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A Possible Angular Quantization as a Complement to the Conventional Radial Quantization in the Hydrogen Atom and Aqueous Systems

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Abstract: In this work we propose, apparently for the first time, a possible *angular* quantization as a complement for the conventional *radial* quantization with the intent of initiating quantitative studies regarding the capability of liquid water to acquire and propagate information. We articulate the proposed angular quantization via the absorption of thermal energy by the hydrogen atom in the ground state at absolute zero degree temperature prior to the transition to the first excited state. We extend the proposed angular quantization to the hydrogen and water molecules; and conclude that if our model of angular quantization is confirmed, the liquid state of water has the capability of acquiring and propagating a truly vast quantity of information, explaining demonstrated chemo-analogous biological effects apart from chemical exposure.

Keywords: Hydrogen Atom, Quantization, Energy Absorption, Aqueous System, Information

1. Experimental Relevance

This work represents a first step towards the specific explanation of informational effects upon biological systems mediated through aqueous systems as defined through the rigorous formalism of hadronic mechanics. As is well known, quantum chemistry, although a laudable and accurate theory, is unable to usefully describe aqueous dynamics beyond clear limitations.

> "Recall that quantum chemistry was unable to achieve an exact and invariant representation of the main characteristics of the water molecule from unadulterated first principles despite efforts over the past century. In fact, a historical 2% has been missing in the representation of the water binding energy, while the representation of its electric and magnetic moments was embarrassingly wrong even in the signs." (Santilli 2005, p. 142).

Naturally, any proposed new formalism which aims to describe a complex system from first principles must begin with the most abundant component piece of the aqueous assembly: the hydrogen atom. In this way the many experimental effects we have demonstrated (Norman et al. 2016; Norman and Dunning-Davies, 2017) upon biological morphology and proliferation through chemo-molecularly derived biologically efficacious *information alone apart from molecular exposure of cells and tissues* can be explained and tested. Why have we been able to demonstrate in many experiments, that encoded *information alone* once mediated through aqueous systems affects diseases such as MRSA and the morphology of cancerous cells, in a way similar to the source drug or agent molecule from which the information was derived? This formalism will begin to explain at a causal level how the aqueous system holds information thereby affecting biological outcomes by way of hadronic mechanics and the resultant chemistry of the magnecular model (Santilli, 2001, 2005, 2017; Norman and Dunning-Davies, 2017).

2. Theory

In this note, we hope to initiate quantitative studies regarding the capacity of liquid water to acquire and propagate a great variety of information at large distances, as is made evident by sharks which sense blood and prey at such distances as to exclude, in our opinion, a sensible quantitative interpretation solely via dilution, which would indicate in some species, sensitivity of scent distinction of one part in ten billion, or one drop in an Olympic-size swimming pool (web ref. [11, 12]).

Our study is based on the principles of quantum mechanics according to which the energy absorption by the hydrogen atom cannot be continuous and, therefore, must be discrete.

To begin, we consider the ground state of the hydrogen atom at absolute zero degree temperature. We assume in first approximation that such a ground state is entirely contained in a plane, thus ignoring fluctuations due to the uncertainty principle and other contributions because of expected second order effects.

The conventional quantization of the hydrogen atom shall be called hereon *radial quantization,* (and be denoted with the superfix "*r*") to indicate its emphasis on a toroidal distribution of quantized orbits as per the magnecular model.

We will study the absorption by the hydrogen atom of thermal energy (e.g., due to infrared waves) in cases where energetic quanta are assumed to be *smaller* than the energy needed for the transition from the ground state to the first excited state.

Our main assumption is that, in order to verify quantum mechanics, the indicated absorption cannot be continuous. Consequently, the said absorption is here assumed, apparently for the first time, to be quantized. Alternative views would imply either deviations from quantum mechanics or the inability by the hydrogen atom to absorb heat.

Since, by assumption, the absorbed energy does not allow the transition to the first excited state, the most plausible transition of the hydrogen atom is that from the planar distribution to a distribution in three dimensions, thus implying the appearance of an *angular component* in the shape of the electron orbits.

The quantization of the absorbed thermal energy by the hydrogen atom when insufficient for the transition to an excited state is hereon called *angular quantization* (and denoted with the superfix "*a*") to indicate its emphasis on angular distributions over the plane of the ground state at 0^o *K*.

The next issue is the identification of the *shape* of the orbit of the electron for the indicated energy absorption. As the considered excitation cannot lead to the first excited state, since the electron orbit is expected to remain near that of the ground state, and since the excited orbit under consideration cannot be radial to avoid violation of quantum mechanics, the most plausible shape is that of a *toroid distribution* much along the lines of that introduced in (Santilli, 2001) at the emergence of the new chemical species of magnecules.

