Henry Margenau

Eine neue wissenschaftliche Wahrheit pflegt sich nicht in der Weise durchzusetzen, daß ihre Gegner überzeugt werden und sich als belehrt erklären, sondern vielmehr dadurch, daß ihre Gegner allmählich aussterben und daß die heranwachsende Generation von vornherein mit der Wahrheit vertraut geworden ist.

Max Planck

Henry Margenau was born on 30 April 1901, and left his old jacket on 8 February 1997.

He was a great man. I will always remember his moral support, from 1985 to 1990, at the time I needed it most. I wrote him a letter in June 1990, in which I stated that his Latency Interpretation of Quantum Mechanics [1] is *the* correct one, and explained my interpretation of his crucial phrase:

> I believe they are “not always there”

At that time (June 1990), I could only speculate about some special quantum state, strongly resembling Platonic ideas, which “is *never* there” , because it should be entwined with Kantian Noumenon (*Ding an sich*). Clearly, this was a purely metaphysical speculation, perhaps more pertinent to Henry's philosophical views [2], yet the clamant proposal was about **fundamental** separation between the *potential* eigenstates of the *latent* observable, and the *latent* observable itself (Henry called it *Onta*), such that (operational definition) we never start with any "linear combination" of the former, hence may eventually solve the measurement problem.

Twenty years later, I can elaborate a bit more.

The act of measurement will always 'force the eigenvalues out of latency', yet there exists a fundamental 'potential *quantum* state' resembling Platonic ideas, which can never be explicated at the length scale of tables and chairs, because it does **not** have any eigenvalues *whatsoever*. It does not live in the Hilbert space either. It is the Kochen-Specker (KS) state.

Thus, Henry's “not always there” can be fragmented into two "parts": speakable (possessing latent eigenvalues) and UNspeakable. The former is subject to 'choice' [2] made **by** 'everything *else* in the Machian universe', while the latter is a **pre-quantum** state resembling Platonic

ideas, which keeps all "non-commutative" quantum states *en bloc* [3], and the Genidentität (Kurt Lewin) of an elementary particle through measurements. It is the KS state, again.

One obvious merit of such interpretation of Henry's "not always there" [1] is that one can think of a single quasi-local trajectory of a single quasi-local quantum particle, because each and every explicated 'quantum state' along such quasi-local trajectory is an *emergent* state, and is being actualized with **unit probability** -- one-quantum-state-at-a-time.

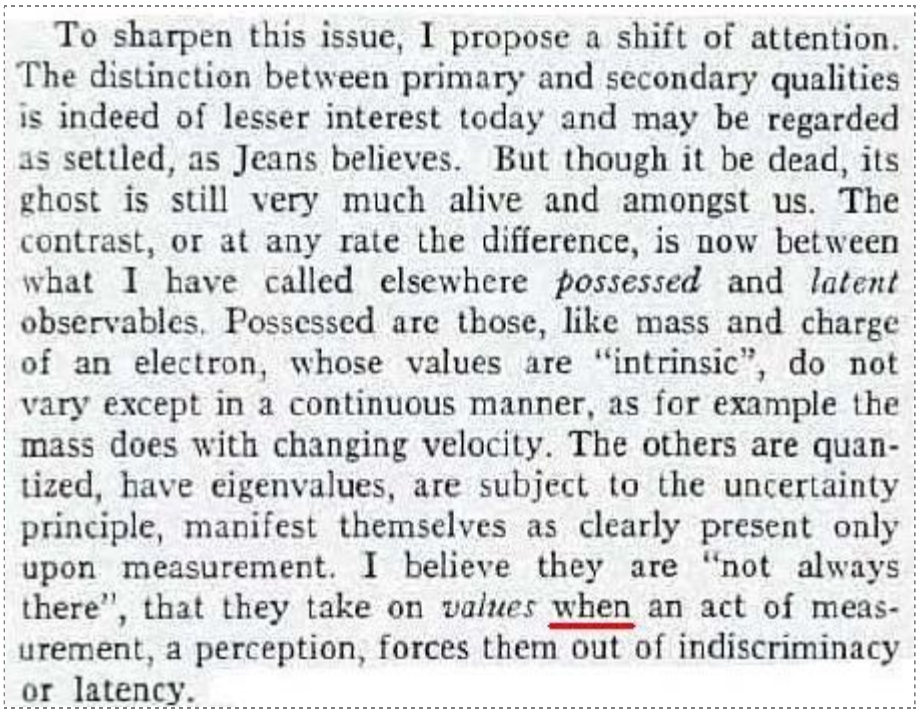
Thanks to the *pre-quantum* stat**e** (never in plural) resembling Platonic ideas, all-but-*one* from its *latent* "eigenvalues" are cancelled from the outset; for example, we never encounter a superposition of |alive cat> and |dead cat>, hence can solve the macro-objectification problem [4] and reconcile QM with Special Relativity.

