Quasi-classical Entanglement, Superposition and Bell Inequalities.

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Abstract

'Quantum state reduction' (QSR) has no classical logic, and the Einstein-Podolski-Rosen (EPR) paradox remains unresolved. Many assume no classical explanation is possible. John Bell disagreed despite his 'theorem' and 'inequalities' (J Bell. 1987).[1] We identify an ontological construction and describe a classical mechanism (CM) predicting experimental data as Bell anticipated by employing different assumptions and a physical analogy of 'superposed' states. Electron spin-flip (reversing polarity and/or spin state) is found to reverse the *local*, not the distant, detector finding, suggesting that an assumption employed in 'weak measurement' analysis is false. Quantum spin is modelled as the small scale ('hyperfine') angular momentum of orbiting charges, each *also* rotating. The classical mechanism produces a violation of the Bell inequality from a cosine intermediate angular surface velocity distribution at each recursive scale of orbital angular momentum (OAM) diameter. The 'probability' of triggering one or the other detector emerges from the angular momentum exchanged on ('measurement') interaction. Standard quantum electro-dynamic (QED) provisions for field phase distribution square the amplitude to give Malus's Law and reproduce the predictions of quantum mechanics (QM). Uncertainty reduces to higher orders. Modified 'quasi-classical' definitions are offered for familiar QM concepts and terms.

1. Introduction

In a classical Einstein-Podolski-Rosen (EPR) paradox case a spin 1 or ½ particle is 'split' into two halves with states (*'up', 'down' or a, b*). Each half is sent off in opposite directions to Alice and Bob who each have a polarising filter/modulator (rotatable 180°), plus detectors, which may be paired photomultipliers. The probability of *a,b* or *b,a.* is random 50:50. A classical view is that, at identical settings, if observer 'A' (Alice) finds 'up' then we know 'B' (Bob) will find 'down'. QM and Bell assumed a 'weak measurement' could 'preview' state 'A'. State 'B' would then be known. But when the polariser settings are 180° **opposite** (*relatively*), correlation is perfect. i.e. if A =30° and B =210°, we find a,a or b,b (spin 1 states may be considered as polarity, but no particle form is assumed).

The problem for that classical view is this; At the same settings, if Alice has '*up*' (so Bob = '*down*'), then Alice decides to switch to an 'opposite' setting at the last instant, Bob's possible 'state' finding is reduced to 'up' to match Alice's, and so we must assume his has instantly switched! So there is the paradox, “spooky action at a distance” or even faster than light signalling. Such 'non-local state reduction' is mathematically predicted by quantum mechanics (QM) and experimentally verified.[8,9] Additionally, at intermediate relative setting angles the probability of an 'up' or 'down' finding has a non-linear distribution. Bell and other ('inequalities') prove that any deterministic theory of 'hidden' local variables has a 'limit' which QM's predictions (giving a cosine^2 curve) violate. The problem is then twofold, to derive the 'non-locality' finding, plus the inequality violation. QM's interpretation is that the particles are 'entangled'; each half has both states 'superposed', and they only 'collapse' to a definite state on observation, analogous to 'collapse of the wavefunction'. The cosine^2 curve then only describes a 'probability amplitude distribution'.

Much sophisticated manipulation of symbols has been tried, but we take the naïve view that if a finding defies logic then one or other starting assumption may be wrong. Bell inherited, identified and employed many assumptions.[(i)] We identify and rationalise why some of the assumptions appear unsafe, then specify and test alternatives. We also hypothesize some typical possible 'particle' forms, morphologies, dynamics and characteristics, now with better evidence than when formulating QM (i.e. see Allen et al. 1992) [2] We describe a classical relationship considering variable detectability of simple polarity as being complementary to angular velocity distribution across the surface of a sphere. Induced mechanical 'torque' exists in light (Allen et al. 1992)[3], and we adopt the concept of complementary 'magnitudes' of both polarities (P) and 'direction (D). Orbiting charges may then also produce similar higher order hyperfine spin states as quantum angular momentum (QAM).

2. Classical Superposition of particle states

Consider a sphere or torus spinning around its x axis. To determine if the rotation is '*up*' or '*down*' we detect its motion ('observe') by interaction ('touching') at maximum radius perpendicular to the spin axis (the 'equator'). There is a random 50:50 chance we find the spin direction '*up*' because relative observer position is arbitrary. If spinning 'up', the polarity to our right side will be found as clock-wise (South pole 'S') and so the left side anti-clockwise (North pole 'N'). We will show that polarity 'P' and *up/down* states have critical but poorly considered characteristics and relationships. We now split the toroid into two halves at the equatorial plane (using a Stern-Gerlach magnet, crystal or sharp knife) and send the halves in opposite directions along the x axis. Each half has the opposite polar spin 'leading the way'. Observers A (Alice) and B (Bob, to left and right will then find opposite polarities on arrival (see Figure 1 and Appendix Fig 4). Each toroid (/spheroid) *retains both* N/S poles. But neither A or B can determine any 'up' or 'down' motion! Before the halves were dispatched, an observer on the other side of the particles also touched the surfaces near the equator, finding both *down*! The surface was indeed moving down when detected from the opposing viewpoint, and so the *opposite* state was detected. Alice, far off to the left found 'anti-clockwise' on arrival. Bob, far to the right, found clockwise (with a 50:50 random chance which polarity for each pair). A surprise finding is that each particle possessed *both states* '*superposed*', but only ***one state can ever be detected at a time*** subject to which *hemisphere* interacts. The 'Majorana fermion' view of positrons as the flip side of electrons emerges. Helices in axial motion also rotating bodily would have dipole asymmetry, which would naturally produce apparent violation of charge parity (CP).

