Gravity and the Nature of Information

Abstract

The question *'It from Bit'* or vice versa is the question of what is real. The answer is a matter of belief, so I analyze why physicists believe theories, including QED and QCD and follow with the simplest possible theory of the real world. I focus on the fact that *gravity is real*, and discuss a new approach to non-linearity. Because Wheeler's *'It from Bit'* is tied to his *Participatory Universe* I explore that topic and a theory of information based on gravity.

As "*It from Bit, or Bit from It*" suggests, physics theories, like life, can be full of ambiguity, aptly illustrated by this scene taken from the famous 900-year old *Qingming Scroll* that depicts[33] life in a bustling Chinese village. The same scene from three tapestry reproductions shows figures on a bridge: one with his back to us, two facing him. One points left, the other right—the ambiguity of life. I hear the man on the left saying "*Information is real, matter is imaginary*", while the one on the right proclaims, "*Matter is real, information is imagined*".



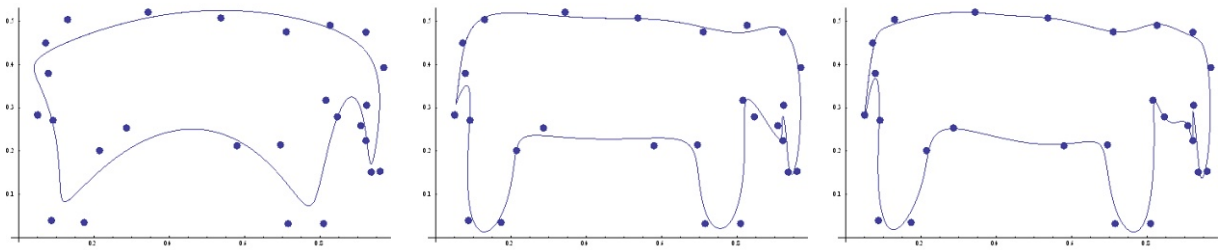
Which is correct? Much of physics is based on symmetry: instead of limitless variation, some situations entail repetition, making physics describable in math and words. Descriptions made possible by this feature of reality are 'maps' or 'models', and Korzybski, in *Science and Sanity*[1], claimed the distinguishing feature of sanity is the recognition that "*the map is not the territory*". This contest could have been titled:

"Map from territory, or territory from map?"

Smolin says[2] of purely math-based ideas: "*sooner or later we'll find ourselves just making stuff up.*" Modern physics, tied maximally to math, minimally to reality, contains a lot of 'made up stuff'.

Why do physicists 'believe' current theories?

Not all theories make predictions, yet some physicists seem to believe in these because of the 'beauty' of the math. But what about theories that *do* make predictions testable by experiment? What does 'testable by experiment' mean? Generally it means a theory can *fit the data*. If a projectile's trajectory is predicted by Newtonian mechanics to be a parabola and calibrated measurements show a parabola, the theory fits the data. What if a theory requires *many parameters* to be able to fit data? QCD requires 30 (I'd argue 40) parameters to fit particle data to the Standard Model, yet still does not produce the same accuracy that the theory of epicycles produced. Smolin[2] says "*it took 55 circles to get epicycles to work*", while Susskind recently summarized physics as depending on from 25 to 150 parameters, whose values are set 'by hand'. How can physicists believe theories that require 25 to 150 parameters to fit data? Fermi said *"with five parameters, I can fit an elephant!"* Here are 5, 10, and 15 parameters fitting data[3]:



If the prediction a theory makes agrees with experiment, then physicists may *believe* the theory, yet, Smolin says, "*the theory of epicycles was good to one part in 1000"*, concluding:

> "*Neither mathematical beauty nor agreement with experiment can guarantee that the ideas a theory is based on bear the slightest relation to reality."*

Mass is energy; if energy is conserved, then quantum events must 'add up'. The Standard Model *defines* allowed energy states (particle masses) and then uses ad hoc 'creation' and 'annihilation' operators to *add* and *subtract* the energies while conserving momentum. As in *all* statistical particle physics, the partition function establishes probabilities based on energy. Is it any wonder the Standard Model fits the data?