What we observe at macroscopic scale is a *perfect* continuum of events explicated with *unit probability -- one-at-a-time* along the Arrow of Space. We perceive this *emergent* continuum as 3-D space, but are unaware of its **pre-quantum** dynamics, which allows *perfectly smooth* transitions between the quantum and macroscopic worlds, while keeping the complex phase of quantum waves **intact**, and without any "quantum jumps". The latter are nothing but artifacts from the measuring devices that cannot screen the *quasi-local* nature of quantum phenomena.

"Wenn es doch bei dieser verdammten Quantenspringerei bleiben soll, dann bedauere ich, mich mit der Quantentheorie überhaupt beschäftigt zu haben," Erwin Schrödinger.

D. Chakalov
November 19, 2010
Last update: November 27, 2010, 13:49 GMT

1. Henry Margenau (March 26, 1954), Advantages and disadvantages of various interpretations of the quantum theory, *Physics Today* 7(10), 6–13 (1954), p. 10.



To sharpen this issue, I propose a shift of attention. The distinction between primary and secondary qualities is indeed of lesser interest today and may be regarded as settled, as Jeans believes. But though it be dead, its ghost is still very much alive and amongst us. The contrast, or at any rate the difference, is now between what I have called elsewhere *possessed* and *latent* observables. Possessed are those, like mass and charge of an electron, whose values are "intrinsic", do not vary except in a continuous manner, as for example the mass does with changing velocity. The others are quantized, have eigenvalues, are subject to the uncertainty principle, manifest themselves as clearly present only upon measurement. I believe they are "not always there", that they take on *values* when an act of measurement, a perception, forces them out of indiscriminacy or latency.

1.1. Harmon R. Holcomb, Latency versus Complementarity: Margenau and Bohr on Quantum Mechanics, *Brit. J. Phil. Sci.* 37(2) 193-206 (1986)

1.2. Mauricio Suárez, Propensities in Quantum Mechanics, in: *Compendium of Quantum Physics*, ed. by Daniel Greenberger, Klaus Hentschel and Friedel Weinert, 2009, pp. 502-503 http://www.springerlink.com/content/k589l3608246r604/

Margenau's *Latency* Interpretation

Different interpretations of quantum mechanics can be in general fruitfully distinguished in terms of the answers they provide to the paradigmatic question concerning the general interpretation of superposed states. Suppose that the state of a quantum system is ψ, a ► superposition of eigenstates of the Hermitian operator that represents the observable Q. The standard interpretational rule within orthodox quantum mechanics, the *eigenstate/eigenvalue link* (e/e link) states that a system in state ψ can be said to have a value of a property Q if and only if ψ is an eigenstate of the Hermitian operator that represents the property. The paradigmatic question regarding these states is then the following: *What does it mean – with respect to the property represented by the observable Q – for a quantum system to be in state ψ which is not an eigenstate of the Hermitian operator that represents Q?* Propensity views of quantum mechanics vary greatly in their details but they all coincide in their answer to the paradigmatic interpretational question: *It means that the system possesses the* propensity *to exhibit a particular value of Q if Q is measured on this system in state ψ.*

In an excellent pioneering article Henry Margenau [1] argued in favour of latent quantities, or *latencies*. Margenau's key contribution was the basic *template* for propensity views. Suppose that state ψ can be written as a linear combination $\psi = \Sigma_n c_n |v_n\rangle$ of the eigenstates v_n of the *latent* observable represented by Q with

spectral decomposition given by $Q = \Sigma_n a_n |v_n\rangle\langle v_n|$. Margenau then answered the paradigmatic interpretational question very precisely as follows: *a system in state ψ has a latent property Q if and only if it possesses a propensity to manifest eigenvalue a_i with probability $|c_i|^2$ in a measurement of Q.*

2. Lawrence LeShan and Henry Margenau, *Einstein's Space and Van Gogh's Sky. Physical Reality and Beyond,* New York: Macmillan, 1982, p. 240:

"Our thesis is that quantum mechanics leaves our body, our brain, at any moment in a state with numerous (because of its complexity we might say innumerable) possible futures, each with a predetermined probability. Freedom involves two components: **chance** (existence of a genuine set of alternatives) and **choice**. Quantum mechanics provides the chance, and we shall argue that only the mind can make the choice by *selecting* (**not** energetically enforcing) among the possible future courses."

