# On Quantum Mechanics: Does G-d Throw Dice? (1.0.0)

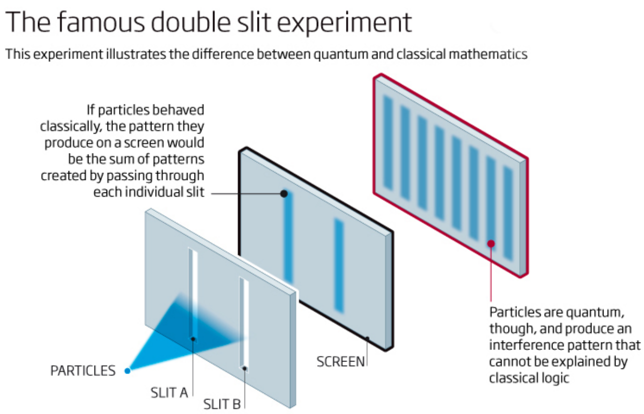
*Quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not really bring us any closer to the secret of the old one. I, at any rate, am convinced that He does not throw dice.*

*Albert Einstein.*

Einstein once expressed dissatisfaction with quantum mechanics, saying that it didn't take us any closer to the secret of the "old one", and that he didn't believe that the supreme being threw dice. Here we argue that traditional interpretations of quantum mechanics invoke a false picture of reality (a picture that takes us further away rather than closer to G-d), and that, just as the abstract brush strokes of a representational painting serve the purpose of creating an orderly image, any apparent randomness there is to the behaviour of objects in the quantum domain serves the purpose of creating overall order.

## Stephen Hawking and the 2-Slit Experiment

Stephen Hawking once reportedly suggested that there is a parallel universe in which ex-One Direction member Zayn Malik remains with band. As Stephen uses the term, a parallel universe is a universe in which life takes an alternative turn, in which you had porridge instead of eggs on toast for breakfast, or -in a more serious vein- in which the Germans won WW11. Some people have the view that there is a parallel universe for every possible alternative. How do we know these parallel universes exist? Not because they can be observed -they can't- but -from one point of view- because of the '2-slit experiment'. In this experiment, photons (particles of light) are shot particle by particle through two slits and their arrival is registered on a screen. If we measure -if a detector shines light on particles as they pass through the slits- we get a pattern indicating that light can be broken down into discrete element and that these elements pass through the slits like bullets passing through a pair of windows; but if we don't measure, we get a pattern indicating that light is a continuous entity and that it passes through the slits like water passing through a pair of sluice gates.

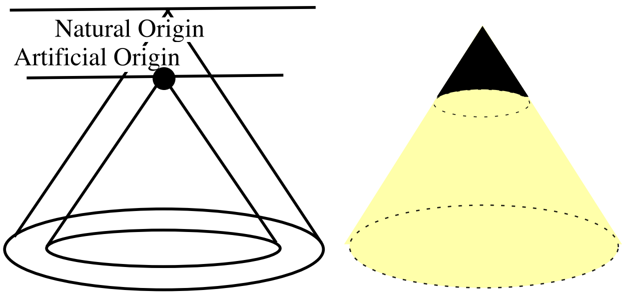



This second kind of a pattern is known as an 'interference pattern' and this is a series of dark/light bands: when the peak of one wave interferes with the trough of another they cancel (destructive interference) resulting in a dark band on the screen; and when the peaks of two waves interfere with each other they reinforce (constructive interference) resulting in a light band on the screen. This duality is common to all atomic and sub-atomic objects, and its peculiarity can be illustrated by an imaginary scenario known as the paradox of 'Schrodinger's Cat' after the physicist who devised it = cat in sealed chamber containing a piece of radioactive material that might or might not decay; if it decays, then a deadly poisonous gas is released into the chamber and the cat dies, if it does not decay then the cat lives. The results of the 2-slit experiment may seem to imply that until we open the chamber and check, or until some kind of measurement is made on the cat, then it exists in a contradictory state of "dead and alive". How can this be? One surprisingly popular answer is that there is one universe in which the cat dies and another in which it lives. The radioactive substance decays and the cat dies, because it was possible, and all possibilities are realized? But in *this* universe a strictly limited number of possibilities are realized, and the question of why the radioactive substance decays in this universe and the cat dies in *this* universe goes unanswered. Clearly something is wrong here - this is not an explanation so much as it is a *reductio ad absurdum* of a would-be explanation. I suggest we may set about trying to find a better explanation in a particular notion of a projective universe...