Quantum Electrodynamics is almost synonymous with accuracy. QED's Feynman diagrams are based on *virtual particles*—which seemed reasonable when vacuum energy was 120 orders of magnitude greater—but that was an error, *the largest error ever made in physics*, and QED made it. The question is '*What do Feynman diagrams predict?*' not '*What do they fit?*' Today QED can't even predict the simplest generic atom, a particle orbiting a proton. Historically, QED has been tailored to the electron very accurately, but simply replace the electron by its sibling, the muon, *differing only in mass*, and the model falls apart; the *Lamb shift* prediction—the Holy Grail that established QED as ultimate physics theory—fails[4]. For four decades Kinoshita[5] measured and calculated a *Lamb shift*-based anomalous magnetic moment and used this to update the value of the fine structure constant, but muonic hydrogen calculations are off by 4%! So, is QED —physics' crown jewel—good for ten place accuracy or only about one order of magnitude? A hard question for many to contemplate. QED's worst gives 4% accuracy and QCD's best about 1%—both ten times worse than the theory of epicycles—yet dogma such as *virtual particles*, *QCD color*, *Bell non-locality* or other premises are *never to be questioned*. ET Jaynes[6] reminds us that:

> *"…a false premise built into a model which is never questioned cannot be removed by any amount of new data."*

Since Bell formulated his simplistic inequality[7]—*which is all that non-locality is actually based on*—the idea of local realism has been losing ground. It's driven the unreal to the forefront, much as Gresham's law—'*bad money drives out good*'—is a truism for economics. Many choose math over physical reality, but as Smolin says, "*The mystic's view that the mathematical curve is 'more real' than the motion itself*", is a fallacy ignoring the distinction between recording motion in time [information] and time itself.

> "*Once you commit this fallacy, you're free to fantasize about the universe being timeless; even being nothing but mathematics."*

Smolin decries references to other universes, non-realized ensembles, or other Platonic realms:

> *"There's a cheapness at the core of any claim that our universe is ultimately explained by another, more perfect world standing apart from everything we perceive. If we succumb to that claim, we render the boundary between science and mysticism porous. [It] is at root a religious aspiration.*

It is far more challenging to accept the discipline of having to explain the universe we perceive and experience only in terms of itself – to explain the real only by the real…"

A GEM theory of reality:

Last month a *paper* [8], *"Inflationary paradigm in trouble after Planck2013",* analyzed the latest results:

"Planck satellite data shows with high precision that we live in a remarkably simple universe."

Yet physicists for half a century have been proposing more and more complex theories by adding strings, new fields, new dimensions, new symmetries, new super-particles, new universes, new nonlocal, unreal interpretations of statistical data. But rather than postulate *hundreds of fields* as Susskind does[9] for his *Multiverse*, we can assume that only <u>one</u> *real field* existed initially. If so, it could evolve *only* through *self-interaction*. If we call this field $\vec{\phi}$ and the change or evolution operator $\vec{\nabla}$, then this English statement about evolution has a math equivalent[10] (expressed in *Geometric Algebra* notation):

$$\vec{\nabla}\vec{\phi} = \vec{\phi}\vec{\phi}. \qquad (1)$$

This is our master equation. Initially we assume nothing of $\vec{\phi}$ or $\vec{\nabla}$. But if $\vec{\phi}$ is a field, then, per Maxwell, it has energy proportional to ϕ^2 and, per Einstein, it has mass proportional to energy, $\vec{\nabla}\vec{\phi} = m$, which resembles Newton's law; hence we propose $\vec{\phi}$ is gravity and $\vec{\nabla}$ is the vector differential operator. If $\vec{\phi} = \vec{\nabla}\psi$ *then* $\nabla^2\psi = (\vec{\nabla}\psi)^2$. Our equation, with $\vec{\phi} = \vec{G} + i\vec{C}$, leads to *space* and *time*:

$$\vec{G} = 1/\vec{r} \quad \text{and} \quad \vec{C} = 1/\vec{t} \qquad (\textit{with } c^2 = 1, \quad \vec{G} \sim c^2/\vec{r} \equiv \textit{acceleration})$$

Although Newton's equation can be derived from it, our equation is *not* Newton's equation, which is time independent and cannot evolve—our equation is defined by evolution <u>and</u> yields unidirectional time—as far as I know, *the only fundamental equation in physics to yield asymmetric time!* $(\vec{C} = -t^{-1} = 1/\vec{t})$

A consistency condition then immediately yields $\Delta m(\Delta x)^2/\Delta t = \hbar$, where $\hbar$ is a constant of action.

In other words, the simplest possible assumption about the origin of the universe yields gravity, asymmetric time, and a quantum action condition isomorphic to Heisenberg's uncertainty principle.

