

The Intelligent Bit

Peter A Jackson

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Abstract

An intelligent 'IQbit' is found in hierarchical 'Sample Space' sub-sets hidden in the *Excluded Middle* between binary 0,1 values. Complex but causal distributions of intensity are found equivalent to Gödel's non-integer 'n-valued' or 'Fuzzy' logic, not accessible to binary systems. When tested by asking more than the 'yes/no' limit identified by John Wheeler the IQbit proves surprisingly capable of resolving the EPR paradox causally, without action-at-a-distance or superluminal signalling. New experiments comparing single photon pairs are proposed, predicted to reveal 'cosine curve' distributions from *each* detector, as John von Neumann proposed. Uncertainty and determinism emerge more consistently superposed. New 'dimensions' and degrees of freedom provide the power, implying new law of nature with a domain limited to only 'real' *entities* and *interactions*, giving quantum mechanical statistical probability amplitudes as Bayesian inverse distributions. The law may then be termed the "*Law of the Reducing Middle*". Probabilities of any occurrence in an infinite universe are non-zero. A related suggestion emerges; that no two *real* entities precisely identical at observable scale exist at any time. The fundamental rule of mathematics, also assumed for predicate logic and calculus; $A = A$ is then replaced only for *natural* phenomena with the 'similar' $A \sim A$. The natural '*Dividing Line*' discussed by Dirac between entities precisely mathematically describable and the rest is identified, the two parts distinguished as; *physical* (entities and interactions) and; *metaphysical*. Only the metaphysical class retains an *excluded middle* between binary 0,1. The class includes; cardinalised integers, assigned symbols, algebra, finite values and numerical derivatives; *speed, frequency, correlations* etc. Bell assumed simple binaries precisely modelled reality. 'Squaring' 2D waves creates the 3D IQbit torus wound by helices harnessing orbital angular momentum and describing a helix when translating axially. Field and relative orientations on interaction (detection) varies intensity distribution as the cosine, as Malus's Law.

Introduction.

In identifying the fundamental quality *change* 0,1 Claude Shannon brought a quantum leap in data handling. Now we've hit *noise* limits implied by his capacity theorem; overcoming noise in one channel needs power, spilling over as noise into another. Supercomputer power input is also at sustainability limits. The thirst for speed and storage is insatiable but practicalities of quantum computing and multiple entanglement means we may have years to wait. A new approach suggests far greater capacity exists in areas not yet fully searched. A quantum leap in a new direction seems possible using new degrees of freedom, 'changes' and information capacity hidden in two higher order '*spaces*'. These spaces are; infinite hierarchical subsets of *Sample Space* an essential gamblers aid, and the '*Excluded Middle*' between 0,1 inaccessible to binary systems but irrepressible in logic. The hidden power found allows an *intelligent* qubit or ***IQbit, from*** nature (*it*), but able to tell us far more **of** nature than the binary bit. A hint of IQbit capacity is that signal noise is found to be reduced by pairing orthogonal carrier polarisations (Xiang et al. 2013)ⁱ, termed '*phase conjugated twin waves*', but hiding the ubiquitous helix. As '*spooky*' instant signalling is the Holy Grail of information theory the Einstein-Podolski-Rosen (EPR) paradox case is used as the sternest of tests for the IQbit's resolving power.

A bit has a state 1 or 0 or wave *peak* or *trough*; *up/down*. Quantum qubits can have superposed states of freedom; *ket 0*, *ket 1* corresponding to two polarization axis of the *spin 1* photon. Electron polarisation (angular momentum AM) differs from *spin* but in a 'photon' the two are considered as the same. It's been assumed that simple 0,1 spin states are all a photon has to offer. But what if they have more to give? Wheeler identified our questions as *yes/no*, which **can only get yes / no answers**. Moore's law of annual power doubling now applies to qubits. A D-Waveⁱⁱ 512 qubit chip reduces a half hour task to half a second. Quantum computing is already exploring unexpected optical phenomenaⁱⁱⁱ, particularly *orbital angular momentum* (OAM)^{iv v}. It was 1948 when man found cardinalised values 0,1 as the most a wave could offer, yet the wavefunction Ψ is more complex, including OAM. It seems a major processor upgrade is needed to resolve issues in physics as well as communication. Better defining detection and measurement proves to be a good start, and a clear line then emerges defining the domains of mathematics and nature, answering the question; could quanta give more information than we ask them? Also hinting at just what *is* Ψ ?

