A Simple Explanation of the Quantum Doctrine

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Abstract

Quantum Mechanics is explained in simple terms, with its contradictions highlighted.

1.- Introduction

There is a microscopic universe of atoms, molecules, photons, electrons, and other particles. The story began in classical Greece and continues to this day. Presently, and after decades of discussion, Quantum Mechanics holds the position of officially recognized physical doctrine that scientifically deals with the microworld.

However the most prominent founding fathers of Quantism, including Max Planck, Albert Einstein, Louis De Broglie and Erwin Schrödinger, considered that QM was incomplete, maintained an active criticism of QM, and died with their boots on. Their criticism was never satisfactorily answered, as attested by the many articles and books that to this date keep trying.

The contemporary scientific authorities on the microworld have solid scientific reputations based in their contributions to the enhancement of QM. Their ascent in science occurred thanks to their work in developing quantum ideas. And these authorities may refuse to look at papers that strongly disagree with their doctrine. Dissenters are quarantined behind walls and doors of indifference, occasionally with derision.

To disseminate a particularly promising alternative to QM the group "Postquantum Deterministic Physics" was created in Facebook. If we can give to the smart, educated, non-specialized public a good explanation of Quantism and its difficulties, hopefully better than provided by Quantists, followed by a clear description of our proposed deterministic theory, then the closed doors will have to open.

2.- Science changes

Long ago, when Alexandria was a Greek city, many wise men, most or all of them firm believers in the Geocentric doctrine, were busy calculating epicycles to predict with some accuracy the paths of planets in the sky. There is no question that they were among the most intelligent men of their times.

But epicycles were too complicated, Geocentrism was replaced by Heliocentrism, and a better understanding of the Universe arose. In particular, the position of man within the immensity was better appreciated, preparing the way for a full Renascence. Still later Geocentrism was perfected with the Laws of Kepler. Then Galileo acted as a high enough stepping stone for Newton, and Modern Civilization arose. These historical processes have been the subject of uncountable monographs, articles, books and educational movies.

Quantism is to electrons, as epicycles were to planets. It works partially, explanations can be concocted, hypothesis about the microworld can be elaborated to hide contradictions. But Quantum Mechanics remains unsatisfactory because it requires too many departures from common sense and lacks the coherence expected from the grand ideas of science.

[1]Due thanks to Renato Iraldi for clever corrections. Remaining inaccuracies are exclusively mine.

3.- The hydrogen atom

Quantism has matter waves, represented by wave functions which are their mathematical expressions. And then Quantism tells us that these matter waves are just probabilities, as if primordial matter disappeared into clouds of numbers. To these ideas Einstein replied "God does not play dice".

To be very specific in what follows a *chunk of matter*, or *matter wave* or their representative *wave function*, refers to *smallest known portion of negatively charged matter*, commonly called *electron*. We will talk here about a single electron trapped by a *proton*, forming together a *hydrogen atom*, without influences or interferences from external electric and magnetic fields.

4.- The electron quantum dance

In Physics movement is often called *evolution*. Thus, the answer to "How Earth evolves around the Sun?" is "Earth evolves following an elliptic path around the Sun". This is one of Kepler laws, and is also consequence of the Three Laws of Newton, together with his Law of Universal Gravitation.

Asking "How, according to Quantism, do the negative chunks of matter move?" for us will be "How, according to Quantism, do *electrons evolve* when trapped in hydrogen". The answer is that the electron evolves *according to Schrödinger Quantum Law of Evolution*.

Is it possible to explain in simple language how, according to Schrödinger evolution, the electron evolves? Yes, it is. The electron, according to Quantism, either *remains completely quiet* or, if given a push, becomes *animated* and *trembles endlessly* as a bewitched piece of jelly. This is a simple minded but essentially correct description of the electron evolution, when considered as a quantum state governed by Schrödinger evolution.