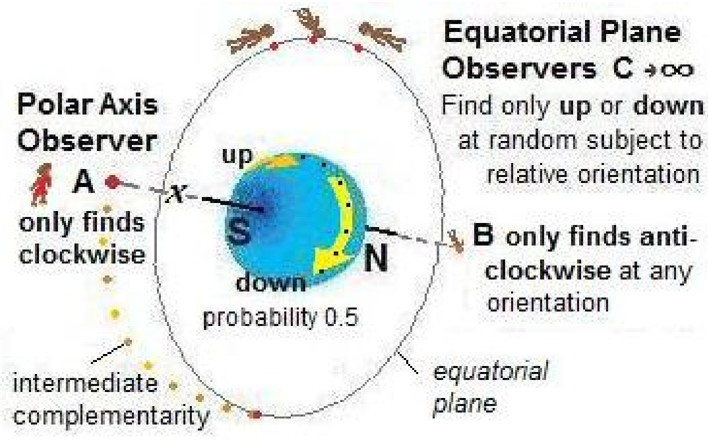


Figure 1: Chirality. A fundamental characteristics of rotation is that all bodies have both poles. We find it inadequately considered that polarity cannot be determined at an equator where separate inverse 'up' or 'down' states exist, entirely subject to the relative interaction orientation of any observer. N/S poles may be reversed by rotation through the y,z axes while conserving x axis angular momentum. Value distributions between these two 'stacked' state pairs is inverse, sinusoidal and reverses at 90^o. *PJ*

Importantly then, in our axial anti-parallel propagation case, the only difference between the particles is '*direction of propagation';* N or S. Now any *y, z* axis rotation, or change of observer position, will produce a relative angle between the polar axis and the direction of observation, which then renders the 'up/down' information detectable. Again the states are 'super-posed', but only ***one state*** can be detected at a time. We may treat the pairs variously as orbiting dipoles, single charges with helical paths as found in light,[2] and solar emissions (Zhang et a. 2014)[4] or spheres. We model the simple spherical case and derive the spherical harmonics of QM below (See also. Appendix Figs 4-5.)

3. Suggested False Assumptions

First we compare our assumptions with those of QM and John Bell. We assume classical OAM, but also the 'hyperfine' spin (Kasovich, Chu 1991)[5] of an orbiting dipole charge, electron models such as Allen [2] and Sturm et al. (2014)[6], and quantum interferometry as QAM in spin ½ particles. We use the same definition of spin 'measurement' as Bell, which is the angular momentum "*relative to the detector*." The resultant implication of an *'exchange'* of momentum in an interaction seems logical. We hypothesise such interaction as normal photon/electron or electron/electron Compton or Raman type 'atomic scattering'. Other quotes of Bell which we find important are given in Appendix 2.

Bell assumed random opposing axes; "*..the magnetic axis of either particle separately is randomly oriented, but...the axes of the particles of a given pair are are always oppositely oriented* " [(1)] p.146, which may be interpreted as random opposite a,b, states either with all y,z, axis freedoms, 'tumbling' randomly, or with a shared conserved anti-parallel polar axis. QM assumed that 'superposed' states were not quite 'locally real'. QM's assumption was inherited by Bell but we suggest it's false. We assume a well evidenced shared common polar axis and propagation direction,[(2-4)] instead allowing the y,z freedoms as *relative* on *interactions*. The paired particles then share and conserve both the same spin AND propagation axis, right up to the interaction with the polariser/ filter/ analyser/ modulator field electrons (at '*preparation*'). The effects of this interaction are consistent with QM and the Copenhagen interpretation, where the 'detector' (von Neumann's 'meter') is "part of the system" contributing to the findings. Bell also assumed that; "*we can predict in advance the result... by previously measuring the same component"* [(1)] p.15, which we identify as a false assumption (see [1] Appendix 2 p.22.), a possibility recognised by Bell. (Davies, Brown 1993)[7] 'Ghosts in the Atom'. A classical assumption that pairs must be found opposite would be false, so 'weak measurement' assumptions that a pre-interaction 'glimpse' of the particle is possible and will reveal a final state are also false. Weak measurement is then entirely 'blind' to final states, and statistical methods *cannot correlate actual pairs*. We analyse implications further below (4). Application of the 'no-cloning' theorem to polarity, Hardy's paradox and the 'indivisibility' of photons appear to be constrained.

4. Mechanism for Entanglement, Non-Locality and State Reduction

Now I point out we have a common non-separable 'datum' which represents 'entanglement' which is the particle's common propagation and spin axis. The angle setting A or B choose with respect to their system orientation can be related back to that 'datum' axis, or indeed to the parallel 'equatorial' planes. Each modulator's randomly chosen angle dictates magnetic field direction, so also dictates field electron spin direction. A 180^{o} reversal of the angle then produces 'spin flip',[8] where the x axis momentum is conserved. Because momentum exchange is relative to detector polarity, the 'finding' is reversed (the detector is "part of the system"). Superposition will then be equivalent to all angular momentum of any body having BOTH polarities and 'directions' (non mirror-symmetry of spin).

Mechanistically, the modulator field electrons absorb the 'particle' and re-emit it with a NEW polar axis, the axis of the re-emitting field electron, which then dictates which photomultiplier is triggered in the NEXT interaction. The resultant axis changes (at A and B) can now be related *to each other* as angles with respect to the original common spin axis. Each then "knows" the others datum (an 'entanglement'). Each setting angle may be drawn as a vector from the centre of a spinning Bloch Sphere. Angles from the equator and the spin axis give *inverse distributions*. The setting angles give two vectors (on any shared plane) striking points on the sphere surface. The final degree of freedom 'z' emerges because the A and B systems and fields may have any orientation, even upside down!