The Excluded Middle.

Binary based mathematics relies on the *Law of the Excluded Middle* between assigned symbols 0,1, A,B, or *yes/no* for waves. Fibre optic cable signal degradation comes from the *blurring* of sharp cornered *steps*, so ***encroaching onto*** that excluded wave 'trough'. Nature is commonly assigned *symbols* such as 'numbers' to allow computation. Yet in this vast excluded middle ground *lies most of nature* and a dichotomy with logic. Gödel's *n-valued* (1932)^{vi} and *Fuzzy logic*^{vii}, Laplacian/Bayesian inverse distributions and the uncertain probability amplitude distribution (PAD) of quantum mechanics (QM) **populate the space between** cardinals 0,1. In information theory brings new views, such as Haykin and Kasko (2001),^{viii} proposing 'Probability' as a sub-theory of fuzzy logic, deriving Bayes' Theorem via '*fuzzy subsets*'.

Russel's Predicate Logic and calculus tried to derive mathematics direct from logic but ended with paradox. No logical or mathematical system claims to have overcome paradox. Infinities and irrational and transcendental numbers (i.e. π) ***outnumber*** rational numbers! A fresh view suggests that the most foundational logical proposition; $A = A$, or '*Aristotle = Aristotle*' is ***false***. Essential to mathematics and metaphysics $A = A$ is proposed as not applicable to *natural* physical entities and interactions. *Aristotle* is a Proper Noun, the definition of which is a *unique entity*. There can't then be *more than one* Aristotle, so $A = A$ can only be true *metaphysically*. Studying physical entities afresh it becomes apparent, if surprising, that for sizes at observable scales ***no two physical entities are identical***. Even cases of numerous similar entities where *set* quantifiers such as *heap*, or *field* are essential no two may be identical. It is then proposed that no two galaxies, planets, trees, people, snowflakes or grains of sand will be found *absolutely identical* when observed at above molecular level.

Common Nouns are then in the *same class* as Proper Nouns, and in a ***different class*** to metaphysical concepts including mathematics, algebraic symbols and derivatives. If there is a non-zero probability amplitude for all possibilities in nature it may then be that in an infinite universe Cox and Forshaw^{ix} are correct; everything that *can* happen *will* happen. QM's non-zero *statistical* amplitude distribution is similarly non-zero but can't offer any hint about underlying mechanisms or meaning. Max Born also had no physical explanation for *squaring* the wavefunction (Born Rule) to give the PAD. So what precisely is now proposed? Firstly we argue that that differentiation and definition of the separate rules applicable to the two identified *classes* is needed. The domain labels already exist; *Physical* and *Metaphysical*. Paul Dirac also identified the existence of such a dividing line, saying;

“the **limitation** in the extent to which mathematical theory applies to a description of the physical universe.” and “...if it is only to a part...this part **ought certainly to be sharply distinguished** from the remainder. But...there does not seem to be any natural place in which to draw the line.”

(P Dirac 1939)^x.

This *natural place* now emerges. Mathematics *freed of paradox* needs only refinement and *layering* in sub-sets to approximate nature with increasing precision. The further discrete hierarchical *sample space* dimensions are addressed below. On the *reality* side, a need for new laws of nature arises with domains constrained to *physical entities and interactions*. Probability amplitudes between propositions can *vary infinitely* in nature with curvature profiles, reducing to the middle. It is then suggested that a new “**Law of the Reducing Middle**” describing Bayesian distributions replaces the *Law of the excluded Middle*, long disputed by Brouwer and others. But the new law only applies only to relationships in the *natural* universe. Probabilistic descriptions of infinite n-outcome subsets relate the domains. The proposed law, covering outcomes of real interactions formalises the proposition;

a) *In an infinite universe all probabilities are non-zero.*

The concurrent denotation of *similar to*; $\mathbf{A} \sim \mathbf{A}$ better describes real *entities*. Socrates held a similar view that there is no absolute equality in nature. The rule's domain limits may be characterised as temporal and a classical scales provisionally between galaxy and molecular levels, proposing;

