers is in all cases less than 200 Km => A superbradyon with speed $\sim 10^6 \, c$ would possibly be able to leave the black hole in less than 1ns => No time to interact gravitationally ?

Then, assuming Cherenkov decay in vacuum, superbradyons emitted by the observed black hole mergers should be able to reach Earth with a speed close to c

Energy ? Interaction with detectors ? Preonic waves together with gravitational waves ? => Can one detect such superbradyons and preonic waves ?

Can gravitational waves propagating on very large distances interact with the preonic vacuum ?

FURTHER WORK IS NEEDED

IV - GODEL-COHEN INCOMPLETENESS,

THE LAWS OF PHYSICS AND THE REAL WORLD

http://plato.stanford.edu/entries/goedel-incompleteness/

Stanford Encyclopedia of Philosophy
Gödel's Incompleteness Theorems

(…) The first incompleteness theorem states that in any consistent formal system F within which a certain amount of arithmetic can be carried out, there are statements of the language of F which can neither be proved nor disproved in F. According to the second incompleteness theorem, such a formal system cannot prove that the system itself is consistent (assuming it is indeed consistent). (…) (end of quote)

Cohen completed this work for the continuum hypothesis

Goedel and Physics

John D. Barrow

We introduce some early considerations of physical and mathematical impossibility as preludes to the Goedel incompleteness theorems. We consider some informal aspects of these theorems and their underlying assumptions and discuss some the responses to these theorems by those seeking to draw conclusions from them about the completability of theories of physics. **We argue that there is no reason to expect Goedel incompleteness to handicap the search for a description of the laws of Nature, but we do expect it to limit what we can predict about the outcomes of those laws, and examples are given.** We discuss the Goedel universe and the role it played in exposing the full spectrum of possibilities that a global understanding of space-time would reveal. Finally,we show how recent studies of supertasks have shown how global space-time structure determines the ultimate capability of computational devices within them.

Stephen HAWKING : **Gödel's theorems suggest that there is not an ultimate theory that can be formulated as a finite number of principles**

http://www.hawking.org.uk/godel-and-the-end-of-physics.html

http://www.damtp.cam.ac.uk/events/strings02/dirac/hawking/

Godel and the End of the Universe

(Cambridge lecture)

Paradox at the heart of mathematics makes physics problem unanswerable

Gödel's incompleteness theorems are connected to unsolvable calculations in quantum physics.

Davide Castelvecchi

A logical paradox at the heart of mathematics and computer science turns out to have implications for the real world, making a basic question about matter fundamentally unanswerable. (…)

Toby Cubitt, David Perez-Garcia, Michael M. Wolf

Undecidability of the Spectral Gap (short version)

The spectral gap - the energy difference between the ground state and first excited state - is central to quantum many-body physics. Many challenging open problems, such as the Haldane conjecture, existence of gapped topological spin liquid phases, or the Yang-Mills gap conjecture, concern spectral gaps. These and other problems are particular cases of the general spectral gap problem: **given a quantum many-body Hamiltonian, is it gapped or gapless? Here we prove that this is an undecidable problem**. We construct families of quantum spin systems on a 2D lattice with translationally-invariant, nearest-neighbour interactions for which the spectral gap problem is undecidable. This result extends to undecidability of other low energy properties, such as existence of algebraically decaying ground-state correlations.

The proof combines Hamiltonian complexity techniques with aperiodic tilings, to construct a Hamiltonian whose ground state encodes the evolution of a quantum phase-estimation algorithm followed by a universal Turing Machine. The spectral gap depends on the outcome of the corresponding Halting Problem. Our result implies that there exists no algorithm to determine whether an arbitrary model is gapped or gapless. It also implies that there exist models for which the presence or absence of a spectral gap is independent of the axioms of mathematics.

Longer version:

http://arxiv.org/abs/1502.04573

Undecidability of the Spectral Gap (full version)

We show that the spectral gap problem is undecidable. Specifically, we construct families of translationally-invariant, nearest-neighbour Hamiltonians on a 2D square lattice of d-level quantum systems (d constant) , for which determining whether the system is gapped or gapless is an undecidable problem. (…)

John Barrow writes (page 10) :

Another possible way of evading Gödel's theorem is if the physical world only makes use of the decidable part of mathematics.

But this does not seem to be possible in standard Physics if one considers the example provided by Cubitt, Pérez-Garcia and Wolf where it is impossible to decide if a many-body quantum system has a spectral energy gap.

AND WHAT ABOUT PARTICLE PHYSICS, QUANTUM FIELD THEORY, COSMOLOGY… ?

WHAT IN THE PRESENCE OF A PREONIC VACUUM ?

If standard particles are excitations of a preonic vacuum, the actual laws of Physics are expected to be exact only at the level of this vacuum.

The standard laws of Physics would then be only low-energy approximations and be deformed as the energy scale increases.

How exact can they be at low energy ?

ACTUALLY, EVEN AT LOW ENERGY, STANDARD PARTICLE PHYSICS CONTAINS BASIC INFORMATION THAT WOULD BE DIRECTLY GENERATED AT THE PREONIC LEVEL (PARTICLE MASSES AND COUPLINGS…)

=> CAN ONE TOTALLY ELIMINATE THE PREONIC VACUUM FROM THE EQUATIONS OF PARTICLE PHYSICS, EVEN AT LOW ENERGY ? IF NOT, THE STANDARD EQUATIONS SHOULD ACTUALLY INVOLVE ERRORS BARS

SIMULTANEOUSLY, GÖDEL'S THEOREMS SHOULD BE APPLIED TO THE DYNAMICS OF THE PREONIC VACUUM INCLUDING STANDARD PARTICLES AS VACUUM EXCITATIONS

ONE MAY EXPECT THAT A FORMULATION OF STANDARD PHYSICS WITH SUITABLE ERROR BARS REPLACES INCOMPLETENESS BY NATURAL UNCERTAINTIES

BUT IT MAY ALSO HAPPEN THAT THE ROLE OF PREONS CANNOT BE IGNORED (QUANTUM FIELDS IN VACUUM… SEE MY PREVIOUS ICNFP PAPERS)

BY NOW, THE PHYSICAL LAWS LEADING THE STRUCTURE AND DYNAMICS OF THE PHYSICAL VACUUM REMAIN UNKNOWN

AGAIN, FURTHER WORK IS REQUIRED

CONCLUSION

A REAL UNDERSTANDING
OF QUANTUM MECHANICS
REQUIRES UNDERSTANDING
THE PHYSICAL VACUUM

=> THIS IS NOT A SIMPLE TASK
AND CAN TAKE A LONG TIME

IF THE VACUUM HAS A NONTRIVIAL
INTERNAL STRUCTURE, ITS CONSTITUENTS
WILL NATURALLY BE SUPERLUMINAL
=> QUANTUM ENTANGLEMENT

THE SST CAN BE AT THE ORIGIN OF THE COMPLEX WAVE FUNCTIONS AND GENERATE A SPACE-TIME CONTRADICTION LEADING TO THE FEYNMAN PATH INTEGRAL

BLACK HOLES, GRAVITATIONAL WAVES, LIGO, VIRGO… CAN CONTRIBUTE TO UNVEIL THE VACUUM STRUCTURE

GÖDEL-COHEN INCOMPLETENESS SHOULD BASICALLY APPLY TO THE (YET UNKNOWN) VACUUM DYNAMICS INCLUDING STANDARD PARTICLES AS VACUUM EXCITATIONS

DIFFICULT, BUT PROMISING