If we used the polar axis as our datum, the vectors rotate around the axis maintaining a constant angle. Each forms a cone within the sphere describing a 'ring of latitude' on the surface (see Fig. 3). As the propagation directions were opposite, if *A,B* (randomly selected) setting angles are identical, the latitudes are also identical, but sphere surface spin (N/S) and direction (up/down) are *opposite* (anti correlated). If the setting angles vary by 180º, the cones 'superpose', so both spin and direction will be in perfect correlation. If modulator *A* is reversed, the LOCAL finding at *A* is also reversed. The apparent effects of 'non-locality' are then reproduced but with no need for FTL signalling or 'action at a distance'. ***Because Alice's finding is reversed, Bob's can remain the same.*** The wave-function is then both 'collapsed' and recreated with a new spin axis by the field electron interaction. If a centre-of-mass propagation vector is conserved, polarisation and helical path are ellipticised.

Only 'time resolved pair' experiments have access to correct correlation data. 'Weak measurement' bulk correlations, developed from Bell's comments by Aharonov et al (1987)[9] and further evolved to be only statistical, are assigned on the basis that modulators do *not* change state vectors. *The a,b data is then incorrectly assigned and 'correlated*'. The nature of randomness maintains the *overall* 50:50 distribution, but weak measurement does not allow a sneak preview' of state so is 'blind' to the critical 'matched pair' information. If 'up' leads the way to Alice, and so 'down' leads towards Bob, if Alice then reverses her modulator setting angle, Alice's 'flips' NOT Bob's, so both Alice and Bob find *'down', not 'up'*, (correlation allocation and statistical analysis are also misdirected). The Aspect (1982) [10] and Weihs et al.[11] experiments used 'time resolved' particle pairs. Aspect reported a persistent problem attributed to his source being (not "*rotationally invariant*") and so discarded the majority of his raw data. A significant allowance was also made for 'accidental occurrences'. Raw data from Aspects thesis was compared (C Thompson 2000, Table 1 & Fig.)[12] against the 'corrected' data. Figure 2.a shows the resultant curves, showing a cosine distribution and suggesting the rotation was a valid polariser effect. Weihs et al. (including Zeilinger), were focussed on timing Alice's 'switchover' to rule out A,B communication. A similar rotation with voltage change from the electro-optic modulator was found, and similarly corrected for. Our model reproduces the raw data of both experiments, so removing the need for 'spookiness' by employing the simple provision of reversing the *a,b* finding of the *local* system (Alice) not the distant system (Bob).

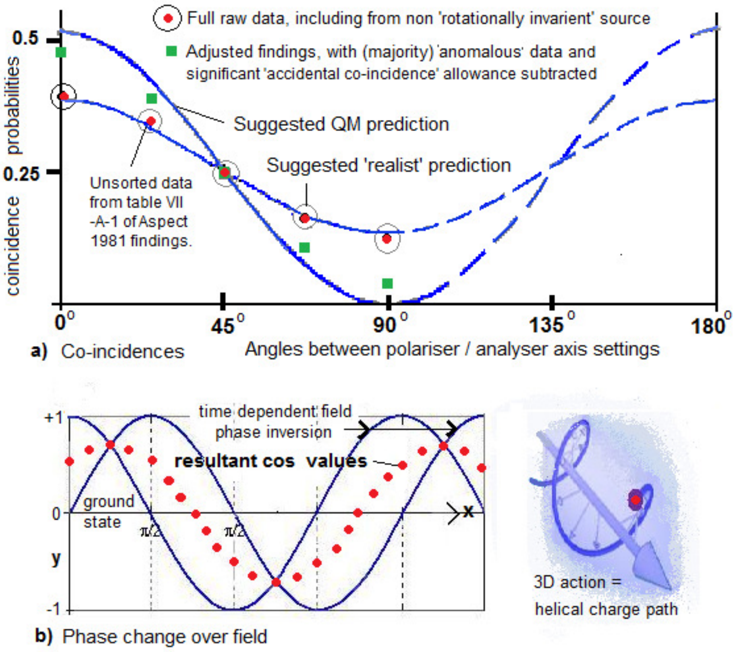


Figure 2: a) (top). Aspect 1981 experiment data plot. The majority of raw data shown by the red dots included anomalous 'rotations' of occurrences, attributed to source problems so discarded. The variation is consistent with 'preparation' rotating polarisation with setting angle. As the polariser is 'part of the system' we suggest that the raw data was correct and that the QM assumption of no effect from polarisers was to blame. From; C Thompson.[12]

b) (bottom) The cosine distribution of momentum transferred to each field electron on interaction would be converted by the QED field phase distribution to a cosine2 distribution at the photo-multipliers, giving the 'probability' distribution. In three dimensions; each helical wave-function path is ellipticised but not at the same space-time instant across the detector field. PJ

Jacques et al (2008)[13] considered relative 'distinguishability' (D) and 'visibility' (V) in Mach Zehnder type set-up which included a fast random switchable beam splitter. Changes of electro-optic modulator voltage serendipitously confirmed the inequality violation in terms of; $V^2 + D^2 \leq 1$ though the experiment was not strictly a non-local case. (See also Ma, Kofler, Zeilinger 2014. Fig. 18).[14] Part b of Fig. 2b shows the helical charge path and the consequences of time dependent interactions across the whole field, producing phase changes. Quantum electro-dynamics (QED) precisely gives a time dependent result by 'squaring the field', which produces the modified distribution shown, *equivalent to the square of the wave-function and the* cos^2 *probability amplitude distribution of QM*.