3. For example, "the state of any two-level system, represented by a 2 × 2 density matrix ˆρ, can be fully determined only through measurement of three linearly independent observables

which do not commute and cannot be simultaneously measured" (G. Aquino and B. Mehmani, arXiv:quant-ph/0702013v1). Yet the "two-level system" surely exists 'out there', keeping all of its "non-commuting" observables available to us for further macro-objectifications.

4. GianCarlo Ghirardi: “How, when, and under what conditions do definite macroscopic properties emerge (in accordance with our daily experience) for systems that, when all is said and done, we have no good reasons for thinking they are fundamentally different from the micro-systems of which they are composed?”

Addendum

To explain the **quasi-local** *exchange of energy* in General Relativity, and the failure to produce anything that can be physically interpreted as a **local** "energy-momentum tensor" [5], look carefully at [6] (emphasis, links, and comments added - D.C.):

In order to determine the energy of each part of the detector, one must **first** specify a timelike vector field -- the “time direction” conjugate to the energy -- with which to form an energy current-density (ibid.).

First things first.

It's not a "timelike vector field" though. One cannot define 'time direction' by splitting the spacetime into two entities, and then "define" one of them (called "time") with respect to the other one, which has **nowhere to move**. If one "part" from spacetime is deprived from any dynamics, the other "part" will also be dead frozen, and we cannot pinpoint the **global** "time" at which the *total* energy is conserved (see ExplanatoryNote.pdf, pp. 35-36). To address the issue of (quasi-local) energy conservation in GR, one needs to specify an arbitrarily large *isolated system* with "cut off" placed at Finite Infinity, to capture the **global** characteristics of 'space' pertinent to a **global** time. The former is missing from current GR, hence it is not surprising that the latter is missing as well. Consequently, the so-called 'problem of time' in canonical quantum gravity is an inevitable result from the fact that what we call 'spacetime' is actually one entity, and if one "part" from it (called 'space') is frozen, there will be no dynamics from the outset. The problem stems from the lack of **global** time in present-day GR: it does not originate from 'coordinate change *in* space', but from 'global change *of* space' bzw. Arrow of Space. The latter makes *any* observable of the gravitational field "*necessarily* quasi-local" (Laszlo Szabados).

We need an Arrow of Space and **non-unitary** dynamics of 'space', because "the appearance of *additional energy* which was not already present" (ibid.) is just **too much** (some people call this *additional energy* "dark", and offer tantalizing insights about how "spacetime can give energy to matter, or absorb it from matter" [7]).

Let me try to explain my viewpoint, in the framework of 'the universe modeled as a brain'. I take for granted that matter can *interact* with matter only. Corollary: any direct action of geometry on matter is banned. It is like direct action of the human mind on its brain or other physical objects. To avoid such "psychokinesis", we should investigate how matter interacts with matter in a Machian universe, in which the non-linear negotiation and feedback from 'everything else from the school/universe' is encoded in the **emergence** of what has been called gravitational "field" -- a *holistic* effect common to biological, quantum, and gravitational systems. The end result is an *emergent* geodesic of *quasi-local* objects bootstrapped by their gravitational "field". The *additional* input from 'everything else in the universe', exerted on every *quasi-local* object, will be inevitably *camouflaged* as "self-force" and "more gravity". The **source** of this *additional* input will be always "dark", because there is no way in GR to be traced back - it is simply an *omnipresent*, ether-like 'reference fluid'.