The next issue is the shape of the electron orbit inside the indicated toroid. Since the said trajectory cannot be radial for the reason indicated above, the most plausible trajectory in angular quantization is that of a helix entirely contained in the indicated toroids, as illustrated in Figure 1.

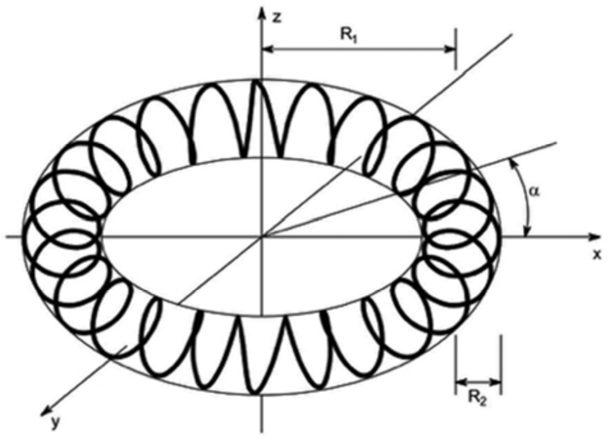

Figure 1. *Above.*

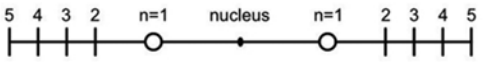

FIG. 2A

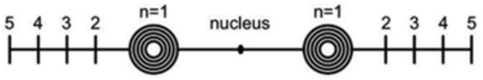

FIG. 2B

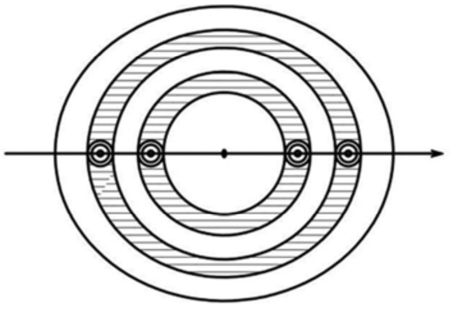

FIG. 2C

Figure 2. *Above.*

In order to appraise the plausibility of orbital quantization, we believe that the first quantitative treatment should be done in the simplest possible, semi-classical Bohr approximation, and then pass to full treatments in first and second quantization.

Therefore, we consider the wavelength of the electron of the hydrogen atom for the ground state and the first excited state in the Bohr approximation

$$\lambda_1^r = 2\pi r_1 = 6.28b, \lambda_2^r = \pi r_2 = 12.57b. \qquad (1)$$

with related difference

$$\Delta\lambda^r = \lambda_2^r - \lambda_1^r = 6.29\ b \qquad (2)$$

where b = 0.053 × 10−8 cm is the well known Bohr radius.

The thermal energy absorption here considered should verify the condition

$$\Delta\lambda^a \leq 6.29\ b. \qquad (3)$$

We consider now the corresponding (negative) values of the energy

$$E_1^r = 1.36\ eV,\ E_2^r = {}^{1.36}/_{2^2}\ eV = 0.34eV \qquad (4)$$

Consequently, the thermal energy absorbed by the hydrogen atom E^a here under consideration is restricted by the condition

$$E^a \leq 1.02\ eV. \qquad (5)$$

We consider now the quantization of the helical trajectory of the electron inside the toroid as illustrated in Figure 1. As one can see, the said trajectory is characterized by two lengths: r_1, which is the original radius of the ground state; and r_2, which is the radius of the toroid; plus the number of turns p of the helix in the said toroid.

The quantization connected to r_1 is conventional and, therefore, it is indicated with the traditional quantum number $n = 1,2,3,...$; the quantization connected to r_2 will be indicated with the new quantum number $m = 1,2,3,...$; finally, the number of turns cannot be fractional for stability, thus constituting a third quantum number $p = 1,2,3,....$

Therefore, the wavelength created by thermal energy λ^a has the following functional dependence

$$\lambda^a = \lambda^a(r_1, r_2, n, m, p) \qquad (6)$$

under conditions (3) and (5).

By keeping in mind the limitations of our model that are unavoidable for first studies, the following ideas are important. In order to initiate a quantitative treatment, we approximate the toroidal helix of Figure 1 with a cylindrical helix with length $2\pi r_1$, cross-sectional area with radius r_2 and the same number of turns p, in which case the length of the helix and, therefore, the wavelength electron in orbital quantization, is given by the known expression

$$\lambda^a_{n=m=p=1} = \sqrt{(2\pi r_1/np)^2 + (2\pi r_2 p/m)^2} \qquad (7)$$

where one recognizes the conventional quantization for radius r_1, and two new quantizations - that for the radius r_2 and that for the turns.

The first important implication of our model is the introduction, apparently for the first time since the initiation of studies on the hydrogen atom, of a basically new quantization that is geometrically based on the angle α of Figure 1, although mathematically treated through the radius r_2.