5. Basic Intermediate Cosine Distribution.

Occam's razor appears to be satisfied in terms of non-locality, but we must still reproduce the non-linear intermediate distribution (inequality violation) to complete the model. We return to the 'rings of latitude' on the sphere surface. We define measurement as 'exchange of angular momentum' and simplify the harmonic dispersion to consideration of the relative velocity at the tangent point where the exchange occurs. Now we add a final ingredient: A little recognised three dimensional effect of the cosine rule relates disc plane radius at any latitude to the *cosine of the angle to that latitude.* Surface angular velocity on the sphere *is proportional to 'disc plane' circumference at that latitude, which varies with angle to that latitude from the spin axis* (and inversely by the angle with the equatorial plane) *by 2cosπ of the angle, and is also proportional to the plane circumference 2π r.* Only one 'state' (N/S pole OR up/down spin) can be accurately measured at a time. At the equator the N/S information reduces to zero. At the poles the up/down information reduces to zero, a complementarity equivalent to QM's position/momentum relation. *The vector **pair** A,B now have a single **relative** angle and can be rotated as a unit on any axis, but the intervening surface always retains the complementary cosine surface momentum distributions.* (See Figure 3).

Both polariser and photomultiplier fields are considered as individual electron interactions. The underlying ellipticity of a helical path, so also harmonic coupling, is different in each (x,y,z) plane. The two photo-multipliers (*Pm*) of a standard set-up have opposite major field electron 'polar' axes. We propose that the likelihood of 'tripping' a *Pm* depends on charge absorption efficiency across *n* field electrons of similar polar orientation. The 'probability amplitude' of a detection event will then directly correspond to the *intensity* of the coupling potential across the field. The simplified two dimensional (2D) 'curve' representation of a 3D process and value distribution is then the square of the momentum transferred, (relative surface velocity distribution) or cosine values. Malus's Law; (Intensity (I) ∞ $\cos^2\theta$) is then directly derived because ***intensity is the square of amplitude*** (QED).

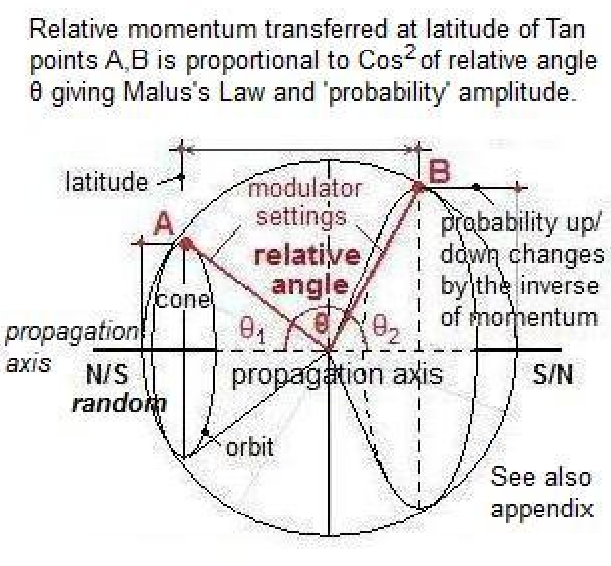


Figure 3: Bloch Cones. A,B are setting angles from the propagation/spin axis giving a 'relative' angle Θ to points of latitude. Surface velocity, and inversely an 'amplitude' of polarity, vary with latitude by the cosines of the angles with both the polar axis and equatorial plane. At any latitude circumference length dictates surface speed so also momentum and new state vectors. Spherical y, z axis freedom exists. (See discussion of ellipticity).

The Born Rule; squaring the wave-function to find the probability distribution has never been physically explained or derived. Our model suggests the wave-function, considered in 2D, is transformed to the real 3D form (a helix) by the Born rule. Underlying the rather subjective 'probability amplitude' description of the cos^2 2D curve is a 3D value distribution of the momentum transferred by harmonic resonant coupling for electron orientations *relative* to the photomultiplier, after the initial polariser 'state vector' modulation. Wave-function modulation may represent 'collapse', but some momentum bandwidth is conserved and re-emitted with a different 'wavefunction code' until finally 'absorbed' to obtain a 'measurement'. Contrary to the assumption of weak measurement we can then only 'sample' any one particle state once because 'measurement' and other interactions always modify state vectors. There is a subtle difference in the polariser and *Pm* detection interactions. The partner with greatest momentum dominates and will modulate the weaker state in each case. We employ the QED conventions of the particle states to extend the Bayesian cos data to 3D, spreading over the whole field as a causal wavefront until re-quantized and rotated locally by the dominant modulator state (the 'preparation'). Interaction Lagrangians at any point are *direct products of the square of the field* (= 'current density'). A strongly focussed or re-focussed signal and weaker magnetic field will result in the field electrons being modulated, not vice versa, as appears to be the case at the photomultiplier. The familiar effects of Raman atomic scattering, the rotation of optical axis away from causal wavefront normals, and birefringence during gradual absorption in a diffuse field (high 'extinction distance') emerge as fundamentally consistent.

Our mechanism extends the Cosine Law itself to classically violate the inequality predicted by QM. Underlying the simple model are 3D helical charge paths with longitudinal and transverse vectors. Any point on the surface of an expanding Schrödinger sphere may be assigned such a helical path. Polarity is reversible on interaction while maintaining x axis angular momentum, as in a spinning sphere. The higher order effects of the smaller scale spin of orbiting charges become significant in spin ½ cases such as electron/electron (/positron) interactions. Further hyperfine spin states would result if each charge is considered as a 'fractal' dipole in its own sample space. One candidate with such 'dark' motion is the Casimir force, varying inversely as the 4^{th} power of separation distance.