b) *No two entities are absolutely identical at any instant.*

Time itself is a special case. The concept *time* is a human invention to describe change, often confused with the *physical* evidence of emissions from 'clocks'. Physical artefacts propagate as sequences (giving Minkowski's *events*) obeying the laws of physics so liable to evolution due to spread and requantizations, en-route^{xi} or at 'detection'. Apparent changes observed are changes to physical entities and relationships NOT to any *entity* called 'Time'. **Dirac's Line** then more clearly divides *Proper Time* (unchanged) from apparent *co-ordinate time*^{xii} from signals originally emitted in *any other* frame. Defining 'detection' as the *real interaction* of the photon sequence with an electron allows this simple axiom, tested below. Propositions a) and b) are axiomised in discussing ψ (Ψ) and Born's rule.

So what's just happened? Has the universe been split into two!? No. The new propositions only untangle the discordant elements of each half. Those other two *halves*, the classical and quantum universes, can then cohabit more consistently. In particular John von Neumann's proposal for a more consistent application of QM's uncertainty principle, to *all interactions*, is followed. Better conceptual understanding of the *real* 'reducing middle' to consider nature in full will enable mathematics to follow sound conceptualization. As Wheeler said; “*Never make a calculation until you know the answer*”.^{xiii} Most differences are small. They may be reduced to trivial by using hierarchical subsets *but uncertainty will never* vanish. Other differences are fundamental and ***fatal to comprehension***. Wigner, unlike Dirac didn't recognise the domain boundary line, so some often now wrongly seem to assume that equations ***are*** nature! The apparent 'chaotic' signals now also found to overcome physical constraints (Ren et al 2013)^{xiv} seem to show nature's insistence on keeping it's freedom. Quantum logic, layered and 'time stepping' maths may at least help improve mathematical precision in describing uncertainties in nature. But a higher order space with implications for mathematics also exists, found by pre-Galilean mathematician Geralamo Cardano.

Cardano's Sample Space.

Studied by students of probabilism but still mysterious and hidden, *Sample Space* is the home of chance and invisible 'probability mass'. New degrees of freedom are hidden both by binary cardinalisation and by *intuitive* assumptions. Often described as the *set of all possible outcomes* sample space is also an infinite scale hierarchy of *many* higher order spaces or subsets in which variables must be separately enumerated. Difficult to visualize, sample space needs explanations and examples to reveal its full power. The initially counter-intuitive lessons to be learnt are difficult to generalize and easy to forget. Cardano, also a doctor, objected to gruesome medical practice but did well at gambling. He defined sample space in a book "*On Kinds of Games*" as containing enumeration of a full *circuit* of possible outcomes. Correct odds can *not* be calculated from **derivations** such as *correlations* of 1,0, or number *combinations*. Galileo later explained in '*Sopra Le Scoperte dei Dadi*', how 3 dice had the same side *combinations* totalling; 9, 10, 11, and 12, yet the odds were **unequal**.

The "*Parade*" agony aunt *Ask Marilyn* won an argument with leading mathematicians in the 1990 *Monty Hall* case using sample space: A prize lies behind 1 door of 3. One is chosen. One *other* is then opened to reveal **no** prize. Two doors remain. The question is "*Are the odds of winning improved by changing choice?*" Clearly choosing now has 50:50 odds. Mathematics said No, Marilyn said Yes. Long argument ensued. But Marilyn was using the IQbit, hidden from maths in in sample space. She was proved correct. The invisible inequality of a 2:1 *probability mass* lies with the two doors *not* first selected, and **remains** there. Only *removing* the original choice removes the mass. Only one '*new*' choice then remains, with 50:50 odds. For Galileo's 3 dice; number *correlations* can't give the *full circuit of possible throws*, utilising each of the 18 faces. 216 different cases then exist. Only counting those shows the hidden true odds (bet on 10 **not** 9).