It should be stressed that representation (7) is only an *approximation* of the expected full angular quantization of the electron trajectory inside the toroid which is currently under study. In fact, expression (7) is a mere "linearization" of the toroid. However, to be valid, the said linearization should occur for the helix in the toroid without solution of continuity, that is, without beginning and end. The verification of the latter condition is done via the condition that the number of turns p be positive integers.

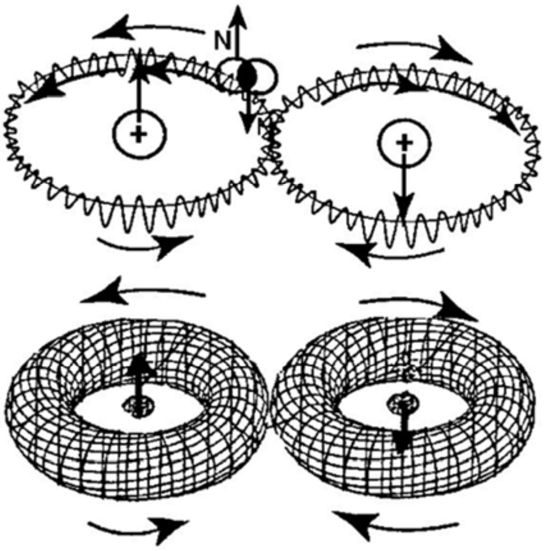

Figure 3. *Above.*

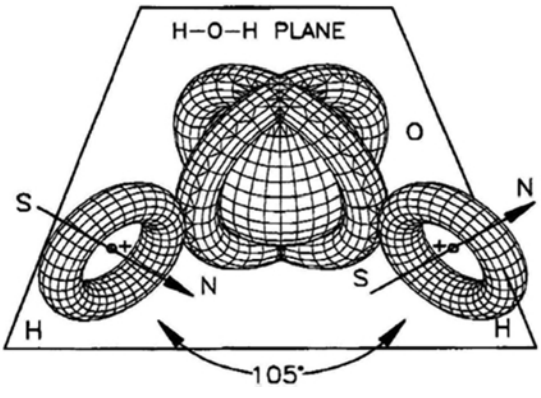

Figure 4. *Above.*

The following comments are in order:

1. When the radius of the toroid is null, $r_2 = 0$ (in which case $p = 1$), the absorption of thermal energy is null, and Eq. (7) recovers Bohr's quantization uniquely and identically,

$$\lambda^a \equiv \lambda^r = 2\pi r_2/n \qquad (8)$$

as a result of which our model can be considered as being a "completion" of the Bohr model with quantized angular contributions.

2. The smallest possible quantized absorption of thermal energy by the ground state occurs for $n = m = p = 1$, with wavelength

$$\lambda^a_{n=m=p=1} = \sqrt{(2\pi r_1)^2 + (2\pi r_2)^2} \tag{9}$$

namely, the wavelength is given by Bohr's wavelength for the ground state plus a correction term.

3. When the absorbed thermal energy is that with the equality in value (5), there is the transition to Bohr's first excited state with no toroids. The same occurs for subsequent excited states.
4. It is evident that, for large values of the quantum numbers n, m at constant p, the absorption of thermal energy tends to zero, and so does the associated wavelength

$$Lim\lambda^a_{n,m\to\infty} = 0 \tag{10}$$

By keeping in mind the limitations of our model that are unavoidable for first studies, the following comments are in order also:

i. In addition to the right and left degrees of freedom of the helix for a given n, there exists a large number of values of m and p verifying conditions (3) and (5), as necessitated for reasons indicated below. This occurrence is conceptually illustrated in the sectional view of Part B of Figure 2 with several concentric toroids associated with the ground state without encompassing the first excited state.

ii. Until now we have considered the absorption of thermal energy (e.g., due to infrared waves) by the *structure* of the hydrogen atom. In addition, we have the thermal energy due to collisions, which causes known rotations of the hydrogen atom conceptually illustrated in part C of Figure 2. The latter absorption occurs for *the hydrogen atom as a whole* and, as such, cannot be quantized.

iii. The application of a sufficiently strong external magnetic field to the hydrogen atom (such as that caused by a high current DC discharge in a hydrogen gas) eliminates the rotation, therefore exposing the quantized toroids of the new species of magnecules (Santilli, 2001) as experimentally confirmed by Day and Yang et al (Day, 2004; Yang et al. 2013, 2013*a*). A second important implication of our model presented in this note for the first time, is that the toroidal distributions at the foundation of the new chemical species of magnecules have a quantized structure in full agreement with quantum mechanics.