Considered along the propagation axis, the polarity may be circular or elliptical. It is the degree of ellipticity which varies non-linearly with the angle of the orbital plane of the helix and corresponds to transverse momentum amplitude. The major axis of ellipticity has full y,z axis freedoms, giving QM's 'spherical harmonics'. Recursive reducing 'curled up' higher order gauge uncertainties remain, consistent with the circumference of an ellipse (area πa,b) being an infinite recursive series. Dirac and Godel identified similar limits of mathematical approximation of nature's mechanisms. The Hestenes (1990)[15] 'Zitterbewegung' interpretation of QM showed that mathematical formalisms for relativistic physical geometries are possible. The formalism appears is valid for a helical orbiting charge description, but our recursive fractals retain the Dirac higher order terms Hestenes rejected.

The dynamic geometry at the heart of our model will be unfamiliar and will be best understood at a conceptual level, as follows: *The surface angular velocity at any point on the sphere is directly proportional to the cosine of the angle from the equatorial plane (sphere centre) to the latitude of the surface point.* The cosine itself is the distance to the 'disc' of latitude at that point, and also the relative angular velocity at that latitude. Two 'spheres' are involved in interactions, and so the transfer is relative. 'Intensity' is then directly proportional to the square of the amplitude or cosine value, which is also proportional to the *minor axis diameter* of the ellipticity produced at any angle on any axis to the disc, also proportional to the orbital velocity or momentum 'action' on that axis. Further, if the segment between the vector pair found at *A* and *B* within the Bloch sphere (see Fig.3) contains a 'crossing' of a pole or equator, that finding will be anti-correlated. If both vectors are within one 90^o 'zone', then one particle is 'flipped', and the findings will then *correlate*. If the angle between vectors is 90^o, the probability of flip/no flip of one of the opposing states is precisely 50%.

Random variable opposite states *a,b*, *(up/down)* 'distinguishability' (D) of approaching particles are reversible by A and B on arrival so also have *b,a,* states 'superposed'. Values are zero at the poles (0^o and 180^o) and vary inversely with *detectable* polarity ('P') which is zero at the equatorial plane; 90^o and 270^o. Independent *inverse distributions* are then required for inverse qualities D and P. For spin 1 pairs where A_1,B_1 are 'negative' (absolute settings within 90^o each side of zero), A_2,B_2 are 'positive' within 90^o each side of 180^o, the joint probabilities for *each* of D and P then appear to be;

$$p(A_1 B_1 | a,b, \lambda + b,a, \lambda) = p(A_2 B_2 | a,b, \lambda + b,a, \lambda) = p(A_1 B_2 | a,a, \lambda + b,b\ \lambda) = p(A_2 B_1 | a,a, \lambda + b,b\ \lambda) = 1$$

where λ represents the non-linear inverse 'complementary' sphere surface distributions at the selected angle, meeting the complementarity relation; $P^2 + D^2 \leq 1$. The fundamental source of complementarity may be identified as the inverse relationship of detectable polarity (derived from ellipticity of a helix) and momentum, derived from surface angular velocity at recursive gauges. The inverse relationship is represented by the sine and cosine curves on each axial plane. The more fundamental distribution curve emerges from the simple correspondence between the circles and helices of nature and the theoretical 'lines' typically used by man. Representing findings as interaction angles drawn as equal increments on a straight line contorts the natural distribution of equal increments around a circumference, round or elliptical, or a three dimensional ellipticised helical path with all axial freedoms.

6. Discussion

The dynamics we propose are not 100% deterministic, so are only 'quasi-causal' as proposed in principle by Gell-Mann and Hartle (1989) [16]. Hyperfine orbiting charge spins of spin ½ and non-integer spin particle adds higher order layers of complexity. Gluon orbital angular momentum is found to contribute significantly to proton spin state, resolving the 'spin crisis' (de Florian et al. 2014), [17] and electron states are similarly found multiply divisible (Wei et al 2014).[18] At smaller gauges we can only *assume* electrons are precisely identical. Chiral vortices are consistent with the Majorana fermion, recently confirmed (Nadj-Perge et al. 2014)[19] where each particle is its own anti-particle, which polarisation 'found' again subject only to observer orientation. The four component (twin handed pair) stacked Dirac spinor emerges in our spherical case, where any surface position (or charge) will describe a helical path in the orbiting frame. Rotations of the sphere y,z axis on interaction modulate the 3D wave-function and ellipticise helical paths. Orbiting dipoles and more complex spin states will describe twin and multiple helix charge paths. (See Appendix Fig 4). Our fundamental view of duality is the helix, whose full 180^o rotation from the polar axis in any plane gives the "*particulate*" conditions, but the orthogonal view is purely wavelike. Nothing seems to be entirely 'pointlike' in time beyond the notional frame centre-of-mass, defining re-emission velocity and suggesting speed 'c' is related to orbital period. Neither wave nor particle view reveals the full dynamic state. Superposing one state 'hides' the other. We also suggest that the 'half height' 0 ground state (see Fig 2.a) is an important concept to apply in general.

Causality is extended to imply convergence of the 'local influence' concepts within both classical and quantum descriptions, emergent from re-emitted states adopting local electron polarity and centre-of-mass rest frames. A convergence of quantum and relativistic descriptions is then implied consistent with the Special Relativity postulates (localising c) and the Lorentz Factor at electron densities near the optical breakdown plasma limit $\sim 10^{23}/cm^{-3}$. Implications are and will be discussed elsewhere.[20] Further investigation appears to be warranted. A precise time-resolved pair comparison experiment could falsify the model. Two competition finalist essays (Jackson a)2013/b)2014).[21] discuss 'discrete field' dynamics and report on a repeatable 'classroom' experiment using coloured circle segment subjective selection. The findings suggested a generalisable proof of concept.