Our master equation also leads to[11] a relation for gravito-magnetism, *C*:

$$\vec{\nabla}\times\vec{C} = \kappa\rho\vec{v} \qquad (\kappa = \textit{coefficient}, \quad \rho = \textit{mass density}, \quad \vec{v} = \textit{velocity})$$

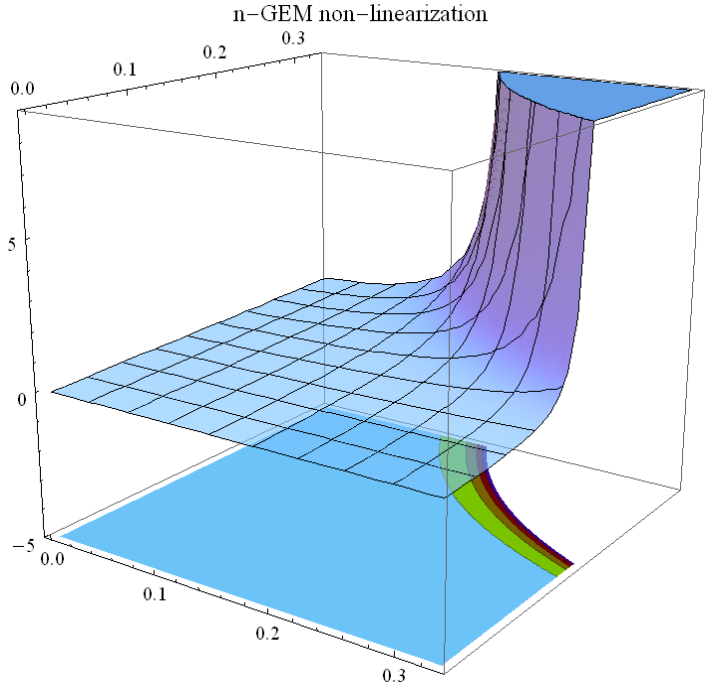
Both Einstein and Maxwell derived[12] this same equation. It is *the* key equation for much of what follows. It leads to Schrodinger's equation and even provides quark confinement without color. As it is simply the 'weak field equation' of general relativity, one might think it identical to GR. But *our Master equation is not GR*. It reproduces GR equations, but it represents a Yang-Mills gauge theory of mass that addresses many current anomalies of particle physics: proton size of muonic hydrogen, halo neutrons, negative core of neutron, lack of sea quarks, 'string-like' p-p collisions, J/ψ-suppression at LHC and RHIC, and *may* yield particle mass from first principles. It also has significant qualitative implications for Big Bang, dark energy, dark matter, and cosmological jets, but I've performed no relevant quantitative calculations, so I make no claims here.

Is gravity real?

Take LSD. Or find a big rock and kick it- *hard*. Jump off a tall building. These actions provide proof, in a way mathematical proof can never hope to equal, that *molecules are real*, *rocks are real*, *gravity is real*. Many math-oriented physicists no longer believe in reality, claiming physical reality is derivative, based on 'information'—imagined to have some reality that supersedes 'hard' things. Bell led these physicists into *Strawberry Fields* (*"nothing is real, and nothing to get hung about"*). They now <u>believe</u> local reality does not exist—all is math until a *measurement* collapses the information-based wave function, which then miraculously affects physics arbitrarily far away, *instantly*. Yet conjectured strings, branes, axions, anyons, super-symmetry, multiple dimensions and universes have only imagined reality. Not so gravity.

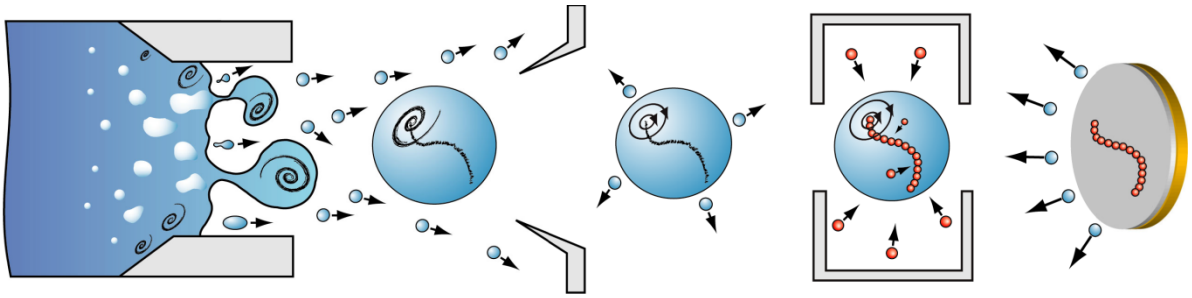
Gravity is real. This is experientially obvious, yet gravity is considered *mere geometry* by many, despite MTW's statement[13] that "*any physical theory originally written in a special coordinates system can be recast in geometric, coordinate free language*." Of course it can—distance *determines* geometry! Gravity may not fit into quantum mechanics, but quantum mechanics *does*[14] fit into gravity.