Probability Theory uses sample space, but it seems its full domain and power are not yet fully understood. Independent parametrization and mathematics must also be hierarchically *layered* as subsets in 3D+T space, then access limitations between layers identified. The description above uses the words *inequality* and *correlation* for good reason. When deriving his famous theorem and inequalities John Bell used the normal assumptions about sample space, so the additional mechanisms and freedoms were not accessible. The IQbit was obscured beneath the simplified *photon* parameters 1,0. Such hidden higher order factors **must then be parametrized**. In excluding hidden variable theories Bell didn't rule out *large scale* variables such as action at a distance and $c < .$ The new distribution **within** 0 and 1 is Local and Universal, deterministic and probabilistic, so agreeing with Bells;

"...nobody knows just where the boundary between the classical and the quantum domain is situated. (...) More plausible to me is that we will find that there is no boundary. (Ψ)...would prove to be a provisional or incomplete description of the quantum-mechanical part. It is this possibility, of a homogeneous account of the world, which is for me the chief motivation of the study of the so-called "hidden variable" possibility."
J.S Bell 1987^{xv}

Toroid & Helical Wavefunctions.

Collapse of Ψ may also be seen as *creation* of Ψ^1 on interaction. To avoid anomaly and paradox convention in optics and astronomy uses change to *physical* quantity *wavelength* λ/λ for Doppler shifts. *Frequency* (f) is a numerical *derivative* so only *metaphysical*. Assumptions that f is *physical* lead to paradox. A value can only be assigned to f *after* the process of detection, channelling (via a wire or optical nerve) to a *processor* and computing against time using **some**

datum for signal 'speed' (speed itself is only a *derivative* of length λ and time). **Only then can any measurements be produced.** Using λ also clarifies that the *datum* we must always use for assigning a *speed*^M to calculate f is the *observers rest frame*, i.e; *the rest frame of the channel* to the processor. Traditionally the previous 'approach medium' rest frame has been assumed by some processors as applicable. In that case paradoxes are created for observers moving through that medium. No observer in motion through a background has direct access to **relative approach speed** or λ . If a relative 'observer speed' is obtainable then relative 'far field' approach speed and λ can be derived. When at rest in the medium light 'speed' is Locally Real propagation speed c . It then becomes clear that only the difficulty of envisaging *relative speed* in a diffuse medium (previously considered a 'perfect vacuum') creates theoretical problems. Defining **detection** as real first **interaction** allows resolution consistent with the postulates of Special Relativity.

A '*detection*' may then exist at *all* particle interactions, at a lens or not, but '*measurements*' are the **later output of a processor**. The IQbit may help with processor upgrades. Assigning the propagation frame datum relevant for '*speed*' is critical because Ψ needs a *background frame parameter*. Instantly on interaction with the *first peak* of a wave **changes occur** to wavelength λ and Ψ . The old frame then *cannot* be used for computing the new frequency f . Using the **observer** frame means *Proper Time* may be properly used (the rate of a clock at rest in that frame) to compute f .

Detection is then defined as the *physical interaction* 'collapsing' Ψ which state *changed* instantly. Ψ can be both a 'potential' **and** a real entity. The optics convention is 'Huygens Construction' of infinitely many wavelets expanding and interacting, so any point just has a potential. *Squaring* to 3D **spherelets** is more precise. Coherent forward scattering (CFS) in plasma narrows scattering angles (plasma beams can be self focussing). Yet a photon *on interaction/re-emission* is particle-like. Two *starting assumptions* of Wheeler's 'delayed choice' case would then be wrong: Photon *particles* scatter, and *statistics* can't access the same data as comparison of each entangled pair, explaining the apparent paradox.

Collapse then creates a new Ψ in the new medium. *Potential* may then be seen as the players of a team heading to one point to *interact as an entity*, representing multiple Huygens *spherelets*. The anomalous *spread function*^{xvi} of Schrödinger's non-linear (NLS) time-dependent wave-packet is consistent with gradual spread from *particle* to *waves*. Expanding Schrödinger sphere surfaces also contain local angular momentum combining 360° 'transverse' **and** 'longitudinal' states. Figure 1 shows the 2D/3D relationship between waves and *rotating or orbiting* particles. The *real* form is the helix. The toroid and implicit *helical path over time* is as found in recent optical research, of waves, particles or surface plasmons^{xvii xviii}. The helix as a wave *squared* to a 3D distribution of energy offers a hint of grounds for squaring the wavefunction to find the PAD. The helix/torus/ helix formed by particles and time appears to epitomise duality and the multiple IQbit vectors.