7. Summary

We've shown that 'superposed states' are equivalent to the possession of both north AND south poles by all spinning bodies, and, orthogonally, both spin states (up/down) subject to orientation, in which case a shared spin and propagation axis reproduces the effects described as quantum entanglement. We invoke electron 'spin flip' on reversal of magnetic field direction and also absorption, rotation and re-emission of x axis momentum by field electrons. Polarisers do not then 'absorb' part of light but rotate it's polarity, proved by the Zeilinger's resolution of the '3 filter' case where inserting a 3rd (45^o) filter 'releases light blocked by two orthogonal filters; "*...light always has the polarisation state given by the last polariser and has no memory of it's earlier history.*" Re-emissions then reduce with the (minor axis of) *ellipticity on that axis*. In defining 'measurement' as angular momentum exchange 'relative' to the spin state of a detector field electron (as Bell), we have shown that the classical assumption of 'opposite' states even after modulator interaction is false. The same assumption is required for 'weak measurement' statistical correlation assignments. However, if Alice changes her setting at the last instant, then Bob's finding does NOT have to reverse because Alice's state (opposite at identical settings) is reversed. The apparent effects termed quantum 'non-locality' are thus locally derived.

The pairs shared coincident spin and propagation axes allow *A,B* setting angles to be related or entangled as cone angles of 'latitudinal discs' in a Bloch Sphere (from the original spin axis and also inversely from the equatorial plane). A pair of vectors from the sphere centre point may be obtained representing the *relative A,B* setting angles. *This fixed angle vector pair may be rotated anywhere around the sphere on any axis and there will always be a complementary Cos* 'Polarity/Direction' (P, D) *amplitude distribution between them.* (We embrace the concept "distinguishability" used by Jacques et al.[13], but applicable to *each* quality). The cosine law relates the angle to a latitude, the latitude circumference length 2πr is directly proportional to surface angular ('orbital') velocity, which gives the momentum at any tangent point at that latitude. Values at each individual A or B latitude are complementary, in which case values at and between the *A,B* vector pair are *also* complementary; ($P^2 + D^2 \leq 1$). Both polarity and direction vary in amplitude by the the cosine of the angle from the sphere centre, which is also the radial distance to the *plane* of the latitudinal disc *and* the angular or orbital or charge ***relative velocity.***

Our fundamental model of light is multiple oscillations at any point on a sphere surface with both longitudinal and lateral components. Ellipticised helical paths emerge. Dipole asymmetries would arise from any bodily rotation in the helical co-ordinates. Interaction is from the 'front' where the form is purely circular, so particulate. The radius at any point in spherical co-ordinates providing a latitudinal 'disc'. Viewing the disc at any angle from the disc plane gives an ellipse, the minor axis diameter of which is also equal to the cosine and orbital velocity. Modelled as spheres interacting in 3D as a representation of spherical coordinates and x,y,z axis helical ellipticity, the intermediate cosine^2 distribution of '*intensity as probability'* between relative setting angles predicted by QM is precisely reproduced as a QED 'field adjusted' coupling intensity distribution which directly derives Malus's Law; Intensity (I) $\infty \cos^2\theta$. We show that the model reproduces all raw experimental data including 'anomalous' and modulator rotations. Because the modulator is 'part of the system' the rotations directly resultant from setting angles can now, correctly, be included in the data analysis.

Classical 'real states' then do exist before measurement, but we can only extract limited information, and we may affect *which* information and its value by changing the configuration of measurement apparati. Such a 'local cause' finds common ground between the Bohr and Einstein views, as the Copenhagen interpretation IS the 'local variable'. We stress that the underlying geometrical derivation described is only a *representation* of spherical harmonics, and of the ellipticity of three dimensional helical dynamics. Absolute determinism is not demonstrated and higher order uncertainty is retained in recursive fractals, the 4^{th} order apparently equivalent to the Casimir scale. John Bell's theorem is not falsified, merely circumvented by using different assumptions. We identify that Bell anticipated such circumvention, both in concept and as a function of "fermion number density."[1] p.175. (see Appendix 2.)

7. Bibliography of implied and proposed revised interpretations of phenomena.

Measurement.	Exchange of angular momentum on physical interaction, where the input ('wave state vector') properties modified by the interaction are 'sampled', (if not re-emitted), providing dual output state vectors; Momentum and polarity, *both* with both magnitude and direction from surface velocity and a 'torsion', with the 'field' squared (QED).
Wave-function collapse.	Modulation or absorption of states such as wavelength, axis angle and the vector states identified below, including by polarising interactions.
Non-integer Spin.	The 'Hyperfine' quantum angular momentum (QAM) spin states of orbiting charges or dipoles, produce higher order and recursive fractal

quantum gauge 'curl' states of polarity or; 'angular momentum in the orbiting frame'. An SU(3) space rotation may still be considered as a half rotation in SU(2) space. Spinors may have additional components (as well as the right and left handed SU(2) sub-groups. Higher order uncertainty then remains under quasi-causality. (Equivalent to the circumference of an ellipse as an infinite series).

