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QUANTUM MECHANICS – DETERMINISTIC *VS.* PROBABILISTIC

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A deterministic quantum mechanics theory is presented. The proposed theory is shown to be consistent with the current mainstream statistical quantum theory as well as with classical physics. It produces solutions that demonstrate that causality, physical reality, and determinism are restored and can explain in simple form concerns raised by results from the current mainstream statistical quantum theory. The meaning of particle-wave duality and complementarity, the possibility of a particle, like an electron, crossing through the nucleus as it does when the angular momentum of the electron is zero at the ground state of the hydrogen atom, the possibility of a point-size particle to have an "intrinsic spin," the possibility of "quantum jumps" as the electron transitions instantaneously from one stable orbital to another without passing through the space in between the orbitals and does that at irregular time intervals. The natural collapse of the wave function as part of the solution is a result that emerges from the proposed deterministic quantum mechanics theory. The phenomenon of entanglement is also discussed in the context that information transfer between entangled "particles" does not occur in a superluminal fashion and is not a "spooky action at a distance" but rather the local measurement of global property. A linear stability method presents actual analytical solutions consistent with current mainstream quantum theory and classical physics. The Bohr-Schrödinger energy levels leading to the experimentally confirmed spectral lines and the fine structure constant emerge from an approximate solution to these equations.

Keywords: Deterministic quantum mechanics; Statistical quantum mechanics; Intrinsic spin; Quantum jumps.

1. INTRODUCTION

Bohr [1–3] in his planetary model of the atom introduced the postulate indicating that the electron radiates only as it moves from one stable orbit to another stable orbit but can never pass through the space between these orbits during these "jumps". This postulate was accepted and retained in the modern quantum theory represented by the Schrödinger [4] and Dirac [5] equations. Recent experimental evidence provided by Minev *et al.* [6] revealed that the electron does move in the space between the orbitals by "catching and reversing a quantum jump mid-flight". Vadasz [7,8] presents via a deterministic interpretation of quantum mechanics details that show how the equations governing a continuously distributed mass, such as an inviscid compressible fluid, convert into the Schrödinger equation subject to a certain condition. In addition, the Bohr-Schrödinger energy-levels leading to the experimentally confirmed spectral lines, as well as the fine structure constant emerge from an approximate solution to these equations[14]. The analysis of the properties of these governing equations reveals a realistic interpretation of quantum mechanics that is consistent with the current results from the probabilistic interpretation as well as with classical physics concepts and simple common sense.

2. RESOLVING CLASSICAL PHYSICS VIOLATIONS

The proposed interpretation of quantum mechanics here follows Vadasz [7,8], introducing only one postulate, which states that the electron and, most likely, other quantum (sub-atomic) particles consist of continuously distributed masses and behave like inviscid compressible fluids. They possess mass density

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$\rho(\boldsymbol{x},t)\left[\mathrm{kg/m^3}\right]$, and if they are charged particles like electrons, they possess electric charge density, too $\rho_q(\boldsymbol{x},t)\left[\mathrm{C/m^3}\right]$, which is allowed to vary in space and time. Then, one can define the center of mass of the electron-fluid $\boldsymbol{x}_{cm}$ in the form of the "quantum particle"

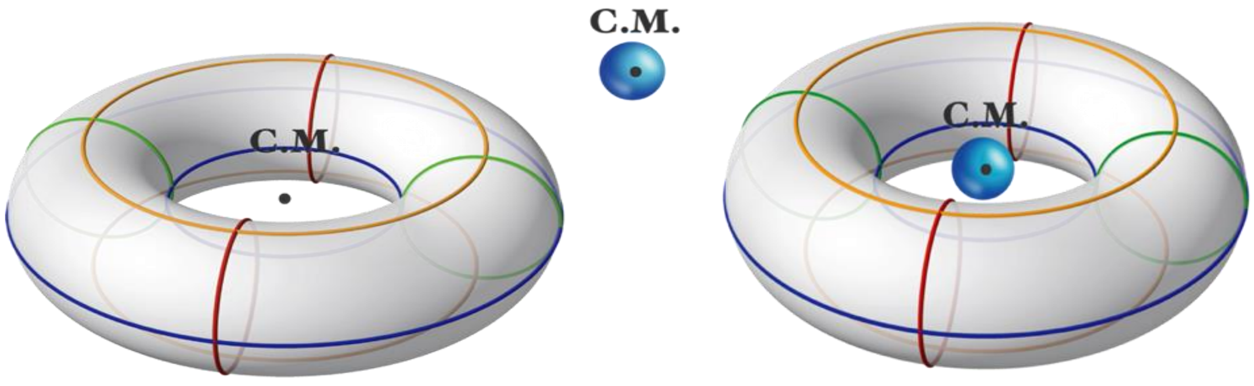
$$\boldsymbol{x}_{cm} = \int_{\tilde{V}_o} \rho(\boldsymbol{x},t)\boldsymbol{x}\,\mathrm{d}\tilde{V} \Big/ \int_{\tilde{V}_o} \rho(\boldsymbol{x},t)\,\mathrm{d}\tilde{V}, \tag{1}$$