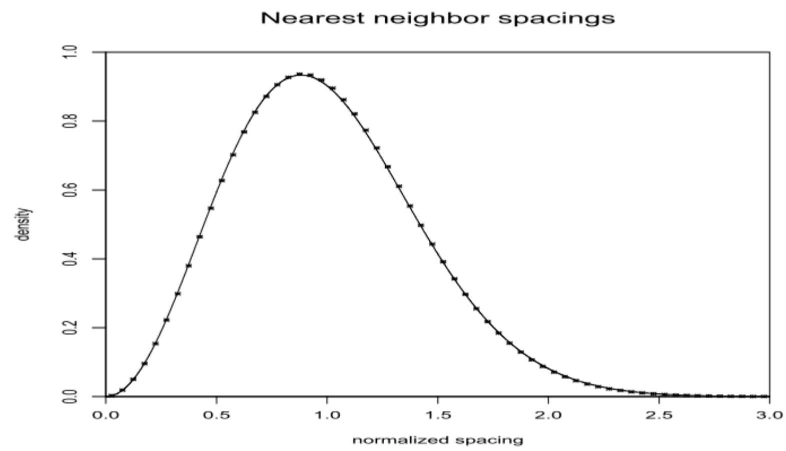
**The Projective Universe**
*Wolfram Mathworld* defines a projection in this way:

A projection is the transformation of points and lines in one plane onto another plane by connecting corresponding points on the two planes with parallel lines. This can be visualized as shining a (point) light source (located at infinity) through a translucent sheet of paper and making an image of whatever is drawn on it on a second sheet of paper.

But a "(point) light source" is the same thing as a zero-dimensional light source, which involves the infinite concentration and the zero diffusion of light. The problem with the *Wolfram Mathworld* definition of projection, and with every physical theory that relies on zero-dimensional point-sources, is that these involve an infinite concentration and zero diffusion of light. Kepler and Newton showed that the motions of heavenly bodies follow orbits resulting from the intersection of a cone by a plane, i.e, they showed that gravitational attraction can be understood in terms of the intersection of a cone by a plane... A *solution* to the problem then is that for every way of positioning the plane that allows for light to be diffused over space, a further point-source is required such that this is greater than zero-dimensional and involves therefore a finite quantity of concentrated light and a non-zero quantity of diffused light:




Note that nothing is to be done to the light, and thus that we have the idea of a universe which is created according to the ancient Hebraic tradition by the projection, not of light *per se*, but of space (the *Genesis* account of creation has puzzled many because it explicitly says that light comes before any materiel source of light). We can identify these differences with atoms: as the gap widens, the atom absorbs light, jumps to a lower higher level; and as the gap narrows, the atom emits light, jumps to a lower energy level. In particular, we can identify the gap with the *nucleus* of an atom, whose energy levels are known in some cases to be statistically identical to the imaginary parts of the non-trivial zeros of the zeta function:

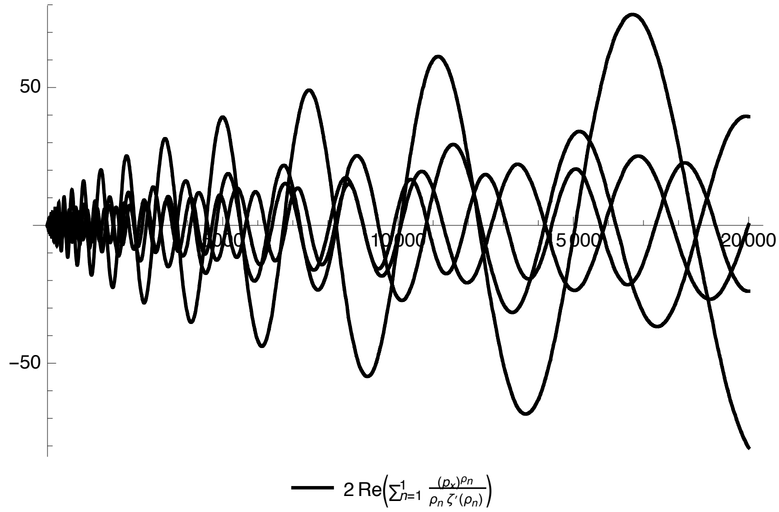


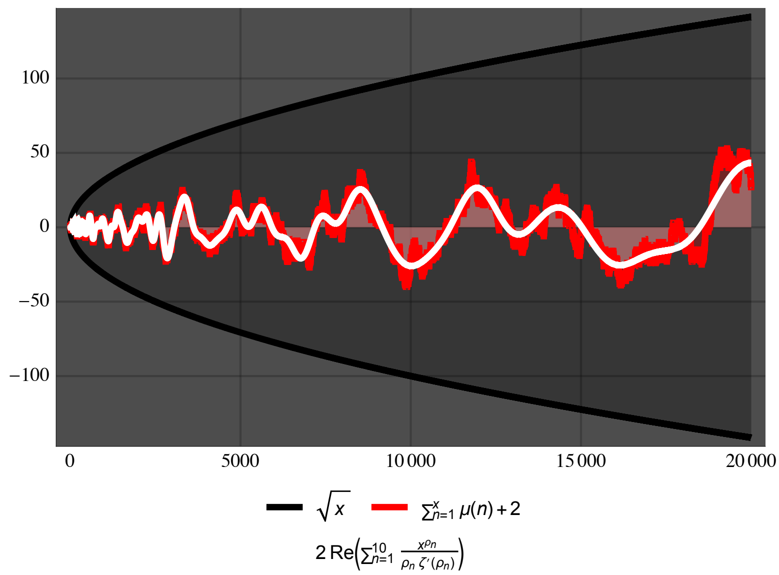

As the amount of light diffused into the projection increases, the amount of light concentrated by the projector deceases, and so we have two related but distinct sets of numbers, one set representing the projection, and one set representing the projector. These ideas can be given initial mathematical form by associating the creation operators

$b_n^\dagger$ and $f_n^\dagger$ to prime numbers $p_n$... Now we have identified the unique 'factorization' of a state into creation operators acting on the 'vacuum' with the unique factorization of an integer into prime numbers (and we have a hierarchy of states: |1> is the 'vacuum'; |2> and |3> and |5> are one-particle states; |6> is a two-particle state... and so on). By reference to the Witten index -the number of bosonic minus the number of fermionic zero-energy states- we see that the Mobius inversion function

$$\mu\, n = \{1 = n \text{ has an even number of distinct factors},\ -1 = n \text{ has an odd number of distinct factors}, 0 = n \text{ has a repeated factor}\}$$

is equivalent to the operator $(-1)^F$ that distinguishes bosonic from fermionic states, with $\mu(n) = 0$ when $n$ has a repeated factor being equivalent to the Pauli exclusion principle. If we re-express the Mertens function (which sums the 1s and -1s of the Mobius function) as $\sum_{n=1}^{p_x} \mu(n)$:




This wave depicts fluctuations that from a local perspective exist in a square root-bond balance of concentrated and diffused light. If a balance is within the bounds the Riemann Hypothesis imposes on arithmetically continuous phenomena, then the range of the diffused light is potentially infinite, but if it is *outside* of these bounds, then the range of the diffused light is finite. This is the distinction we need between a projector (which is strictly finite) and the projection (which is potentially infinite). To find the deep mathematics underlying this distinction, we first appeal to the notion of a circle of area 1. Then an energy source $E$ located at the center of this circle will posses the same strength from center to circumference for $E/1 = E$, which is the same thing as saying that there is no difference between center and circumference. If there is no such difference, then either the circle has no area and no radius (it is a point), or it has infinite area and an infinite radius (it is a line); if there is no such difference, then $E$ either has either infinite strength or no strength. These are the extremes of infinite light-concentration and infinite light-diffusion, and in reality the balance of concentration and diffusion always lies between them. By the $\pi$ r^2 formula, we know that a circle of area 1 has a radius of

$1/\sqrt{\pi}$ or 0.56419. $1/\sqrt{\pi}$ or 0.56419 ≈ $e^{-\gamma}$ or $\frac{1}{\sqrt{e^{2\gamma}}}$ or 0.561459, and since gamma is a limit (of the difference between the sum and the integral of the harmonic series)

$$\gamma = \lim_{x\to\infty}\left(\sum_{n=1}^{x}\frac{1}{n} - \int_1^x \frac{1}{n}\,dn\right)$$

a measure that is better able to capture the dynamism we seek that than $\pi$ is $e^{2\gamma}$ or 3.17222 rather than 3.14159. But gamma is the limit of a potentially infinite number of values, so instead of

$$\pi\sqrt{\frac{1}{\pi}}^{2} = 1$$

we may write

$$\lim_{x\to\infty} e^{2\gamma}\left(\sqrt{\frac{1}{e^{2\left(\sum_{n=1}^{x}\frac{1}{n}-\int_1^x\frac{1}{n}\,dn\right)}}}\right)^2 = 1$$

which can then be re-written as

$$\lim_{x\to\infty} e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}\left(\left(\frac{1}{\exp\left((s+1)\left(\sum_{n=1}^{x}\frac{1}{n^s}-\int_1^x\frac{1}{n^s}\,dn\right)\right)}\right)^{\frac{1}{s+1}}\right)^{s+1} = 1$$