The Born Rule.	Squaring the 'wavefunction modulus' to transform a 2D wave to a 3D helical path of any 'point' or hyperfine charge on the surface of an expanding Schrödinger sphere. Both longitudinal and transverse wave components are then allowed, measurable as described below. Spatial and temporal coherence of phase shift from interactions requires the field to be squared to give measured intensity. (see Fig 2.b).
Superposition.	For polarity and spin as angular momenta; the possession by a body of four detectable vector states; Two polarities, and (orthogonally) two two equatorial directions ('up/down') relative to detector orientation. (the 4 stacked Dirac spinor). Only one state is detectable at one time
Entanglement.	The sharing by two bodies of a single axis of rotation or orbit which coincides with (anti-parallel) propagation directions. Separate random angles of interaction with this axis may then be assigned a 'relative' set angle pair in a spherical co-ordinate system. (See Figs 3 and 5).
Modulation/Polarisation.	Absorption and re-emission by an electron of the modulator magnetic field where the field magnitude is dominant. Re-emissions then adopt the field electron axis, centre-of-mass frame speed c, and polarity. Spin states and polarity may be ellipticised and/or reversed. Reversing the magnetic field direction reverses electron state vector ('spin flip').
Non-local state reduction.	An 'apparent' effect due to not allowing for local state reversal (both polarity and spin) due to reversal of modulator magnetic field vector.
Weak measurement.	Conceived as the possibility of 'pre-measurement' of a state before interaction without interference but not possible. (Bell. p15). Used for mass 'beam' experiment statistical analysis but without access to time resolved pairs so unable to accurately assign states for correlation due to 'spin flip' of modulator electrons flipping 're-emission' spin state.
Inequality violation.	The non-linear distribution of velocity across the surface of a spinning sphere (and inversely the detectable polarity) with constant change of angle (from sphere centre to latitude) between the equatorial plane and either pole. The distribution of momentum transferred by (interactive) measurement at any point (cos), multiplied 'by the field' (QED) to average out time dependent phase shifts, gives 'Intensity' ($\cos^2$) which is Malus' Law and is proportional to ellipticity of spherical harmonics.
Probability Amplitude.	Momentum exchanged due to relative angular momentum or velocity at the tangent point between a polarised body and a field electron, the field squared at any point gives current density and thus 'probability' of tripping the resonant photomultiplier as Quantum Electrodynamics.

Appendix 2.

Further relevant quotations from; '*Speakable and Unspeakable in Quantum Mechanics*'. J.S. Bell. (Collection). Cambridge University Press. 1987.

Preface. Discusses; "*Bohr's insight that the result of a 'measurement' does not in general reveal some pre-existing property of the 'system' but is a product of both 'system' and 'apparatus.*' p.viii.

Introduction. Discusses assumptions; "*We are interested only in the possibility of hidden variables in ordinary QM and will use freely all the usual notions.*" p.2.

Ch.18. 'Speakable and Unspeakable in quantum mechanics.' agreeing with Koestler's 'The Sleepwalkers' that progress on cosmology;*"is made in spite of the fundamental obscurity in quantum mechanics. Our theorists stride through that obscurity unimpeded… sleepwalking?"* p.170

"The founding fathers of quantum theory decided even that no concepts could possibly be found which could emit direct description of the quantum world. So the theory which they established aimed only to describe systematically the response of the apparatus." p.170.

"*...in my opinion the founding fathers were in fact wrong on this point. The quantum phenomena do not exclude a uniform description of micro and macro worlds…systems and apparatus*." p.171.

Ch.19. 'Beables for quantum field theory.' *"I think that conventional formulations of quantum theory, and of quantum field theory in particular, are unprofessionally vague and ambiguous. Professional theoretical physicists ought to be able to do better."* p.173.

"What is essential is to be able to define the position of things, including the positions of instrument pointers... In making precise the notion of position of things the energy density comes immediately to mind." (but) We would have to devise a new way of specifying a joint probability distribution. We fall back then on a second choice ***– fermion number density****." P.175*
"The lattice fermion numbers are the local beables of the theory." P.176

Ch.18; "*It may be that a real synthesis of quantum and relativity theories requires not just technical developments but* ***radical conceptual renewal****.*" p.172.

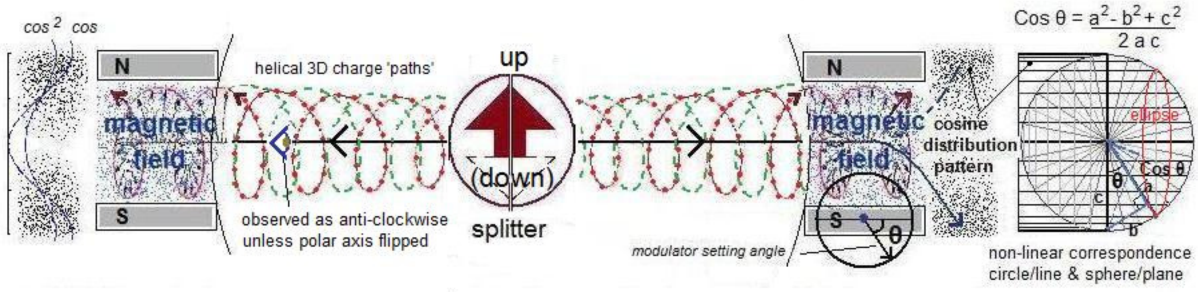
Ch.3. In stating his belief that his theorem must be effectively circumvented with some new approach; *"...the new way of seeing things will involve an* ***imaginative leap*** *that will astonish us. In any case it seems that the quantum mechanical description will be superseded."* p.27

Ch.20. 'Six possible worlds of QM'. *"...the 'Problem of Interpretation of QM' has been encircled. And the solution, invisible from the front,* ***may be seen from the back.****."* p.194.