Representing quantum physical states with wave functions Ψ implies a "phase redundancy". A physical state actually corresponds with the *Hilbert ray* $[\Psi]$ determined by the wave function. Strictly speaking the dichotomous condition of being *stationary* or *animated* applies to the *Hilbert ray representation* of the quantum state.

Then, in technical parlance and according to quantum evolution, *the electron* is either *stationary* or is *animated* with an endless *periodic* or *quasi-periodic* movement. These movements, postulated by Quantism and supposedly performed by electrons, are the origin of the quantum difficulties. The energies of the stationary states are the *stationary energies*.

"Bewitching" and "jelly" have been used metaphorically, but our *criticism of QM is technical* and can be stated saying, and proving, that the Schrödinger evolution equation *contradicts* the actual behavior of electrons.

The merit of QM has been to proclaim, and *convince the civilized world*, that the quantum contradictions are a *new mode of existence* of material objects at the level of microscopic particles. This was possible because QM is endowed with a correct procedure to calculate the energies of the stationary states, but next to this feat the quantum evolution law is a total failure. The *right stationary energies*, an *almost right stationary states*, a *completely wrong law of movement* and the *ad hoc probabilistic quantum jumps* are the four horsemen of quantum confusion.

In uninhibited technical terms, QM fails because it postulates states $[\Psi]$ that belong to a

complex projective space $PE^{\mathbb{C}}$ of wave functions and oddly ignores the precious *canonically conjugate variables* $\Phi \in T^*PE^{\mathbb{C}}$ that lie in the cotangent manifold. In fact, imaginary numbers play no role and the correct space of states turns out to be T^*PE, the cotangent manifold, of the projective space, of the vector space of real valued wave functions.

If the quantum state is pushed away from stillness *just a little*, it receives a *small amount of energy* and discreetly, but permanently, quivers. Under a *strong push* a *large quantity of energy* is supplied and the jelly quivering becomes ceaseless horror shuddering. The movement under Schrödinger evolution stops only if some process carefully restores the electron to one of its stationary states.

It is like the grim curse punishing Karen in Hans Christian Andersen story "The Red Shoes". If the stillness of the trapped quantum-like electron is perturbed it begins a dance that cannot be detained. In the quantum model this incapacity to stop is the otherwise benevolent *Law of Conservation of Energy*. For quantum electrons Schrödinger law is a malediction.

Summing up, according to the mistaken Schrödinger quantum evolution law the electron, while trapped in hydrogen, can remain *motionless*, still, stationary, like a lead soldier standing guard. Or can be *animated*, endlessly dancing, suffering like Karen the energetic torture of eternal movement.

5.- Electron rebellion

The quantum theoretical electron dance is particularly worrying because, as proved *by experiment* perfomed on *physical electrons*, mad dancing is not what electrons do. If an initially stationary electron is offered an amount of energy insufficient to exactly reach a new stationary state, the electron *rejects* the offer and *remains* in its initial state, or falls down to a stationary state of lower energy. That is why spectral lines and Spectroscopy exist.

Physical electrons perturbed away from a stationary state *do not conserve* the added energy but are *always radiating* and *will continue radiating* until a *new stationary state* is reached. In physical reality an animated electrons trapped in hydrogen and remaining animated do not exist. The experimentally verified facts *contradict* the hypothetical energy conservative dancing dictated by Schrödinger evolution equation.

On one hand the quantum theoretical evolution is handicapped with a curse of restlessness. On the other hand physical experiments tell that the fairy tale of unstoppable dancing is not happening in the real world. Then the fathers of radical Quantism *decided* and *relentlessly preached* that the Schrödinger bewitched evolution law is *physically correct* and must stay. Why? Any modern physical theory needs an evolution equation, and no other law of movement was available. To break their own spell Quantists invoked an external, strange, demoniac probabilistic intervention.

6.- Quantum jumps

Quantism postulated that certain probabilities exist of an intervention that converts states perturbed from stillness into new stationary states, accompanied by the emission or absorption, as the case may be, of a photon. The intervention was called *quantum jump*.