This extended equation involves a significant division between $s = 1$ and real values of $s$ other than 1, for if and only if $s$ is a real number other than 1 does

$$\sum_{n=1}^{x}\frac{1}{n^s} - \int_1^x \frac{1}{n^s}\,dn$$

not reach the limit

$$e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}$$

We know this to be true, for otherwise there would be a value of $x$ such that

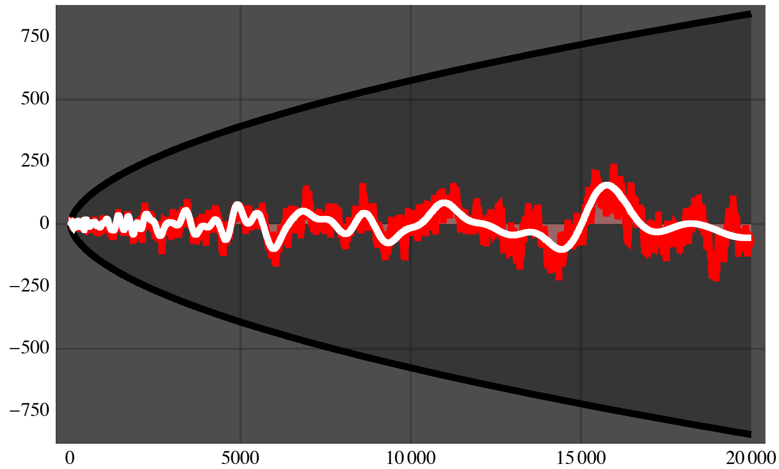
$$e^{2\gamma}\left(\sqrt{\frac{1}{e^{2\left(\sum_{n=1}^{x}\frac{1}{n}-\int_1^x\frac{1}{n}\,dn\right)}}}\right)^2 = 1$$

and a circle of area 1. If we examine the equation $e^{2\gamma}\left(\sqrt{\frac{1}{e^{2\gamma}}}\right)^2 = 1$, we see that it is an expression of the inverse square law, and concerns quantities that spread out rather than die off. The inverse square law comes from geometry alone, but the most well known examples of the inverse square law arise in physics - gravity and electromagnetism are governed by the inverse square law. These forces are to contrasted to the nuclear forces, because the former -and not the latter- are long-ranged. In its familiar form, the inverse square law tells us that as the radius of a circle grows arithmetically its area grows quadratically, meaning that a light arising from a projector located at the center of a circular area varies inversely as a square of the distance from that center. But if the units are units of area rather than units of distance, then we get an inverse square root law - as the radius of a circle grows arithmetically its area grows quadratically, but as the *area* of the circle grows arithmetically, its radius grows inverse quadratically.

in the case that $s = 1$, we find that if $s$ is a real number *other* than 1, then the ratio of the circumference of the circle changes, which changes the relationship between the concentration and diffusion, and we get a diffusion of light over a short-ranged. With this in mind, we can draw out the structure hidden inside $n$ firstly by re-expressing $\sum_{n=1}^{p_x}\mu(n) + 2$ as $\sum_{n=1}^{p_x}\mu\left(e^{2\gamma}\left(\sqrt{\frac{n}{e^{2\gamma}}}\right)^2\right) + 2$, and then re-arranging the latter as

$$e^{2\gamma}\sqrt{\frac{p_x}{e^{2\gamma}}}^{2} - \frac{\int_1^x a_1\,x\,H_x\,dn + \left(\int_1^x a_2\,x\,H_x\,dn + \int_1^x a_2\,x\log(x)\,dn\right) + \int_1^x a_1\,x\log(x)\,dn + \ldots}{n\,x}$$