FQXi recently noted[15] Kauffmann's work: *self-gravitation establishing an upper bound on local energy* — the bugaboo of all quantum field theories. A week later a *Phys Rev Letters* paper[16] showed how colliding particles can produce black holes. Both depend on the remarkable fact that <u>*all*</u> *energy gravitates*. Energy has mass, and mass gravitates. Given sufficient energy and short enough wavelength, gravity dominates all other energies, *including kinetic and Coulomb*. This most revolutionary concept in physics has yet to be grasped by most physicists, who believe gravity has little to do with particles. Due to non-linearity, *particle level gravity has been unsolvable*; the *n-GEM* technique (see below) may change this.



The problem has been solving Einstein's equations for non-linear behavior of the field. I've succeeded in *non-linearizing* the linear weak field equation of relativity, which is necessary since the full non-linear field equations are impossible to solve in any but the simplest cases (Schwarzschild and Kerr metrics). My approach is easy to understand. Motion of mass induces C-field circulation, which, per Maxwell, has energy, $E \sim C^2$ and hence, per Einstein, mass, $m = E/c^2$. Thus *the field itself adds mass to the motion,*

which produces more C-field, which produces more mass, etc. If we add the induced terms to the linear equation, it becomes non-linear, *but in a simpler form* than Einstein's field equations. I've solved this and the behavior of the solution is shown above. The axes are mass density ρ and velocity $|\vec{v}|$, representing the source terms in $\vec{\nabla}\times\vec{C}=\kappa\rho\vec{v}$. For low mass density and velocity, the solution is relatively flat; the self-interaction grows until a threshold is reached, whereupon the field grows in strength almost without limit! The process does not *create* energy; it transforms it from a driving force. Since all such forces are finite, non-linear growth of the field terminates, but the process should yield sufficient field strength for effects I've claimed, and its predictions can be tested. The theory leads to a number of predictions, but I've not had time to apply the new *n-GEM* technique to these, so I will mention only one. Gomez, et al. have observed[17] vortices in superfluid ^4He droplets, by introducing Ag atoms, subsequently deposited and imaged via electron microscopy, as shown below.



They expect to be able, via x-ray diffraction, to image inside the droplets in flight. I predict—if this is a C-field-induced phenomenon—that the vortices will be found to be aligned with the particle velocity.

What does it mean to linearize an equation?

From conversations, I conclude that it's often believed linearizing a non-linear field equation *linearizes the field*. What one does to an equation has absolutely no effect on the physical field! Let me be clear:

> *Linearizing an equation does NOT make a non-linear field linear. It only allows one to solve the equation as if the field were linear.*

The field does not cease to be non-linear, nor to interact with itself. The self-interacting behavior, seen in the diagram, is dependent on mass density ρ and velocity $\vec{v}$. Gravity is a *field*, not *abstract geometry*. Given sufficient energy it can produce particles; electrons and quarks or micro black holes. The G- or gravito-electric field produces black holes, the C- or gravito-magnetic field produces particles. The C-field aspect underlying its ability to produce particles is shown in the following duality diagram:

a. linear-mass-flow-induced circulating C-field b. circular-mass-flow-induced linear C-field

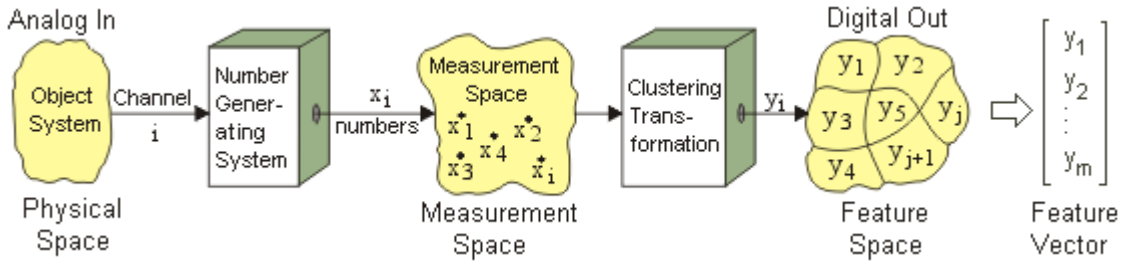
Maxwell's electrodynamics has well known dualism between E- and B-fields. Physicists love dualism, their current love being AdS/CFT duality—a conjectured equivalence between string theory and gravity, formulated in 11-dimensions. Try to find anything real in Schwarz's AdS/CFT paper[18]. The *real* dualism of gravity arises from a magnetic analog relating field energy density to current density: $\vec{\nabla}\times\vec{C}=\kappa\rho\vec{v}$.