where the electron-mass contained in the volume $\tilde{V}_o$ is the denominator in equation (1), and it is therefore constant. For one electron system this is $m_e = \int_{\tilde{V}_o} \rho(\boldsymbol{x},t)\,\mathrm{d}\tilde{V} = \mathrm{const.}$, where m_e is the mass of the electron. Representing the wave function in the general form $\psi = \rho^{1/2}\,\mathrm{e}^{iS(\boldsymbol{x},t)/\hbar}$; $\psi^* = \rho^{1/2}\,\mathrm{e}^{-iS(\boldsymbol{x},t)/\hbar}$ yields the probability density function $r(\boldsymbol{x},t)$, as $r(\boldsymbol{x},t) = |y(\boldsymbol{x},t)|^2 = yy^*$. The expectation of finding the electron (or a subatomic particle) at a position $\boldsymbol{x}$ within a volume $\tilde{V}_o$ (e.g. in Cartesian coordinates $\boldsymbol{x} = x\hat{\boldsymbol{e}}_x + y\hat{\boldsymbol{e}}_y + z\hat{\boldsymbol{e}}_z$, where $\hat{\boldsymbol{e}}_x, \hat{\boldsymbol{e}}_y, \hat{\boldsymbol{e}}_z$ are unit vectors in the x, y, z directions, respectively) is

$$\langle \boldsymbol{x} \rangle = \int_{\tilde{V}_o} \psi\,\boldsymbol{x}\,\psi^*\,d\tilde{V} \Big/ \int_{\tilde{V}_o} \rho(\boldsymbol{x},t)\,d\tilde{V} = \int_{\tilde{V}_o} \rho(\boldsymbol{x},t)\boldsymbol{x}\,d\tilde{V} \Big/ \int_{\tilde{V}_o} \rho(\boldsymbol{x},t)\,d\tilde{V}, \tag{2}$$

where $\tilde{V}$ represents the volume. From comparing equations (1) and (2) it becomes evident that the expectation of finding the electron (or any subatomic particle) at a position $\boldsymbol{x}$ within a volume $\tilde{V}_o$ according to the probabilistic interpretation of quantum mechanics is identical to the position of the center of mass of the electron-fluid (subatomic-fluid) according to a deterministic interpretation, *i.e.*, $\boldsymbol{x}_{cm} = \langle \boldsymbol{x} \rangle$. Therefore we can decide to define the center of mass of the *"quantum-fluid"* as the *"quantum particle"*.

Wave-Particle Duality: With this definition it becomes clear how a wave associated with the "quantum-fluid" can be represented by a "quantum-particle" associated with the center of mass of the "quantum-fluid".



(a) (b)

Fig. 1 – (a) A torus and a sphere separated; (b) a torus and a sphere sharing the same center of mass, without touching each other.

Instantaneous Collocation: With this definition and interpretation of "quantum-particle" it becomes already clear how two particles can be found in the same region of space at the same time without having any parts of the matter (physical objects) even contacting each other. This is just the same as a small solid sphere concentrically located in the center of a larger solid torus as presented in Fig. 1b. No material from the sphere is touching the torus but their centers of mass are in the same location in space at all times.

An approximate solution of the equations governing the motion of the continuously distributed mass applicable to the hydrogen atom produced the following graphical representation [7,8], as presented in Fig. 2. The solution obtained for the azimuthal electron mass density distribution and its variation in time was integrated to evaluate the motion of its center of mass. The azimuthal electron mass density distribution and its variation in time are presented in Fig. 2. The electron-particle motion overlaps the electron-fluid motion presented as a density plot of the mass density solution on an annulus in the j direction. Figure 2 shows that the electron-fluid performs an "embracing" motion as its differential elements repel each other in the j same direction.

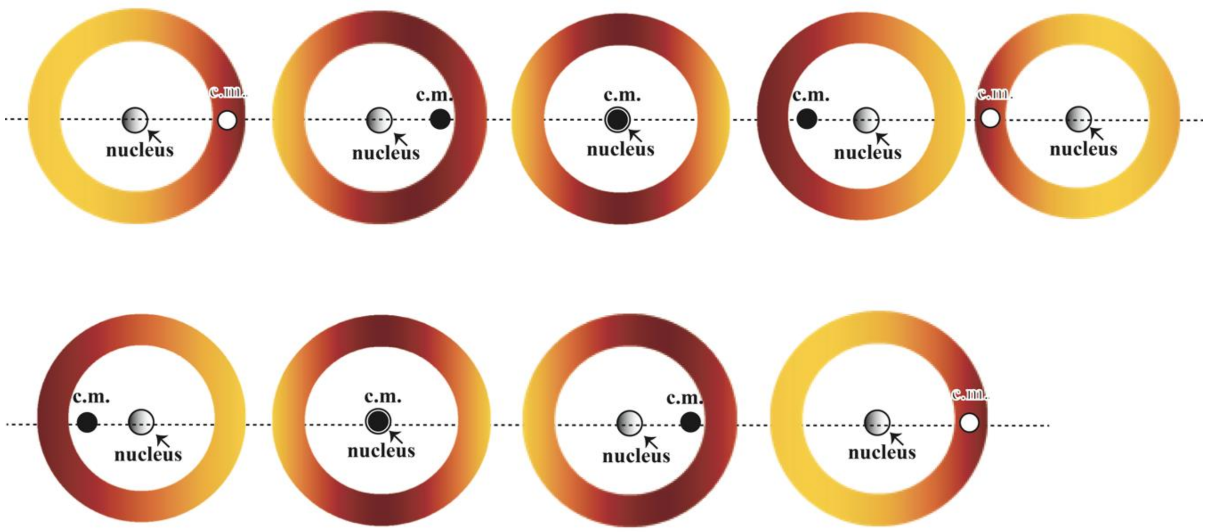


Fig. 2 – The electron-particle motion (center of mass) overlapping the electron-fluid motion presented as a density plot on an annulus in the j direction (Vadasz [7,8]).

At the same time, the electron-particle (center of mass) follows a horizontal motion from one side of the annulus to the other and back horizontally. The third and seventh of the annuli in Figure 3 show the electron-particle located at the center of the nucleus, while the electron-fluid is always outside the nucleus. Additional results related to quantum jumps that are identified as shock waves, intrinsic spin, wave function collapse, quantum tunneling, and quantum entanglement will be presented, too.

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