Then for example




$e^{2\gamma}\sqrt{\frac{p_x}{e^{2\gamma}}}$

$e^{2\gamma}\sqrt{\frac{p_x}{e^{2\gamma}}}^{2} - \frac{\int_1^x x\, a_1 (\log(x)+\gamma)\, dn + \int_1^x x\, a_1 \log(x)\, dn + \left(\int_1^x x\, a_2 (\log(x)+\gamma)\, dn + \int_1^x x\, a_2 \log(x)\, dn\right)}{2x}$ $\quad 2\,\mathrm{Re}\left(\sum_{n=1}^{10} \frac{(p_x)^{\rho_n}}{\rho_n}\right)$

If we re-express $e^{2\gamma}$ as $e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}$, and consider that

$$e^{2\gamma}\left(\sqrt{\frac{1}{e^{2\gamma}}}\right)^2 = e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}\left(\left(\frac{1}{e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}}\right)^{\frac{1}{s+1}}\right)^{s+1}$$

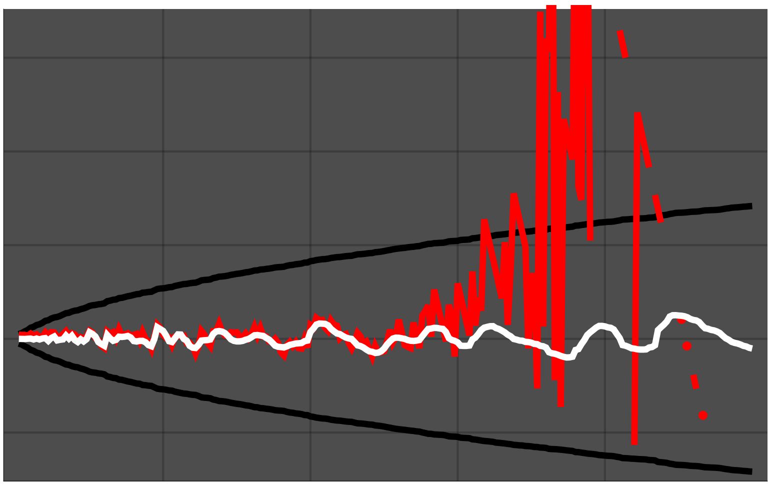
in the circumstance that $s = 1$, re-express

$$e^{2\gamma}\sqrt{\frac{p_x}{e^{2\gamma}}}$$

as

$$e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}\left(\left(\frac{p_x}{e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}}\right)^{1/s}\right)^s$$

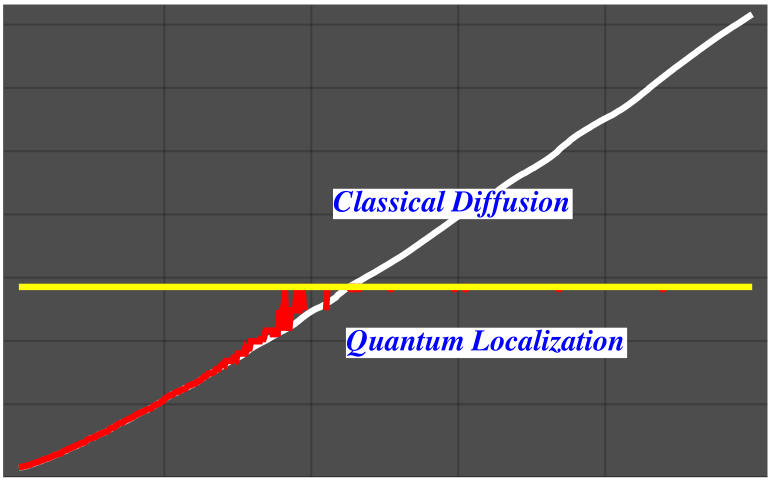
the we can note that if $s$ takes on any real (positive) value a value other than 1 -even if the change is as slight as $1 \to 1.000000000000000000001$- we upset the balance and we get a strictly finite amount of diffusion:



$e^{2\gamma}\sqrt{\frac{p_x}{e^{2\gamma}}}$

$\left(\frac{e^{2\gamma}\left(e^{-\left(\zeta(s)-\frac{1}{s-1}\right)}\right)^2}{e^{2\gamma}\left(e^{-\left(\zeta(s)-\frac{1}{s-1}\right)}\right)^2 - e^{2\gamma}\left(\exp\left(-\left(\sum_{n=1}^{p_x}\frac{1}{n^s} - \int_1^{p_x}\frac{1}{n^s}\,dn\right)\right)\right)^2}\right)^{1/s} - \frac{\int_1^x x\, a_1 (\log(x)+\gamma)\, dn + \int_1^x x\, a_1 \log(x)\, dn + \left(\int_1^x x\, a_2 (\log(x)+\gamma)\, dn + \int_1^x x\, a_2 \log(x)\, dn\right)}{2x}$ $\quad 2\,\mathrm{Re}\left(\sum_{n=1}^{10} \frac{(p_x)^{\rho_n}}{\rho_n}\right)$