Circulation of the field, induced by linear local mass flow, has a dual linear field, induced by circulating mass flow. Linear motion induces circulating motion, and vice versa. An analog appears in the Kerr geometry of General Relativity[19]. Since *linear motion induces circular motion in the field* with dimension $1/t$, every moving mass carries a clock with it; special relativity relates these clocks. Thus a circulating field accompanies every particle like a bow wave accompanies a moving boat—guaranteed by general relativity. De Broglie related its wave-length to the particle motion. The strength of the gravitomagnetic C-field is a function of mass density ρ and electrons are almost certainly *the highest density entities that exist*, so it's not surprising that the C-field is inseparable from electrons, exhibited as the wave function. Even Bell favored *real fields* as wave functions, and recent experiments[20,21] support this.

From this scale-invariant duality is built a *real* world—with 3 dimensions plus time. How does one field evolve into so many things? Leibniz said "*Time and space are not things, but orders of things.*" A field is a *thing* distributed over space and enduring in time. Motion in the field induces an accompanying wave function in de Broglie-Bohm-like (but not *exactly* like!) fashion. Nonlinear vortices in the field form self-capturing solitons to produce particles[22] of the Standard Model. [*The Chromodynamics War*] Three such entities can form a proton and apparently last forever. Their flux tube-based structure is string-like enough for Veneciano to claim that proton-proton collisions look like strings colliding; a wrong turn that led to 40-plus years of string theory. Non-linear gravity can produce, confine and transform particles given enough local energy; these particles then interact and accumulate in rich structures.

How does information use structure? Via thresholds!

Once structures exist it is a simple task to create logic gates. All one needs is a *threshold*–almost any will do—to structure NOT- and AND-gates; *any logic at all* can be constructed from inter-connected NANDs. For example[23], the *Lac operon* activates itself on condition '*lactose AND NOT glucose*' (≡ *lac NAND glu*). The most useful structure to build[24] is a *counter*, to accept inputs and *produce numbers*. Given numbers, how does one construct a model or map? The goal of formal description of the physical world is to build the simplest structure consistent with all observations (numbers derived from measurements) treated as representing an object. But how do we reduce an indefinite number of measurements to a finite number of features to be associated with an object system, and what is the *best* feature set? The most universal function on two numbers is the difference or distance $D(x, y) = \| x - y \|$, easily implemented with logic circuitry. The measurement space is now a metric space, in terms of which arbitrary partitions may be made in the set of all distances, divided into intra-set distances (between the members of a set) and inter-set distances (between numbers characterizing a set). The scheme looks like:



Defining this metric on our set of measurement numbers defines a topology; we can represent the object by a *feature vector*, $[y_1, y_2, ...y_j, y_{j+1}...]^T$, the basis of all formal analogues of repeatedly measurable object systems. But what is the 'best' feature set? Find probability p_i that a measurement represents feature *i*. If p_i is unknown, choose a function that maximizes entropy, subject to known constraints.

$p(\vec{x})$ is chosen to minimize the population entropy for pattern x_i, defined as

$$I = -\int p(\vec{x}) \ln p(\vec{x})\, d\vec{x}\,.$$

Entropy is a statistical measure of uncertainty so the feature set will be selected to minimize uncertainty as to which class a given pattern vector belongs. *This provides the best model of the object.* Means exist to perform all of these functions[25] [see *The Automatic Theory of Physics*]. We begin with an arbitrary classification of patterns and evolve a 'better' classification using entropy as the criterion. The model is thus a *structure* or *form* in hardware (computer or brain) and the addition of measurement data '*in-forms*', or develops improved *in*-ternal *form*-al structure. This is the meaning of *in-form*-ation. It derives from the physical hardware that incorporates the map or model, and is inherently and unquestionably "*bit from it*". Without the physical, there simply is no information. To argue otherwise one must show how a world with no physical reality can be brought into existence from information. Wheeler's remark "*how to combine bits in fantastically large numbers to obtain what we call existence*" was just unsupported fantasy.

Participatory universe and 'in'-formation

A bit represents choice; only a dead static universe could exist without choice. But choice and Wheeler's "*absence of a clear definition of the term 'bit' as elementary unit in establishment of meaning*" imply *awareness,* since there is no *meaning* absent awareness. He believed in a *Participatory Universe*, and participating as a particle or a wave is not what he had in mind. I suppose one can believe that a dead universe of *things* came into existence based on the sheer chance random rearrangements would somehow become *aware* and decide that, ergo, the universe must be participating, but this was *not* Wheeler's idea. A conscious universe is *not* a local event or entity. It makes sense only if *consciousness is inherently a field* which *concentrates locally* to become aware[26] of local structure and *'in'-formation*—the formation of a model or *encoded structure* within more comprehensive structure.