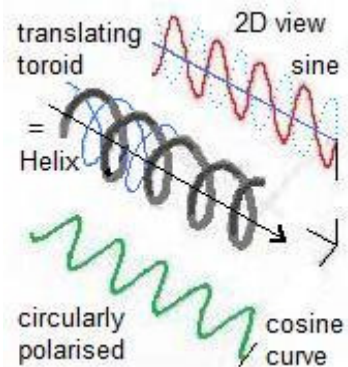


Figure 1: Waves are a simple 2D case of a translating toroid or a spinning dipole as a 3D double helix. Varying ellipticity, amplitude and phase produce unique profiles and PAD's. P.J.

A wave, giving the binary 0,1, is the simple 2D form of a (3D+Time) helix. The first new freedom of the (red) sine wave is then the (green) cosine wave. But many more degrees of freedom may exist in a 4D wavefunction. The simple dipole shown translating on its axis in

time describes the powerful *double* helix. But the popular toroidal (donut) or multi toroid model of a particle contains further inherent helices. The tubular body of the ring is itself counter-wound with two more continuous helices. Nuclear tokamaks, the basis^{xix} of atomic fusion, use this same electromagnetic (EM) toroid dynamic.

Because lines have no thickness curvatures can vary infinitely with ellipticity. Elliptical polarisation is common along with gyro-electromagnetic optical Interstellar Faraday Rotation (IFR)^{xx}. Interaction angle θ critically relates to **detector EM field orientation** so a datum exists for recovering information from these additional freedoms. A datum is essential in the EPR case. Malus' Law states that for plane polarised light; *Intensity* (I) $\propto \cos^2\theta$. Energy distribution is then directly proportional to the **square of the cosine** of the angle between polariser/particle axes and detector field. Malus' Law applies at emitters *and* detectors. When two toroids meet *the settings change the relative orientation* of detector (field) and arriving particle. The **setting θ** then dictates relative ellipticity and, using the detector datum *where* in the circumference the toroids meet and interact^{xxi}. The energy distribution is then **asymmetric** on interaction and *non linear*. The other entangled particle interaction is precisely the converse. The relative positions of the 'charge peaks' around the 360° body sets the additional parameter value, **so also each local cosine curve** of intensity distribution (see Figs 2–5). Malus' Law is well know in the EPR case but false assumptions have obscured it's mechanism and relevance, as shown below.

Uncertainty issues remain. The D-Waveⁱ addresses these by reverting to binaries to represent the *smaller probability peak* positions, so again using statistics and increasing computation time. *Free space* propagation is faster than solid optics but spread and stochastic gradual decoherence effects slowly degrade signal quality. *Multi tube* optical waveguides are now more common. The optical helix has also shown it's power as a waveguide. Wang et al. (2012)^{iv} and Rechtsman et al. (2013)^{xxii} have shown that orbital AM and arrays of helical 'waveguides' act as *topological insulators* allowing the new freedoms to be exploited. The Xiang workⁱ shows that with phase conjugation the principle also applies to solid media. Whether from single particle spin, sphere surfaces or carrier beams, the '**changes**' implicit in the **motions of the various complex orbital angular momentum** give the complexity *between* 0 and 1, termed the IQbit.

Local Resonance effects

The harmonic resonance and phase locking effects involved in tomography, optical tweezers 'quantum teleportation' and other 'steering' phenomena seem closely or directly related to helicity and entanglement. All these effects are relatively short range or topological, with changes limit $< c$. The EPR scenario uses similar opposite handed split spin pairs, but is at long distance to avoid such local effects. The assumption used in 'testing' for local effects in EPR experiments is that the conditions are the same as the distant case. Such an assumption is then incorrect. Phase locking has a finite range and optical tweezers a finite length. Malus' Law at Stern-Gerlach polarising magnets also implies asymmetry of charge, an effect not discernible in *local* phase locked emissions. None the less it may be that sampling and comparing *individual* photon pairs at moderate range will reveal the effects shown below.

Axioms

The principal and apparently disparate effects above are now axiomised. But, axiomised or not, all matters discussed will play a role in the resolution described.

1. Particles as *non-point* charges orbit, propagate, and interact on detection all on an *axis*.
2. Hidden higher order variables exist *between* integers 0,1, requiring enumeration.
3. Real physical entities and interactions (not *derivatives*) produce real physical effects.

5. Law of the Reducing Middle; *In an infinite universe all probabilities are non-zero.*
6. Toroid spin orbit and axial propagation in *time* produces a complex helical form.
7. As John Bell's belief “*that there is no boundary*” to classical and quantum domains.