We see that there is a critically small difference between $\sum_{n=1}^{x} \frac{1}{n^s} - \int_1^x \frac{1}{n^s}\, dn$ and $\zeta(s) - \frac{1}{s-1}$ such that diffusion gives way to localization (symbolized here as $\hbar$):




$$\frac{\int_1^x x\, a_1\,(\log(x)+\gamma)\, dn + \int_1^x x\, a_1 \log(x)\, dn + \left(\int_1^x x\, a_2\,(\log(x)+\gamma)\, dn + \int_1^x x\, a_2 \log(x)\, dn\right)}{2\,x} + 2\,\mathrm{Re}\left(\sum_{n=1}^{10} \frac{(p_x)^{\rho_n}}{\rho_n}\right)$$

— (red) $$\left(\frac{e^{2\gamma}\left(e^{-\left(\zeta(s)-\frac{1}{s-1}\right)}\right)^2}{e^{2\gamma}\left(e^{-\left(\zeta(s)-\frac{1}{s-1}\right)}\right)^2 - e^{2\gamma}\left(\exp\left(-\left(\sum_{n=1}^{p_x}\frac{1}{n^s} - \int_1^{p_x}\frac{1}{n^s}\, dn\right)\right)\right)^2}\right)^{1/s}$$

— (yellow) $$\left(\frac{e^{2\gamma}\left(e^{-\left(\zeta(s)-\frac{1}{s-1}\right)}\right)^2}{\hbar}\right)^{1/s}$$

But in the same way that the finite matrices below are aspects of the potentially infinite matrices, superpositions associated to values of $s$ other than 1 are aspects of superpositions of associated to s = 1:

$$1 = e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}\left(\left(\frac{1}{e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}}\right)^{\frac{1}{s+1}}\right)^{s+1}$$

$$0 = e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}\left(\left(\frac{1}{e^{(s+1)\left(\zeta(s)-\frac{1}{s-1}\right)}}\right)^{\frac{1}{s+1}}\right)^{s+1} - e^{(+1)\left(\zeta(s)-\frac{1}{s-1}\right)}\left(\left(\frac{1}{\exp\left((s+1)\left(\sum_{n=1}^{x}\frac{1}{n^s} - \int_1^x \frac{1}{n^s}\, dn\right)\right)}\right)^{\frac{1}{s+1}}\right)^{s+1}$$

$$\begin{pmatrix} 0 & -1 & -1 & -1 & \ldots & -1 \\ 1 & 0 & -1 & -1 & \ldots & -1 \\ 1 & 1 & 0 & -1 & \ldots & -1 \\ 1 & 1 & 1 & 0 & \ldots & -1 \\ \vdots & \vdots & \vdots & \vdots & \ddots & -1 \\ 1 & 1 & 1 & 1 & 1 & \hbar \end{pmatrix}$$

$$\begin{pmatrix} -0 & 1 & 1 & 1 & \ldots & 1 \\ -1 & -0 & 1 & 1 & \ldots & 1 \\ -1 & -1 & -0 & 1 & \ldots & 1 \\ -1 & -1 & -1 & -0 & \ldots & 1 \\ \vdots & \vdots & \vdots & \vdots & \ddots & 1 \\ -1 & -1 & -1 & -1 & -1 & \hbar \end{pmatrix}$$

$$1 = e^{2\gamma}\sqrt{\frac{1}{e^{2\gamma}}}^{\,2}$$

$$0 = e^{2\gamma}\sqrt{\frac{1}{e^{2\gamma}}}^{\,2} - e^{2\gamma}\left(\sqrt{\frac{1}{e^{2\left(\sum_{n=1}^{x}\frac{1}{n} - \int_1^x \frac{1}{n}\, dn\right)}}}\right)^2$$

$$\begin{pmatrix} 0 & -1 & -1 & -1 & -1 & \ldots \\ 1 & 0 & -1 & -1 & -1 & \ldots \\ 1 & 1 & 0 & -1 & -1 & \ldots \\ 1 & 1 & 1 & 0 & -1 & \ldots \\ 1 & 1 & 1 & 1 & 0 & \ldots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

$$\begin{pmatrix} -0 & 1 & 1 & 1 & 1 & \cdots \\ -1 & -0 & 1 & 1 & 1 & \cdots \\ -1 & -1 & -0 & 1 & 1 & \cdots \\ -1 & -1 & -1 & -0 & 1 & \cdots \\ -1 & -1 & -1 & -1 & -0 & \cdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