As Anderson said[27] "*more is different*". Our world results from entities—photons, neutrinos, electrons, and quarks—accumulating to build *micro*-, *meso*-, and *macro*-systems: protons, nuclei, atoms, molecules, proteins, DNA, viruses, cells and organisms. One might believe that arranging these in magical order creates awareness or one might suppose that a global field is self-aware, concentrating *locally* based on non-linear field interactions with mass flows. I hypothesize that *awareness came into existence but once*. A consciousness field does *not* arise when a number of Lego blocks are first assembled in correct order—and re-arise with every organism that is born! It's been a *Participatory Universe* from the beginning.

Is math 'alive' or is gravity 'aware'?

The notion that gravity is '*aware*' sounds strange to physicists, despite that, for several decades physicists have been speaking of math as '*alive*': "*living on a manifold*" or "*math lives in its own separate Platonic world*". What a debased concept of life! Yet gravity, which *is* real and which *does interact with itself* must, in some meaning of the word, be *aware* of itself. For all but true believers, the contrast is stark.

I could propose a *different* field, never seen, as the consciousness field. But rather than propose one more mystical field in physics (as if we need another one) the conscious field I propose is the same field that accounts for the physical existence of reality, that is, *gravity*—it is self-interacting and non-linear. It is *not* geometry, but a real physical field. To interact with itself, gravity must be, in some sense of the word, *self-aware*. In fact, it's the *only* physical field that is aware of *all* energies, *including potential and kinetic*.

Thus the field is aware of both position and motion aspects of reality — Space and Time!

But *awareness*, the ultimate mystery, differs from[28] *logic*, which is the basis of reasoning and thought. The *equations* of the gravity field do not relate to subjective *awareness* but to the objective physical interaction of the field with mass current density. Subjective awareness is not describable either in words or equations; only the objectively describable physical interaction with mass. Awareness is *located* in the field, but *concentrated* where the action is. The gravity field *affects* all mass and energy to an extent that depends on geometry; local awareness is of *action*—tied to local mass current density. In the theory of weak interaction it shows up as *neutral current density*. In low-energy quantum mechanics it's evidenced by wave functions induced by momentum flow. In neural networks it is the flow of ions in axons and of vesicles across synaptic gaps. At any level of structure the nature of 'in'-formation is *form*ation with*in* a local structure or system of structures. If mass flows, the field is aware of it.

The *meaning* of the flow is based on *local structures*, effectively the *decoding book*, whatever its form.

The *interpretation* of information, necessary for extracting meaning, demands a *code-book*, or decoding *structure*. As a simple example, when I was a child "*one if by land, two if by sea*" was understood by every child, and conveyed much information. What does it mean to one unaware of American history, one who lacks the initial data? McEachern's point[29] that initial data contains most of the information relating to equations is just as true of decoding information. Shannon's information need not be decoded, hence need not have meaning, but in physics, extracting meaning is the *purpose* of generating information! As McEachern also noted, we discuss particles in English without attributing to them the characteristics of the alphabet, but when we discuss them in Fourier terms (the heart of the Hilbert space formulation) we insist that they have super-position properties, despite that a superposed particle has never been seen.

Finally, note that Yau, of Calabi-Yau fame, said[30]:

> *"In general relativity mass can only be defined globally ...as measured from far, far away (from infinity actually). In the case of local mass [...] there is no clear definition yet. [And] mass density is a similarly ill-defined concept in general relativity."*

So mass is no better defined, in physicists' primary theory of mass, than a consciousness field is defined.

Conclusion

We've reviewed physics based on the evolution of *one* field, *not* hundreds of fields plus initial conditions. The field's *self-interaction* clearly implies, in some sense, *self-awareness*. The simplest self-interaction equation, $\vec{\nabla}\vec{\phi} = \vec{\phi}\vec{\phi}$ (*change derives from self-interaction*) leads to a flow condition $\Delta m(\Delta x)^2/\Delta t = \hbar$ which establishes a *threshold* enabling 'in'-formation. It also yields the Maxwell-Einstein equation $\vec{\nabla}\times\vec{C} = \kappa\rho\vec{v}$ with linear/circular duality resulting in particle generation (when energy is great enough) leading to Schrödinger's equation for unitary evolution of C-field-based wave functions. Such particles make possible semi-stable two-state systems with a *threshold*, thereby enabling logic, counting, and arithmetic. Logic circuits allow pattern recognition based on inter-set versus intra-set distances, and thus

> *the division of the unitary world into 'feature'-based models and maps!*

I've shown[25] how robots accomplish such, and how the human brain does it more elegantly. Key to both:

> *the threshold—essentially two-state—which provides the only real meaning of 'bit'*

i.e., *above or below threshold*. Thus a bit has meaning only when a real change *in form* of the structure (*in-formational* change) occurs. All else is simply energy exchange.