Confronted with such weird, unnatural hypothesis Schrödinger, certainly a visionary but a rational one, said: "Had I known about this *damned quantum jumping*, I would never have messed with the subject". The original German phrase *diese verdammte Quantenspringerei* became a landmark.

It is certainly hard to believe that new stationary states can be reached by pure chance, without the guidance of a wise and purposeful hand. Ideally this should be the hand of a *differential equation* that knows exactly where to go. Instead, Quantists tell that it is the hand of blind luck. To further elaborate our discussion we now look at energies of photons, and then of hydrogen trapped electrons.

7.- Energy of photons

At the beginning of the 20th century Spectroscopy was a well grounded branch of Physics. James Clerk Maxwell and Heinrich Hertz had discovered the electromagnetic spectrum, establishing that *light* is an *electromagnetic wave* with constant speed c, *wavelength* L and *frequency* ν, related by $L = c/\nu$. The wave is composed of successive individual *cycles* each of these having *length* L. Trains are to electromagnetic waves as individual wagons are to cycles. The waves transport energy *spread among the cycles*.

The year 1901 Planck found that, for certain electromagnetic waves within a cavity, there is a *fixed proportionality* between the energy E of *each cycle* and the *frequency* ν. He calculated the value of the proportionality constant as $h = 6.62 \cdot 10^{-34}$ J $\cdot$ s $= 4.13 \cdot 10^{-15}$ eV $\cdot$ s, now called *Planck constant*. The *Planck relation* for the energy of a cycle is $E = h\nu$ or equivalently $E = hc/L$.

In 1905 Einstein introduced the idea of a *smallest* possible portion of light and called it *photon*. He then stated that photons carry *energy* and that, although they are very small objects (in general much smaller than a full train of waves within a cavity), nevertheless can be individually assigned an *energy* E, a *frequency* ν and a *wavelength* L.

Einstein also proposed that for *photons* their energy, frequency and wavelength *obey Planck relation* earlier applied to electromagnetic waves within a cavity. When dealing with individual photons the expressions $E = h\nu$ and $E = hc/L$ are called *Planck-Einstein relations*.

Using contemporary language, and in conflict with Maxwell equations, the *photons* physically behave like *three dimensional electromagnetic solitons* that travel in space under a still unknown evolution equation.

Note that, if considered as a soliton, the physical *wavelength* of a photon is simply its *longitudinal size* (along the travel direction). On the other hand the *frequency* may not correspond with any oscillatory physical process internal to the photon and should then be considered as a formal definition $\nu = c/L$, *adopted* from traditional Maxwellian wave trains.

8.- Hydrogen energy range

Each electron state, either *stationary* or *animated*, has a well defined amount of energy. As the electron state evolves under Schrödinger evolution its energy remains always the same. But the energy of the electron must *decrease* if photons are *radiated*, and must *increase* if photons are *absorbed*. It was deduced from the experimental study of spectral lines that the possible energies for an electron trapped by a proton are in a range that starts at a minimum of 0 and reaches a topmost value of 13.6 eV, called *Rydberg constant* and denoted Ry. Thus Ry = 13.6 eV.

Energy is always *relative*, like height or depth. The relevant facts, when dealing with energy, are not so much the values themselves but the *differences of the energies* between the various

states. If we are careful enough instead of the range 0 to Ry we can *add any constant*, say -3.1416, and use the range -3.1416 to $-3.1416+\text{Ry}$. It was found that *for electrons bound in hydrogen* the most convenient *range* is obtained subtracting the value Ry so that the energies lie in the *continuum of values* comprised in the range *from* $-\text{Ry}$ *to* 0.

If hydrogen is conceived as a well where the electron is trapped, the *well bottom* is at energy level $-\text{Ry}$ and the *well top* is at energy level zero. Thus the range is a *full continuum* between $-\text{Ry}$ and 0, which are values available to the bound electron states, whether stationary or animated.