**The Pre-Established Harmony Interpretation of Quantum Mechanics**

The Many Worlds interpretation of QM we know, and we can reject it because is doesn't really explain anything. The well-known "Copenhagen Interpretation" says that a quantum-states are observer-dependent (the tree falling in the forest doesn't make a sound if there is no ear to hear it), and this suggests that the same might also be true of the classical world. We can reject this interpretation also because it doesn't anchor to a reference-world that is absolute - as Bertrand Russell once observed, it is false that everything is relative because in that case there would nothing for anything to be relative to. From the mathematics above, the misconception underlying the Many Worlds and the Copenhagen and other interpretations of QM is that quantum systems are the building blocks of classical systems in the same sense in which bricks are the building blocks of brick walls, which implies that a classical system (a brick wall) is merely a scaled up version of quantum systems (bricks). They are atomistic interpretations of the phenomena due to the atomistic nature of physics since the ancient Greeks. But from the mathematics above atomism is false: if you follow a classical system back in time as far as possible, you will not come to a quantum brick or to a small pile of quantum bricks, but to a maximally energy-dense classical system that appeared at the moment of creation in an instant (this maximally energy-dense state can be associated with the smallest prime (2)

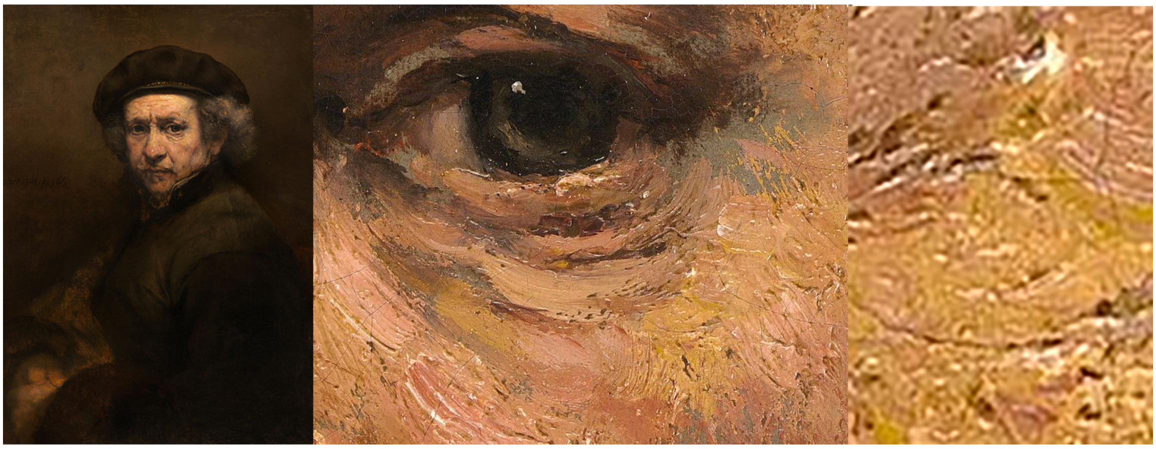
$$\begin{pmatrix} 0 & -1 & -1 & \cdots \\ 1 & 0 & -1 & \cdots \\ 1 & 1 & 0 & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

and the smallest non-trivial zero (0.5 +14.1347 $i$)

$$\begin{pmatrix} 0 & -1 & \cdots & -1 \\ 1 & 0 & \cdots & -1 \\ \vdots & \vdots & \ddots & -1 \\ 1 & 1 & 1 & \hbar \end{pmatrix}$$