Physicists' idea of a 'real' bit is a bit too simple; it doesn't account for *fractional* information or deal with the concept of 'false' information. It places all bits on the same level: '*Will it rain?'* has the same value as '*Will I get the death penalty?*' It is unclear what bits refer to: does *spin* have only two states, or is it that the direction of the apparatus' magnetic field forces spin into one of two states? For something from which physicists hope to derive all physical reality, 'bit' is pretty ill-defined. Smolin claims *entropy is inverse to information* and notes that entropy is an emergent property "*since it makes no sense to attribute an entropy to the precise microstate of the system.*" If both statements are true, it's difficult to see how information can be inverse to an emergent property but yet not be an emergent property—'*Bit from It*'.

Newtonian gravity is time independent, thus cannot evolve; our master equation is defined by evolution, hence is implicitly a function of time. The field's local and global nature, linear/circular duality, self-interaction and unique *awareness* of all forms of energy serves as the basis of everything. Newtonian gravity is too simple for this purpose and Einstein's non-linear field equations are impossible to solve for any but the simplest situations. *n-GEM's* non-linearization of weak field equations may provide the tool needed to develop solutions based on one field, versus the *Standard Model*'s dozens of fitting parameters needed to fit the data. Jaynes: "*the proper question is not "How well do data D support hypothesis* H *?"* [*but*] "*Are there alternatives* H' *which data D would support relative to H, and how much support is possible?*" For a *unitary* universe rather than a multi-universe fragmented into dozens or hundreds of fields, particles, dimensions, symmetries, etc., properly understanding gravity is a good place to start, particularly self-gravitation of kinetic energy and its dominance at high energy over Coulomb fields. Smolin: "*the universe naturally self organizes to increasing levels of complexity, driven by gravitation.*"

This is an anti-entropic characteristic that only gravity seems to exhibit—and living beings!

One can accept the physics of the field and reject the interpretation of awareness associated with the field. The physics still works. But then one must explain awareness. No one has done so, and it's not for lack of trying. Physics has been averse to bringing consciousness into the picture, but this may be changing. In April *Phys Rev Letters*,[31] "*Causal Entropic Forces*" connects intelligence and entropy maximization!

Bits and *information* imply consciousness; *knowledge* and *meaning* of information require awareness!

From Oppenheimer's deep interest in *Zen*, to Cristi's *Tao* essay[32], physicists are fascinated by the idea that *unity* underlies an apparent surface division of the world into related and correlated entities. Yet Zen *koans* remind us how terribly difficult it is for brains that have mastered the skill of partitioning and relating systems to reach mindful awareness of undivided Nature: the '*Not two*' aspect of reality. This difference in awareness separates '*It from Bit*' and '*Bit from It*' —the difference in believing '*math lives'* versus awareness of a unitary, self-aware universe.

Those focused on bits may say (as stated twice already in this contest) "*we don't have access to reality*". This claim is symptomatic of belief that "*math is real, but reality isn't*".

But we do have access to reality. I am aware of gravity right now—it's not 'bits' I feel, but gravity.

And I'm aware of *time passing*. I am *self-aware*—that too is *real*. My self-awareness is integral, not fractured or fragmented. So I see *light* —not *a photon*, not a '*bit*'—but *images* focused by my lens on my retina in stable organized patterns that reflect the real source or at least the surface of last scattering. And I can *touch* that surface. It's hard. Korzybski was right about that.

One doesn't have to give up awareness of territory to appreciate the maps of physics.

Technical Endnotes

Jaynes uses the basic product and sum rules [based on standard symbolism]

$$P(AB|C) = P(A|BC)P(B|C) = P(B|AC)P(A|C)$$

$$P(A|B) + P(\bar{A}|B) = 1$$

to derive the extended sum rule

$$P(A+B|C) = P(A|C) + P(B|C) - P(AB|C)$$

and, given reasonable desiderata, if on background information B the hypotheses ($H_1, H_2, ...H_N$) are mutually exclusive and exhaustive, and B does not favor any one of them over any other, then

$$P(H_i|B) = \frac{1}{N} \qquad 1 \le i \le N\,.$$

Application of the extended sum rule yields the Bernoulli urn rule: if B specifies that A is true on some subset of M of the H_i, and false on the remaining ($N - M$); then

$$P(A|B) = \frac{M}{N}\,.$$

"Much of probability theory derives from no more than this." In particular combinatorics applied to this yields entropy. While the entire formalism above is based on information, or 'bits', the key word is 'urn'. An urn is a *physical* container, containing *physical* entities, whose probability of selection is computed. This is the 'it' on which the 'bits' are focused. *No 'it', no 'bits'*!