9.- Discrete spectrum

From spectroscopic studies, and from the Planck-Einstein formula relating photon wavelengths to energies, a *remarkable fact* was obtained. The *stationary energies*, defined above as the energies of the *motionless electron states*, are extremely particular. They are not arbitrary values in the continuum range but only the following *very special* energy values are *stationary*: -Ry , -Ry/4, -Ry/9, -Ry/16, -Ry/25, and so on. This sequence is called, in contrast with the continuum range, the *discrete spectrum* of hydrogen.

Thus, *only* the negatives of *Rydberg constant divided by the square of an integer*, $-\text{Ry}/n^2$, can be *stationary energy values*. This was remarkable and strange. Why in the Nature should this be so? Nobody knew.

10.- Hydrogen models

There was a time when scientists compared electron in atoms to plums in a pudding. This was the *Thompson model*. Then the idea arose in 1913, inspired by the heliocentric Solar System of Kepler, that electrons were little points moving in circles around the atomic nucleus. This was *Bohr model*, already endowed with energies $-\text{Ry}/n^2$ and mysterious quantum jumps. Several additional atomic models were created, but all were eventually abandoned and are now considered *obsolete*.

To this day only *Schrödinger model* survives. This is the model claimed by Quantum Mechanics, based on wave functions, *structured around Schrödinger operator* $H^{\mathbb{C}}$ (see below), and patched with probabilities plus "diese verdammte Quantenspringerei", always under the *skeptical sight* of our much admired quantum-reluctant hero Edwin Schrödinger.

11.- Debut of the orbitals

The electron shapes are beyond human view. We can admire sculptures in art galleries or enjoy ballet at the theater, but the electron is too small for our eyes to see. Several decades ago, and recently again, some scientists claimed to have observed orbitals, or rather to have taken their pictures, but the issue remains *controversial*. Anyway, and visible or not, the electron shapes fall into two mutually exclusive types: They are either stationary or eternally animated.

It was said before, in informal language, that the electron is the "smallest known chunk of negatively charged matter". The term "chunk" has connotations of arbitrariness, irregularity or disorder. It is *not* the case of the *stationary electron shapes*. They exhibit astonishing combinations of form and symmetry suggestive of a completely new aesthetic of Nature. For a glimpse Google images with "hydrogen orbitals" or go to Wikipedia

The colorful figures that are usually exhibited in Internet as stationary electron states do not represent the wave functions of Schrödinger list themselves, but are the pictures of their *orbitals*, which are the *normalized squared modulus* of the wave functions.

If electron shapes are invisible, how can we speak about they being symmetric or appreciate any aesthetic in their shapes? Imagine the surprise in 1926 when Erwin Schrödinger calculated an *exhaustive list of motionless electron shapes*. To accomplish this feat he invented the physically miraculous Schrödinger energy operator, or Schrödinger Hamiltonian, whose hieroglyphic formula is $H^{\mathbb{C}} = -(h^2/8\pi^2\mu)\nabla^2 + V$.

The operator involves wave functions, second order partial derivatives, Coulomb electrostatic potential, reduced mass of hydrogen, linearity, orthogonality, spherical harmonics, and Laguerre polynomials, at least. It requires considerable physical background just to arrive at a *reasonable heuristics* for $H^{\mathbb{C}}$.

12.- Schrödinger list

Associated to $H^{\mathbb{C}}$ there is a so called *eigenvalue problem*, which Schrödinger solved. The solution to the eigenvalue problem consists of a *sequence of numbers* and a *list of wave functions*.

The sequence of numbers turned out to be exactly the *sequence of stationary electron energies* already known from spectroscopy. And the list of wave functions consisted of fabled, dream-like, physically invisible *stationary electron shapes*, since then visualizable by means of their mathematical formulas. For each stationary energy value $-\mathrm{Ry}/n^2$ there are in Schrödinger list exactly n^2 wave functions having that energy and constituting the *n-th partial list*. Schrödinger results and their initial consequences were later supported and confirmed by many additional studies and experimental facts.