which respectively mark the maximum amount of light concentrated in a projection and the minimum amount of light diffused by a projector. As indicated, an alternative picture can be formed by using the notions of projection and projector. In the light of this picture, physics has been based on an category mistake that equivocates between the projection (classical) and the projector (non-classical): projected classical domains arise from a particular balance of concentrated light and diffused light ($s = 1$), whereas the non-classical domains of the projectors involve imbalances in favour of concentrated light ($s \neq 1$ ). More particularly, the projectors (artificial point sources) produce continuous balances of light and space in the form of projections - *more* particularly, they produce spiral-waves associated to the non-trivial zeros of L-functions- but are themselves light-dominant. *All* balances are superpositions, projections are associated to symmetric superpositions, and projectors to asymmetric superpositions; no projector or combination thereof can possibly produce an infinite amount of diffused light -an infinite projection- because there can be no such thing as an infinite amount of diffused light, and so this sets up the need for the collapsing of asymmetric superpositions: whenever an asymmetric superposition can produce no further diffused light and further a symmetric superposition, it collapses to make room for a further asymmetric superposition. The primes ($s = 1$) are the atomic projections, and the zeros of L-functions ($s > 1$ are the atomic projectors... In a sense there are Many Worlds in which Schrodinger's Cat exists, and in a sense Schrodinger's Cat is as the Copenhagen Interpretation proposes subjective, because there are infinite perspectives (each associated to an L-function) in which Schrodinger's Cat exists. But these worlds are not contradictory (at all times in these worlds the cat is either dead or alive, and not, both), and they are all tied to an objective real world on account of the relationship between non-canonical L-functions whose starting prime-density is sub-maximal, and the reference L-function, the Riemann zeta function. If the radioactive substance in the tale of Schrodinger's Cat decays, then the cat dies, and if it doesn't decay the cat lives, and until a measurement is made the state of this particle is in a superposition, but this doesn't imply that until a measurement is made the cat is dead and alive at the same time

Why not? Because the inconsistency of the quantum system in which particles are in one state and another at the same time is not inherited by the consistent classical system in which the cat is either dead or alive (but not both) any more than the non-representational nature of the brush strokes that make up a portrait by Rembrandt is inherited by the painting as a whole:



Furthering the painting analogy, there is an ideal distance between the painting and the viewer, and there are distances such that a representational image disappears because the viewer is too close or too far from the painting. If the viewer is too close, then he or she will see seemingly haphazard brush strokes, but these brush strokes combine to create a coherent image. If the viewer goes extremely close -if they use a microscope- then they will see individual paint particles. As it is with the painting, so it is it is with the world: the painting was painted, and the world was created, specifically to be seen, and so brush strokes and quantum states combine to create coherent paintings and predictable classical states. And while there is undoubted randomness in the world, this randomness is strictly constrained by mathematical limits and precisely calculated to produce an orderly classical whole. To the eye of an ant crawling on the surface of a painting the artist has apparently distributed the paint in a haphazard way on the canvas, but these brush strokes are painted in such a way that the canvas is coherent to the eye of the man who surveys it from an appropriate distance. “Quantum mechanics”, wrote Einstein in a letter to said Bohr, “is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not really bring us any closer to the secret of the old one. I, at any rate, am convinced that He does not throw dice.” Stephen Hawking’s response was

*So Einstein was wrong when he said, “God does not play dice.” Consideration of black holes suggests, not only that God does play dice, but that he sometimes confuses us by throwing them where they can’t be seen.*

To the narrow mind, G-d plays dice at the non-classical level of atoms and black holes, but in the same way that the ant doesn’t see the image of a man in a Rembrandt self-portrait when it crawls on the surface of the canvas, the narrow mind doesn’t realise when it surveys the universe that the cosmic dice are deliberately rolled in such a way that the end result is something entirely orderly. Order it can, be said, emerges out of chaos, not in the sense that the chaos is rearranged or has order imposed on it, but in the sense that the chaos interacts with chaos in a purposefully calculated manner to bring about order.

**REFERENCES**

Borne, I (1971), *The Born-Einstein Letters*

Dirichlet, P (1837), *Beweis des Satzes, dass jede unbegrenzte arithmetische Progression, deren erstes Glied und Differenz ganze Zahlen ohne gemeinschaftlichen Factor sind, unendlich viele Primzahlen enthält" (Proof of the theorem that every unbounded arithmetic progression, whose first term and common difference are integers without common factors, contains infinitely many prime numbers)*

Everett, H (1957), *Theory of the Universal Wave Function*

Hawking, S and Penrose, R (1996), *The Nature of Time and Space*

Riemann, G (1859), *Über die Anzahl der Primzahlen unter einer gegebenen Grösse (On the Number of Primes Less Than a Given Magnitude)*

Schrodinger, S (1935), *Die gegenwärtige Situation in der Quantenmechanik (The present situation in quantum mechanics)*

Spector, D (1990), *Supersymmetry and the Möbius inversion function*