Needless to say, in order to allow, in due time, experimental verifications, the proposed angular quantization must be extended to the hydrogen molecule. For this purpose, we adopt the *Santilli-Shillady isochemical model of the hydrogen molecule* (Santilli, 2001) which is based on an actual *attractive force* between the identical valence electrons in singlet couplings; that attractive force being of sufficient strength to bond the electron pair into a quasiparticle called *isoelectronium.*

With reference to Figure 3, the application of our angular quantization to the hydrogen molecule is then given by the extension of the initial helical trajectory of one single electron (Figure 1) to the helical expression of two bonded electrons represented in the isoelectronium in the oo-shaped toroid of Figure 3. Therefore, the extension of our model to the isoelectronium of the hydrogen molecule appears indeed to allow the extension of the angular quantization from the hydrogen atom to the hydrogen molecule.

Verification and other issues:

The experimental verification of the proposed angular quantization is rather difficult because it requires:

1) the use of hydrogen at absolute zero degree temperature;

2) the irradiation of such a liquid state with infrared radiation with energy insufficient to cause the transition to the first excited state;

and

3) the accurate measurement of the temperature increase of the liquid. The possible detection of a discrete increase of temperature would then confirm our angular quantization.

A number of additional experiments based on spectral emissions is conceivable but would require detailed specific studies beyond the introductory level of this note.

However, second order demonstration and partial confirmation of the model is possible. In (Chen et al., 2017) (pp. 3-4) we read: "At water-water distances of R < 1 nm, water molecules experience changes in their orientational distribution on the order of 10° to 20° per molecule." It is possible to encode a 7Hz carrier frequency modulated at 3 KHz (Norman et al. 2016; Norman and Dunning-Davies, 2017) with the information associated with salt water. Perturbations of the collective H bond network causing ionic signature angular variance can be predicted. One would compare demonstrated angular perturbations of the pure water aqueous system exposed to the carrier frequency with no encoding, to that with encoding. We can predict the effect of the encoded information will be to create a similar perturbation in angular orientational distributions as that demonstrated by exposure to a chemical ionic constituent. If we apply the mathematics of our model and do indeed gain increased perturbation effects and improved biological informational response with predicted alterations in encoding methodologies, we may at least partially confirm the factual utility of the model from those second order effects. If so, we may also then speculate those long range perturbations, perhaps in the context of extended coherence implied via the Schumann fundamental (roughly analogous to our carrier frequency), might account for the shark's ability to sense blood and prey at extreme distance (web ref. [11, 12]), and demonstrate informational capacity in water.

In order to flesh out preliminary considerations on the possible application of angular quantization to the liquid state of water, we consider the conventional knowledge of the water molecule depicted in Figure 4, see e.g., (Eisenberg and Kauznann, 1969) in which the two hydrogen atoms do not have a spherical distribution, but their electrons are distributed in toroids as a condition for establishing a proper bond with the corresponding valence electron of the oxygen. The same toroidal distribution is then necessary for the two valence electrons of the oxygen.

Our angular quantization implies that the isoelectronia of the two $H - O$ dimers of the water molecule describe a helical trajectory within the oo-shaped toroids of Figure 4. Consequently, the water molecule can indeed acquire a substantial amount of data expressed precisely by the angular quantization described above, as a function of the descriptively encoded multiplicity of quantum numbers associated with the evolving toroids, the angular interactivities demonstrated by individual water molecules and their collective orientation in the H-bond network. Future work will spell out the toroid as a proposed new sort of harmonic oscillator, within the context of the magnecular H bond model.

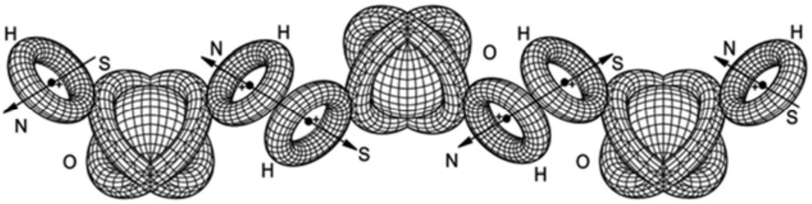

Figure 5. *Above.*

In order to initiate a quantitative study pertaining to informational propagation in aqueous systems, it is necessary, in our view, to use a model of the liquid state with an explicitly articulated *attractive force* between the water molecules, such as the magnecular model of Santilli (Santilli, 2017). In fact, only as a function of this attractive force can the information acquired by one hydrogen atom of the water molecule be propagated to the corresponding hydrogen atom of the next water molecule, evidently with progressively decreasing intensity.

3. Conclusion

In conclusion, it appears that should it be confirmed, our model of angular quantization can indeed allow a quantitative understanding of functional informational capacity associated with the water molecule permitting acquisition of a large volume of information propagated at considerable distance across liquid aqueous systems.

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