Since they are stationary, the wave functions in Schrödinger list are safe from the curse of Schrödinger evolution and are spared the fate laid on beautiful little Karen. Any theory alternative to Quantism *must assimilate* Schrödinger list.

13.- Schrödinger list is exhaustive

The Schrödinger list cannot explicitly include all the motionless states (these constitute "multidimensional manifolds"). But the list is *exhaustive for stationary states* in the following sense: "Any *motionless wave function* which (necessarily) has energy equal to one of the stationary discrete values $-\mathrm{Ry}/n^2$, can be uniquely expressed as an *averaged superposition* of the n^2 wave functions appearing in the n-th partial list".

In mathematical terms, the "wave functions that appear in Schrödinger list with energies $-\mathrm{Ry}/n^2$ are a *basis* of the *eigenspace* of the *eigenvalue* $-\mathrm{Ry}/n^2$".

Allowing several stationary energies Schrödinger list is *exhaustive for all electron states* as *all* the electron shapes can be mathematically obtained from the list: "Any *wave function*, stationary or animated, having any energy in the continuum range, can be uniquely expressed as an *averaged superposition* of stationary wave functions belonging to the full Schrödinger list".

Formally expressed, "the full list is *linearly independent* and spans a *dense linear subspace* of $L^2(\mathbb{R}^3;\mathbb{C})$".

If we consider *arbitrary non-stationary quantum states* the nice symmetries of the stationary shapes no longer exists. If adequate superpositions are made capricious shapes, beyond the most feverish imagination, can be permanently animated with the trembling of Schrödinger evolution.

14.- The quantum evolution equation

In the 1926 work (a four chapter saga) where Schrödinger presented his operator, the sequence of stationary energies and the list of stationary wave functions, he also postulated what we call *quantum law of evolution*, mathematically expressed as $\partial\Psi/\partial t = (-i/\hbar)H^{\mathbb{C}}(\Psi)$.

This is the equation responsible for the electron hypothetical ceaseless dancing mentioned in section 4 and is therefore the *source* of all the *quantum contradictions* that Schrödinger himself duly denounced.

To the best of our knowledge Schrödinger never questioned the physical validity of his evolution equation. But he dedicated efforts to highlight, and did express firm opposition against, the *misconceptions* of Quantum Fundamentalism.

Recall here that quantum states are Hilbert rays $[\Psi]$. The evolution of a wave function Ψ is expressed in symbols as $U_t(\Psi)$. Then the *evolution* of the *Hilbert ray* $[\Psi]$ is given as $[U_t(\Psi)]$.

In a typical quantum scenario the quantum state $[\Psi]$ is a perturbation of the excited stationary quantum state $[\Psi_m]$ and while the energy conservative quantum evolution $[U_t(\Psi)]$ takes place there is a probability equal to $|\langle U_t(\Psi), \Psi_k\rangle|^2$ (somehow normalized) for the occurrence of a *quantum jump* that lands in the stationary quantum state $[\Psi_k]$ with energy $-\lambda_k$. The jump is accompanied by the emission of a photon having energy $\lambda_k - \lambda_m$. This is the *probabilistic patch* to the inefficiencies of the quantum evolution equation.