The Einstein Podolski Rosen (EPR) Paradox

The EPR case correlates *spin* 0,1 found by two distant detectors at various relative field angle θ settings. The correlations predicted by QM appear classically impossible without *spooky action at a distance* or superluminal signalling. John Bell's famous Theorem and *Inequalities* showed mathematically that no classical *Locally Real* theory of hidden variables could reproduce QM's prediction of an uncertain cosine probability amplitude distribution (PAD) curve. Despite experimental difficulties the predictions are so far verified, but as with Born's Rule *no mechanism* is offered. The findings predicted at each detector may be simplified to green and red lights. At 0° difference in θ *anti*-correlation is perfect, at 180° correlation is perfect. $90^\circ = 50\%$. But then at relative 60° difference in θ ; correlation = 75% and $120^\circ = 25\%$. These *intervening* results produce QM's cosine distribution curve.

Figure 2 shows a full 360° circuit. The curve is proposed to also represent the inverse Bayesian or Gödel many-valued 'reducing middle' between the certainties of 0° , 180° and 360° . But the curve may be viewed as the 2D form of the part of a helical orbit between wave peaks, which is the cosine waveform curve of figure 1. A *real* rotational interaction mechanism is identified producing the same curve, dynamically represented here; <http://www.youtube.com/watch?v=ynZmZzOhBkM>

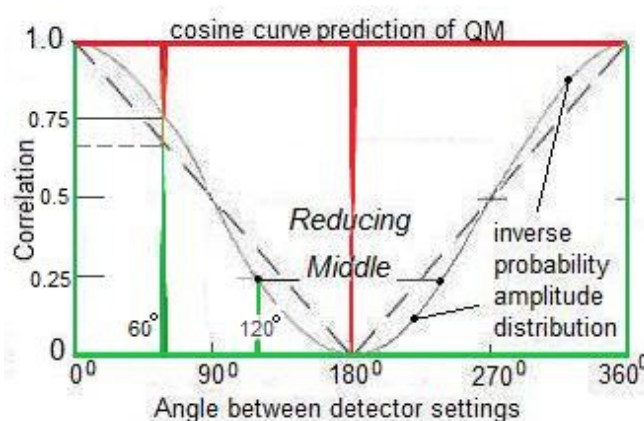


Figure 2: QM uncertainty applied consistently at detectors before 'statistical' 'correlations' reproduces the cosine prediction of QM. The mechanism is otherwise causal. Credit; P. Jackson

To conceptualise consider the left side of figure 2. Below the curve = Green, above = Red. Only the question 'red, or green?' is asked. The curve represents the *proportion* of answers over a large sample at various relative settings of θ . But we now ask a question of the more intelligent IQbit, and for EACH interaction; *How Much?* We introduce an enumeration of differing *values of intensity* of red and green in *each case*. As relative detector setting is changed the **peak charge point separation** changes as Malus Law giving interaction $\Delta\theta$. Because charge density reduces *non linearly*, around the orbit so does the *relative density*, and so will the findings. The physical '*cause*' of this inequality of correlations is then moved from some metaphysical statistical 'space' between *A* and *B* to the *real physical interactions at each* detector.

Because the entangled particles are *handed* they act conversely with respect to relative field θ . Local variables then exist of a different *type* than assumed. The variable is a continuous *orbit* of values. When asked *how much?* the answers are a *range* of values between 0 and 1. At 90° the answer is not; “*don't know*” but “*equal 0,1.*” To answer this question *each particle pair* must be accurately identified. Simply *statistically* correlating the large *sets* of results currently produced denies access to the data and cosine curves of density distribution at *each* detector.

Figure 3 represents a 'face on' view of the *interaction* density distributions, reproducing the predictions of QM with a quasi-causal mechanism. The *scale* of uncertainty is then reduced.