"The probability assignments are not assertions of any physical property of the urn or its contents; they are a description of the *state of knowledge* prior to the drawing." This brings the topic of *awareness* into the picture, as knowledge is meaningless in a completely unaware universe (as are 'bits').

As I developed in my PhD dissertation[25] in 1979, and as Jaynes states in 1996: "to apply [the principle of maximum entropy] we must define a sample space, but do not need any model or sampling distribution.

In effect, entropy maximization creates a model for us out of our data."

Bayesian and maximum entropy methods differ in another respect. Both procedures yield the optimal inferences from the information that went into them, but we choose a model for Bayesian analysis; this amounts to expressing some prior knowledge—or some working hypothesis—about the phenomenon being observed. […] If the extra hypotheses are true, then we expect that the Bayesian results will improve on maximum entropy; if they are false, the Bayesian inferences will likely be worse.

On the other hand, maximum entropy is a non-speculative procedure, in the sense that it involves no hypotheses beyond the sample space and the evidence that is in the available data. Thus it predicts only observable facts […] rather than values of *parameters which may exist only in our imagination*.

Gravity is anti-thermodynamic

Smolin: "…gravity subverts ideas about thermodynamics. […] *Gravitationally bound systems are anti-thermodynamic*. […] Consider a planet around a star. If you put energy in it will move to an orbit farther from the sun, where it moves slower. So putting energy in decreases the speed of the planet, and this lowers the systems temperature because the temperature is just the average speed of things in the system. Conversely, if you take energy out of it, it falls toward the star and moves faster."

Two different Entropies:

Jaynes[6] notes: "…*a persistent failure to distinguish between the information entropy, which is a property of any probability distribution, and the experimental entropy of thermodynamics, which is instead a property of a thermodynamic state… [Many] authors failure to distinguish between these entirely different things [leads to] proving nonsense theorems*."

For example, the *Holographic Principle* in which the addition of a photon with wavelength equal to black hole diameter adds corresponding mass which results in a particular increase in surface area of the black hole. The argument can be entirely formulated in terms of *energy only* with exactly the same result. The black hole surface has nothing to do with information, but entropy arguments applied to the black hole have been used to justify the holographic principle as an informational phenomenon. It is not.

Kerr-Schwarzschild 'ring' model of the electron

Burinskii describes[19] the *Kerr-Schwarzschild 'ring' model* of the electron, a static solution to Einstein's field equations formulated as a low-energy string (which I see as analogous to Fourier analysis of 'orbits' in atoms and molecules.) I don't believe his description provides for particle creation and annihilation (other than as QFT-like operator events); a C-field description provides a *continuum-based* evolution of particles from a *perfect fluid* vortex at LHC collision energies. The approaches described by Burinskii and others lead to various *soliton* solutions of Einstein equations; my approach leads to a torus solution which corresponds to his 'singular ring'. In this regard we both

> *"arrive at the extremely unexpected conclusion that gravity […] may lie beyond quantum theory and play a fundamental role in its 'emergence'."*

Yang-Mill fields

Superficially, electromagnetic fields induced by charge current density are identical to gravitomagnetic fields induced by mass current. The Yang-Mills nature of gravity completely changes the picture. Based only on the form of the weak field equations of relativity, the behavior of the gravito-magnetic field would be identical to the behavior of the electromagnetic field. But electromagnetic circulation, traveling with a charged particle, has equivalent mass, but no charge, hence does not 'self-induce'. The gravito-magnetic field traveling with the particle *does* add momentum (mass current flow) and is *sourced* by momentum, hence it "induces more of itself". This crucial difference between linear and nonlinear does not show up in coupling constants! Analysis of the weak field equation (*linearized* version of Einstein's nonlinear field equation) has focused on the coupling constant, so it's been believed (since 1885) that the C-field is too weak to be of consequence. Yet representing the C-field by a linearized equation does not make the C-field linear. It only makes the equation solvable, it doesn't realistically represent the C-field in regions of high mass density, such as particles and black holes, where nonlinearity reigns. So we must 'recover' nonlinear behavior while 'retaining' solvability. The *n-GEM* model does this.

Disclaimer:

I've quoted Lee Smolin's new book[2] many times. I do so because he is excellent at analyzing the current state of physics and summarizing concepts and conceptual problems. This is *not* an endorsement of his theories and answers to these problems, only an appreciation of the effort he has put into seeing problems.

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