The first off task is to identify the infinitesimal **cracks** through which the *physicalized* (=converted into positive) vacuum energy gets smuggled into the *local mode* in the Arrow of

Space. What is needed is a new *energy conservation* equation (cf. ExplanatoryNote.pdf, pp. 35-36) in which the *additional* "dark" energy is compensated by an equal amount of positive energy density spread evenly, without any irregularities, over the whole space *en bloc*. There isn't any "privileged observer" (M. Montesinos) associated with such ether-like 'reference fluid in GR', because the "ether" is *omnipresent* "inside" each and every point from the spacetime *manifold*, hence there is no "point" at which it is '*not* there', to be used as a reference object with respect to which we could identify such "ether". Notice that the dynamical object in question is the spacetime *manifold* which is being **re**-created along the Arrow of Space. And again, we have here one-*compensation*-at-a-time along the Arrow of Space.

The prerequisites for this task have been laid out by Henry Margenau [1]. He also stressed the most acute unresolved task in Quantum Theory -- the absence of a '**chooser**' (the alleged "decoherence" is a myth, and of course doesn't work for quantum cosmology). Henry suggested that "only the mind can make the choice by selecting (not energetically enforcing) among the possible future courses" [2], but in the framework of 'the universe as a brain' one can safely replace the notion of 'Universal Mind' with 'the whole universe as ONE', and recover the ultimate 'chooser': it is the universe *itself* which makes the choice. It is **ONE** *pre-quantum* entity resembling Platonic ideas (global mode of spacetime), hence the choice of '*one* possibility among infinitely many' does not imply any "observer" nor pre-existing macroscopic world equipped with measuring devices. Thus, the universe is self-correlated and bootstrapped, and by exercising its 'free will choice' it **re**-creates, as a genuine Phoenix Universe (Georges Lemaître, 1933), a *perfect continuum* of such 'choices' -- one-*choice*-at-a-time along the Arrow of Space.

All this is encapsulated in the motto of this web site: Dead matter makes quantum jumps; the living-and-quantum matter is smarter.

Many experts in quantum gravity do not appreciate this proposal (most notably Chris Isham), but haven't so far offered any viable alternative to the 'chooser' in Quantum Theory.
NB: It is impossible to recover the continuum of spacetime from present-day Quantum Theory and General Relativity. Both theories can only offer an *approximation* to it: the former cannot solve the macro-objectification problem [4] and reconcile QM with Special Relativity, while the latter cannot recover the dimensionality of 3-D space, to explain the obvious fact that we can indeed "look around, and see as far as we like" (Lee Smolin). Namely, Quantum Theory cannot account for smooth bi-directional transitions between the quantum and classical realms, while General Relativity cannot provide "any natural way of imposing *global* constraints on the spacetime — certainly the Einstein equations provide no such nonlocal constraint" (Matt Visser, p. 3). In both cases, the spacetime continuum and its global topology, which enable things to possess objective states 'out there', which can be seen from "as far as we like", is a miracle. Ergo, both theories **must** contain wrong ideas. Why is this difficult to understand, I wonder.

May I propose 'a shift of attention', by comparing the two main approaches toward quantum gravity, string theory and loop quantum gravity (LQG), with the third one outlined at this web site, which will be called 'Machian quantum gravity' (MQG).

Carlo Rovelli, who has studied the fundamental research in quantum gravity by Karel Kuchar and has been coached by Chris Isham, has published extensively in support of LQG. He explained his criticism of the string approach, as a theory "over a background Minkowski spacetime (perhaps in high dimensions)", and stated:

"But success, I think, can only be granted by scrupulous intellectual honesty."

Beautiful words. But it seems to me that the proponents of LQG are also short of this quality.

Here's the common feature of string approach & LQG: they consider only those particular *bits and pieces* from Quantum Theory and General Relativity, which work fine in their respective domains of application (ignoring the unsolved issues), and try to blend them into some new theory of quantum gravity.

Metaphorically speaking, consider a car that runs quite well on straight dry roads, but fails

miserably on twisted icy roads, and a helicopter that flies well in quiet weather, but is totally useless in windy conditions. Then try to blend the car and the helicopter, hoping that the problems of the car may be fixed with the problems of the helicopter and *vice versa*, and keep dreaming of some brand new vehicle which will run better than the car and fly better than the helicopter, and will also dive deep into the ocean, like a perfect submarine.

The proposed 'shift of attention' is to start with fixing the old problems of Quantum Theory and General Relativity: (i) resolve the macro-objectification problem [4] and reconcile QM with Special Relativity, and (ii) find 'the right answer to the right question' regarding the gravitational energy-momentum [5], clarify the exact meaning of the Equivalence Principle and Finite Infinity, and the (quasi-instantaneous?) propagation of gravitation in the context of Mach 11 [8]. Which obviously requires a modern formulation of 'the reference fluid in GR' [9].