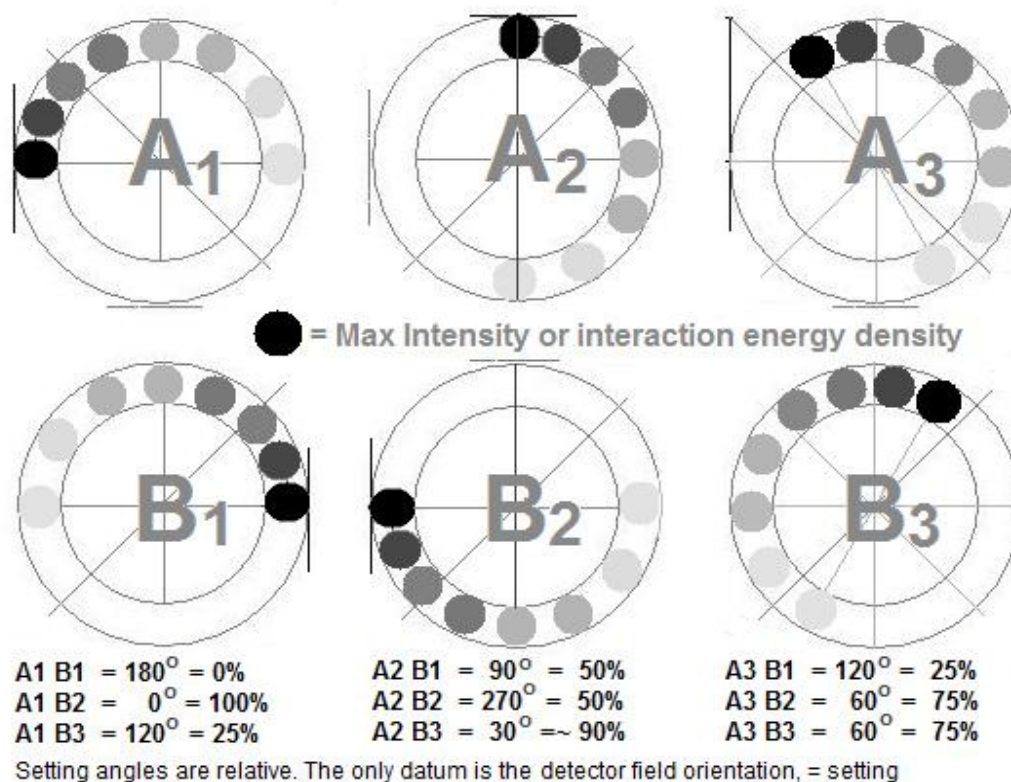


Figure 3: Relative energy density on **detections** gives the cosine curve locally at EACH detector via relative field orientation parameter. Intensity change is NON-linear. (See also actual findings Fig.4)

Due to the non-localizable nature of the 'photon' the photon Ψ is “still not fully accepted among the scientific community,” partly because the “photon wave function cannot exist in position eigenstate.” (Chandrasekar 2012)^{xxiii}. A successful new approach to interactions uses “a term proportional to the **current density induced in the media due to the presence of the photon.**” (Saldanha and Monken 2011)^{xxiv}. Both the EPR case and Bell assumed single 'photon particle' pairs, but true 'single photon emission' (SPE) remains problematic. Normal 'pumped pulses' are multi photon streams or beams, though single photon production has been claimed as technically possible particularly^{xxv} in a waveguide. Yet hints of the orbital invariance exist. The sources of the *Aspect experiments*^{xxvi} typically emitted $\sim 5 \times 10^7$ photons/sec, selecting < 40 /sec, but even the best time varying analysis can't guarantee pair matching, and so called *single photon detection* is also still problematic^{xxvii}. But Aspect reported a number of aberrations in the data, including that his signal source was “**not rotationally invariant**” (1983, p 265-7). Over 99.999% of Aspects results were excluded. With no theory explaining this aberration at the time the exclusions may be considered reasonable, but it now appears that the opportunity for a serendipitous finding may also have been excluded. This rotational invariance is precisely what the IQbit thesis predicts. Full rotational analysis at detectors is now required.

A search reveals no valid experimental findings as yet correlating individual pair returns, as needed to access the pattern predicted herein. No arguments raising valid objection to this original thesis have been found and no EPR 'loopholes' are invoked.

Figure 4 shows the angle change, ellipticity and non-linear density distributions obtained from THz laser experiments by Chen et al. (2008)^{xxviii} and all as Malus' Law.

John von Neumann proposed the solution outlined here in 1932; suggesting that as *system* and *meter* physically interact *both* must act as quantum mechanical systems, so *each* meter should “*equally obey the uncertainty principle*”. Pascual Jordan said “*Observations not only disturb what is to be measured, they produce it.*” The IQbit's *reality* based solution allows coherent application of QM principles with a largely deterministic mechanism but including uncertainty at *each* detector.