15.- Quantum mirages

The bottom line is that *Schrödinger quantum evolution* and *quantum jumps* obviously *contradict* each other and constitute a most dangerous inconsistency. To make the paradoxes palatable an extensive *quantum ideology* was *developed* by the Quantists or sometimes *adapted* from the arguments of outstanding critics. They are various principles, concepts and flights of fancy, several already enshrined as great scientific truths, including the following:

Wave-Particle Duality	Principle of Complementarity	Principle of Correspondence
Principle of Uncertainty	Principle of Indeterminacy	Breakdown of causality
Breakdown of continuity	Breakdown of determinism	Virtual particles
Creation operators	Destruction operators	Quantum wave reduction
Entanglement	Observer roles	Measurement theories
Schrödinger cat	Local energy violation	Multiverses
Probabilistic jumps	Statistical interpretation	Probabilistic interpretation
Hidden variables impossible	Pauli matrices	Quantum spin

Their role is to remedy the deficiencies of the quantum evolution and to appease the doubts and worries of all parties, quantum radicals and their opposites. They exists only because Quantism postulates a *mistaken evolution equation* over an *inadequate space of states*. With the correct evolution equation and space of states the quantum ideology can be disposed. For example, quantum spin gives way to classical rotations.

16.- The quantum model

The quantum hydrogen atom, understood as a dynamical system on a smooth manifold, uses the following *basic ingredients*:

Complex valued wave functions	$\Psi : \mathbb{R}^3 \to \mathbb{C}$
Normalized squared modulus	$\|\Psi\|^2/\|\Psi\|^2$
Complex Hilbert space	$E^{\mathbb{C}} = L^2(\mathbb{R}^3; \mathbb{C})$
Schrödinger operator	$H^{\mathbb{C}} : E^{\mathbb{C}} \to E^{\mathbb{C}}$
Eigenvalues	Λ_n
Eigenspaces	$E^{\mathbb{C}}_n$
Schrödinger evolution equation	$\partial\Psi/\partial t = (-i/h)H^{\mathbb{C}}(\Psi)$
Quantum linear unitary flow	$U_t = \exp((-i/h)H^{\mathbb{C}}\, t) : E^{\mathbb{C}} \to E^{\mathbb{C}}$
Hilbert rays	$[\Psi]$
Associated complex projective space	$PE^{\mathbb{C}}$
Associated projective eigenspaces	$PE^{\mathbb{C}}_n$
Quantum energy function	$e_{H^{\mathbb{C}}}(\Psi) = \langle H^{\mathbb{C}}(\Psi), \Psi\rangle/\langle\Psi, \Psi\rangle : PE^{\mathbb{C}} \to \mathbb{R}$
Critical manifolds of $e_{H^{\mathbb{C}}}$	$PE^{\mathbb{C}}_n$
Energy conservation by the flow	$e_{H^{\mathbb{C}}}([U_t]([\Psi])) = e_{H^{\mathbb{C}}}([\Psi])$
Tangent manifold	$TPE^{\mathbb{C}}$ of $PE^{\mathbb{C}}$
Symplectic structure	$T^*PE^{\mathbb{C}} \to TPE^{\mathbb{C}}$
Hamiltonian vector field	$X_{e_{H^{\mathbb{C}}}} : PE^{\mathbb{C}} \to TPE^{\mathbb{C}}$
Hamiltonian flow	$[U_t] : PE^{\mathbb{C}} \to PE^{\mathbb{C}}$

Of the eighteen, three suffice to define the energy observable and the dynamical structure: *Space of states* $PE^{\mathbb{C}}$; *energy function* $e_{H^{\mathbb{C}}}$; and *Hamiltonian vector field* $X_{e_{H^{\mathbb{C}}}}$. To obtain a model capable of handling electron transitions in hydrogen the quantum *probabilistic jumps* are additionally invoked. Otherwise the physical electron transitions remain unaccounted. Note that the probabilistic interpretation of wave functions is optional since it plays no role, but it can be included for adornment.

17.- The natural model

The *natural model* of hydrogen is a *deterministic alternative* to Quantism. Several papers on this topic are available in this page. See also the article *I Do Understand Quantum Mechanics* available at our Facebook group.

The restoration of certainty, causality, determinism, continuity and other important classical principles should soon attract the attention of the younger members of the Physics establishment. A *reexamination* of QM will then occur and Quantism will be replaced.

Most cordially,
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Oteyeva
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