Then all pieces from the jigsaw puzzle will snap to their places -- effortlessly. All we need is a scrupulous intellectual honesty.

I intend to deliver a talk on November 25, 2015 [10], commemorating the 100th anniversary of the joint work by Levi-Civita, Einstein, and Hilbert. Attendance is free, but seats are limited to 35. The whole bundle of issues is quite dense (similar to my previous talk), and is by no means purely academic, as it offers a glimpse at a new possibility for unleashing "dark energy" from the quantum vacuum [11]: depending on the macroscopic boundary conditions, which must be kept under tight control, the energy release may vary from an *almost* vanishing flux up to 10^{54} ergs/pulse, which is much larger than the mundane nuclear energy release of $\sim 10^{22}$ ergs/pulse.

If you're interested, please email me by September 25, 2015.

To avoid misunderstandings regarding the use of Platonic ideas and the general concept of 'potential reality', please read the **NB** note (30.11.2010) at the end of my posting here.

D. Chakalov
November 24, 2010
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5. Luke M. Butcher, Anthony Lasenby, and Michael Hobson, The physical significance of the Babak-Grishchuk gravitational energy-momentum tensor, arXiv:0807.0112v1 [gr-qc]

"The canonical response to the gravitational energy-momentum problem is to dismiss it as “looking for the right answer to the wrong question” [2]; but while the well-known argument presented by Misner, Thorne and Wheeler is certainly compelling, it is far from watertight.

"They remind us that the equivalence principle ensures that all “gravitational fields” [X] can be made to vanish at a point by a suitable choice of coordinates, and conclude that because gravity is locally zero, there can be no energy density associated with it. However, this argument fails to consider tensors containing second derivatives of the metric, which unlike [X] cannot be made to vanish by choice of coordinates, and really do reflect the local curvature of spacetime: for example, the Riemann tensor can be used to construct objects such as the Bel-Robinson tensor.
....

"Despite these reservations, the argument in [2] remains vindicated as yet by the failure of these escape-routes to yield anything which can be physically interpreted as an energy-momentum tensor."

6. Luke M. Butcher, Michael Hobson, and Anthony Lasenby, Localising the Energy and Momentum of Linear Gravity, arXiv:1008.4061v2 [gr-qc]; *Phys. Rev.* D 82, 104040 (2010)

p. 2: "In spite of these various difficulties, one aspect of this enduring problem stands opposed to conventional wisdom and motivates our present discussion: when gravity and matter interact, the exchange of energy is **local!**

"Furthermore, we can imagine a very small detector, much smaller than a wavelength of the incident gravitational radiation, and observe that at each instant a well-defined power is developed in the detector as heat; thus, at least in this case, the rate of energy exchange is associated with a **particular point in spacetime**.

"One might hope, therefore, that consistency with this phenomenon would be enough to localise the energy and momentum of the gravitational field outside the detector, or even when no detector is present.

"Moreover, even if a gravitational energy-momentum tensor could not be found, there would still be great value in constructing a framework for the description and analysis of local gravitational energy-momentum exchange.

"For the sake of simplicity, we have restricted our present discussion to linearised general relativity on a **flat Minkowski background**. It is only in this linear regime that the convenient fiction of a "gravitational field" propagating on a background spacetime can be taken **seriously**, a construction which is **essentially unavoidable** (Sic! - D.C.) when localising gravitational energy-momentum (the authors are not taking their Footnote 2 seriously - D.C.).
....

"We shall not attempt to extend our results beyond the linear theory at this time.(footnote 2)

"**2** Of course, it may not be possible to extend the framework we develop here to the full non-linear theory, and we accept that localising gravitational energy-momentum in this regime (where the distinction between background and fluctuation is virtually **meaningless**) may be an **inherently flawed idea**."