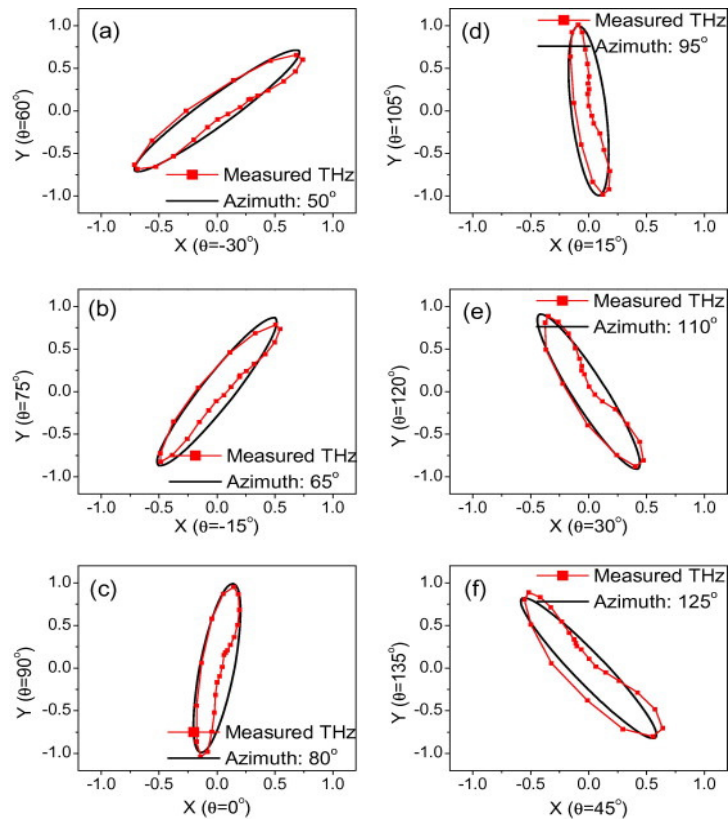


Figure 4: Polar ellipticity from THz laser pulses in air for varying θ . Predicted by the IQbit and found but discarded by Aspect (1983). Credit Chen et al. 2008.

Conclusions

An intelligent *IQbit* with new helical/toroidal freedoms is found hidden in a *Sample Space* of hierarchical subsets, and an *Included Middle* between binary 0 and 1, including Ψ^2 . More than just *yes/no* questions are asked. The answers show the **bit** comes *from* reality (**it**), but unity of *Probabilism* and *Local Reality* is found emergent *from* the IQbit. Quantum computing and fast noise free communication are also found complicit in the toroid based multi helical temporal form.^{xxix} Quantum Mechanical Probability Amplitude distributions are **causally** reproduced to a high order yet uncertainty never vanishes. The findings emerge as Gödel's n-valued or 'fuzzy' logic with Bayesian Inverse energy distributions from orbital variations. Paul Dirac's proposed 'natural line' between the *metaphysical* and the *physical* universes emerges. A new “**Law of the Reducing Middle**” is proposed with a domain strictly limited to nature, founded on the uncertain; $A \sim A$. Mathematics, is untangled from paradox and retains $A = A$.

The *IQbit's* resolving power is shown to be held in the new 'changes' of multiple orbital angular momenta, and is tested against the EPR paradox. All the predictions of QM are shown as reproduced **at each detector interaction**. Superluminal signalling and action at a distance are then falsified. *Loopholes* are not invoked and stochastic effects are secondary. The EPR case specified a **single pair**, but a starting assumption that *statistics* can precisely reflect the evolution of real physical interactions is shown as wrongly used and false. The *quantum eraser* 'particle' case uses the same assumption and 'conserved photons' so produces paradox. Bell's prediction of 'no boundary' between quantum and classical regimes is verified. The 'anomalous' rotational invariance found by Aspect and discarded is predicted and identified as important. A focussed experiment using single pairs is proposed. A clear conclusion is that nature cannot be summed up or reduced to integers or bit's. Some set of causal 'rules' may exist but the results of interactions can't be predicted. A subtle difference between determinism and 'predetermined' emerges. A 'universe as a computer' would exist to find what's *not* known not what is.

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