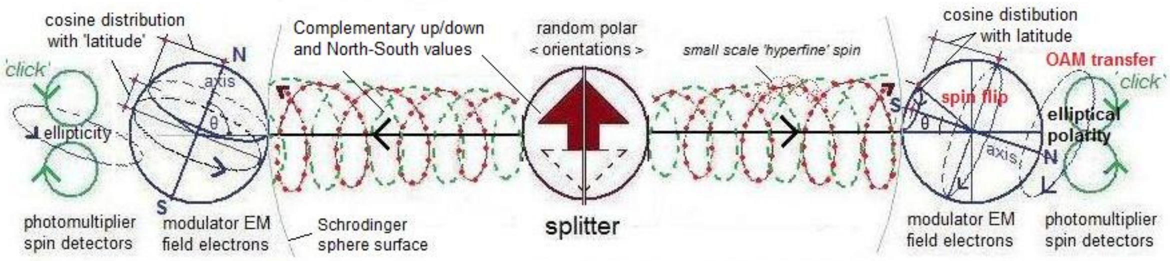
Ch.3. 'The moral aspect of quantum mechanics.'; (we) "*Assume that the immediate repetition of the measurement must give the same result.*" p.22. And;
"*...the plausible assumption that these relative probabilities would be the same if G were measured not simultaneously but immediately afterwards.*" p.22. (which we identify as a flawed assumption)

"*in our opinion lead inescapably to the conclusion that quantum mechanics is at the best, incomplete.*" p.26.

Appendix 3. Figures; 4 – 5.

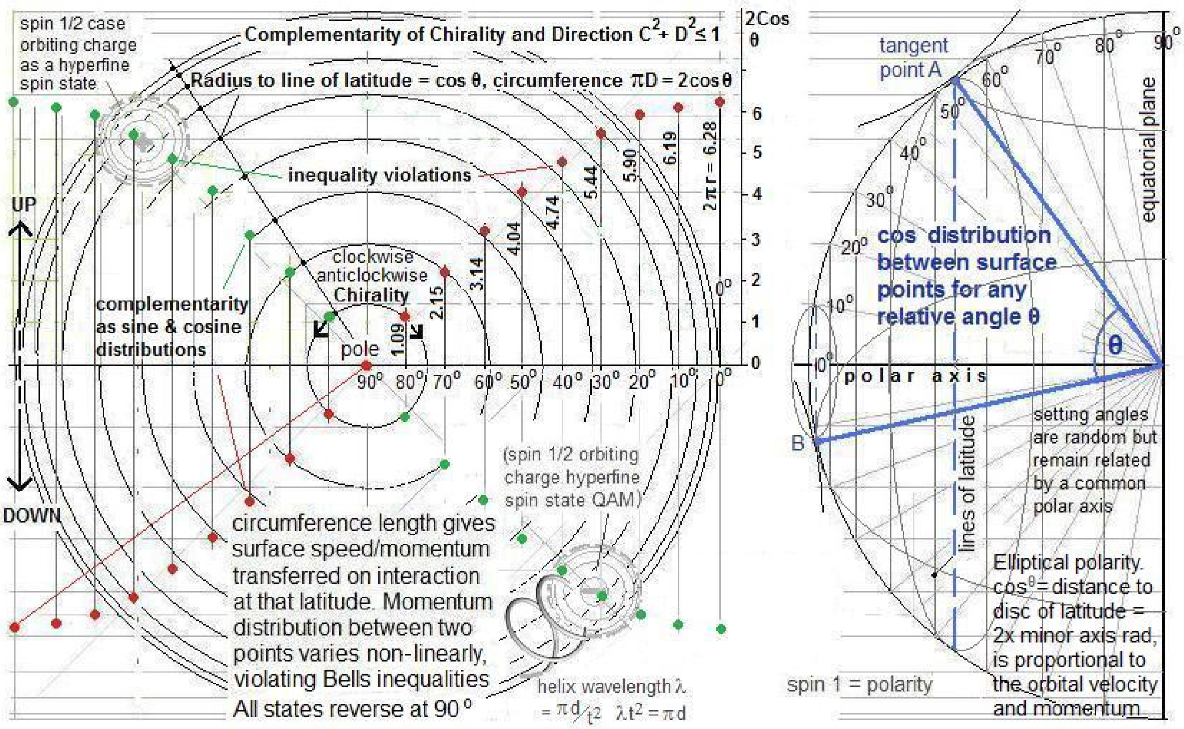


a) EPR-Bohm gedanken experiment with non-linear Schrodinger wavefunction expansion. Note the common axis of propagation and spin/polarity. Detector settings then modulate spin direction independently. The total distribution A,B is invarient to spin reversals



b) Typical experimental set up. Analysis using a common axis as 'entanglement'. Modulator field electron polarity 'flips' with field direction, flipping the re-emission polarity independently. Electron surface orbital velocity changes by the cosine of the angle between the propagation and setting axes (Tan point latitude between pole and equator). Ellipticity gives 'probability amplitude'.

Figure 4: EPR Bohm type experiments. Typical set up showing a quasi classical derivation of the predictions of Quantum Mechanics via 'spin flip' of filter/modulator field electron and also via ellipticity in 3 axes of a 3D helical wave form. PJ



Complementary Inequality Violations. Surface angular momentum and magnitude of Chiral torque. The non linear distributions represent momentum transferred at varying latitude of interaction point. The blue 'relative A,B setting angles' can rotate on any plane around a sphere as a fixed pair retaining the non linear distributions and state reversals between the surface 'interaction' points. PJ.

Figure 5: Non-Linear Distributions. Relative surface linear and rotational (pole) momentums at modulator and measurement interaction positions. Squaring the 'field' (QED) for phase distribution gives $\cos^2$ Note the relative A,B angles shown blue. PJ.

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