B. Energy-Momentum Currents

Superficially, general relativity is a theory in which the energy and momentum of matter is always conserved:

$$\nabla^a T_{ab} = 0. \tag{7}$$

However, the sticky bead argument has already demonstrated that this is not the case; in reality, matter may gain (or lose) energy through interaction with the gravitational field. The reason for this apparent contradiction is as follows. In order to determine the energy of each part of the detector, one must first specify a timelike vector field ${e_0}^a$ (the "time direction" conjugate to the energy) with which to form an energy current-density $J^a \equiv {T^a}_b {e_0}^b$. The incoming gravitational wave will then prevent ${e_0}^b$ from satisfying $\nabla_a {e_0}^b = 0$, and we will find that $\nabla_a J^a = {T^a}_b \nabla_a {e_0}^b \neq 0$. This inequality indicates a

mismatch between the energy of the matter flowing into a given point, and the change in energy of the matter at that point; in other words, it represents the appearance of *additional energy* which was not already present in the matter – this is the energy absorbed from the gravitational wave! What is needed, therefore, is a framework which can account for this gained energy by identifying a corresponding loss in the energy of the gravitational field.

7. Energy Is Not Conserved, by Sean Carroll, http://blogs.discovermagazine.com/cosmicvariance/2010/02/22/energy-is-not-conserved/

"And in my experience, saying “there’s energy in the gravitational field, but it’s negative, so it exactly cancels the energy you think is being gained in the matter fields” does not actually increase anyone’s understanding — it just quiets them down.

"Whereas if you say “in general relativity spacetime can give energy to matter, or absorb it from matter, so that the total energy simply isn’t conserved,” they might be surprised but I think most people do actually gain some understanding thereby.

"Energy isn’t conserved; it changes because spacetime does. See, that wasn’t so hard, was it?"

8. Øyvind Grøn and Kjell Vøyenli, On the Foundation of the Principle of Relativity, *Found. Phys*. 29(11) 1695-1733 (1999); excerpts and comments in Gron_Voyenli.pdf.

9. J.D. Brown and K.V. Kuchar, Dust as a Standard of Space and Time in Canonical Quantum Gravity, arXiv:gr-qc/9409001

"The particles of the reference fluid identify the points of space, and clocks carried by these particles identify the instants of time. In this way, the fluid fixes the reference frame (the space) and the time foliation (the time). In *that* frame and on that foliation (there isn't such "foliation", however - D.C.), the entire intrinsic metric, not just two selected components of the intrinsic geometry, becomes **dynamical**.

"The reference fluid is traditionally considered to be a tenuous material medium whose back reaction on the geometry can be neglected. There are just *enough* fluid particles to discern the points of space from one another, but *not enough* to disturb the geometry (notice the poetry - D.C.). Instead of deriving the motion of the fluid from its action, one encodes it in coordinate conditions. Unfortunately, such a standpoint makes it difficult to view the reference fluid as physical matter (no need to be -- check out its manifestation as Platonic ideas - D.C.)."

10. Machian Quantum Gravity: Virtual Geodesic Path Formulation of General Relativity. Talk by D. Chakalov. Munich, 25 November 2015.

11. Don L. Hotson, Dirac’s Equation and the Sea of Negative Energy, Part II, *Infinite Energy*, 44 (2002).

p. 7: "As shown by Dirac’s equation, an electron has a circular vibration in two “real” directions, giving it a “real” energy of mc^2. However, it also retains its (negative energy) vibration at **± c**

in an “imaginary” direction. Thus its oscillation is **circular** (I'm afraid it is not that simple - D.C.) but complex, having both a “real” and an “imaginary” component, and giving it the anomalously large angular momentum of h_cross/2 in any “real” direction.

"This makes the electron a little gyroscope. However, since this vibration is complex, part “real” and part “imaginary,” this angular momentum plane can not point in any “real” direction, as is also the case with the orbital electron’s angular momentum vector, as mentioned above.
....
pp. 20-21: "(T)his natural frictional loss of energy was somehow interpreted as a Doppler shift, supposedly indicating that everything in the universe is rushing madly away from us in every direction at velocities approaching light speed.
....
p. 23: "The sea of negative-energy one-dimensional *epos*, vibrating in imaginary directions, forms a virtually undetectable background, like “off” pixels in a perfect computer screen. And like a three-way light switch, they “turn on” in three stages, each stage vital to our reality. Epos vibrating in one “real” dimension form the electromagnetic field. Vibrating in two “real” dimensions, they carry angular momentum around at the speed of light: the “photon.” And vibrating in three “real” dimensions, they form matter.
....
"However, at all times we must keep in mind that this is only a model. The map is not the territory, the menu is not the meal. We must remain flexible."

PDF file at
http://www.god-does-not-play-dice.net/HenryMargenau.pdf