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On the Quantum Behavior of Nanoparticles: Quantum Theory and Nano-Pharmacology

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Abstract:

Hypothesis: Nanophase particles exhibit quantum behavior by virtue of their small size, being particles of gamma to x-ray wavelength [atomic range]. Such particles exhibit high frequencies, high energy/photon, high penetration power, high ionization power [atomic behavior] and are stable at low energy levels as opposed to bulk phase matter [macro particles] which exhibits higher wavelength [radio wave end] properties, hence lower frequency, lower energy/photon, lower penetration power, lower ionizing power and are less stable at low temperatures.

The 'unique' behavioral motion of Nano systems will remain a mystery as long as quantum theory remains a mystery, and for pharmacology, pharmacovigilance profiling of Nano systems becomes virtually impossible. Quantum theory is the 4 – 3 – 5 electromagnetic law of life and life motion systems on planet earth.

Results: Electromagnetic [wave-particle] properties of all particulate matter changes as mass [bulkiness] changes from one phase to the next [Nano phase to micro phase to milliphase to meter phase to kilometer phase etc.] and the subsequent electromagnetic effect of one phase particle on bulk matter [different phase] changes from one phase to another.

Discussion: All matter exhibits electromagnetic properties [wave particle duality] and the lower the wavelength [and bulkiness] the higher the gamma ray end properties and the higher the wavelength [and bulkiness], the more the radio-wave end properties.

Recommendation: Quantum age is overdue.

Keywords: quantum theory, electromagnetic spectrum, nanomaterial, electromagnetic radiation properties, quantum systems, Nano pharmacology, pharmacovigilance.

1. Research Questions

- i. How different in behavioral motion is Nano-phase matter to bulk matter?
- ii. What is the root of the physico-chemical differences existing between Nano phase matter and bulk phase matter?
- iii. What properties afford Nano phase matter [nanoparticles] its quantum behavior and if this quantum behavior is exhibited in Nano drug delivery systems, what impact does this have on clinical outcomes?
- iv. Is standard pharmacology practice prepared to provide pharmacovigilance profiles on Nano drug delivery systems?

1.1. Introduction

Phenomena in bulk matter and particles are explained on the basis of classical physics where mass, volume, time and energy are related through exact equations. Hence it is called deterministic physics. The laws applicable to atomic and subatomic particles are less certain and hence termed as probabilistic. These are governed by quantum mechanics.

Nano-phase matter is made up of only a few atoms and the properties are dominated by the surface atoms. In turn the surface of these atoms is made up of outer shell electrons. The behavior of the electrons is understood in terms of quantum mechanics. Hence the principle of quantum mechanics as applied to electrons provides an important basis for interpreting Nano-scale phenomena. The comprehension of these quantum mechanical concepts will facilitate a better understanding of the Nano-scale phenomena such as quantum confinement and quantum tunneling.

The following are the principles of quantum mechanics applied to the electrons.

- Electrons behave as particles as well as waves [wave particle duality] and exhibit phenomena like interference.
- The energy of an electron can vary only by certain discrete values. Thus the energy levels of electrons are quantized.
- The position and momentum of an electron cannot be determined precisely. The higher the certainty in position, the higher the uncertainty in momentum, and vice versa.

- Wavelength of the wave associated with an electron is inversely proportional to its momentum.
- The probability existence of an electron at a given point in 3 coordinate space at a given time is defined by the [square of] wave function.[1]

1.2. Nanotechnology in Drug Delivery

Nanoscience/nanotechnology involves the study of and the manipulation of matter on an atomic and molecular level [$<100\text{nm}$]. Properties of materials at these atomic and subatomic levels differ significantly from properties of the same materials at larger sizes. Although the initial properties of nano-materials studied were for its physical, mechanical, electrical, magnetic, chemical and biological applications, recently attention has been geared towards a pharmaceutical application, especially in the area of drug delivery. This is because of the challenges with the use of large size materials in drug delivery; some of which include poor availability and in vivo instability, poor solubility and poor intestinal absorption, need for sustained and targeted delivery to site of action for therapeutic effectiveness, high incidence of generalized side effects and plasma fluctuations on drugs. Of recent, several researches in Nano drug delivery have been designed to overcome these challenges through the development and fabrication of nanostructures [2].

1.3. Aims and Objectives

1. To determine the reasons behind the unique quantum behavior of Nano particles.
2. Determine the effect of nano-particles on matter as a result of their unique quantum behavior [due to their size, less bulkiness and electromagnetic properties].
3. Explain what quantum theory is and its relationship to life and life motion systems with respect to the electromagnetic spectrum [solar system].
4. Suggest the reasons why for now pharmacology may not be able to provide answers to Nano-pharmacovigilance and the possible reasons why answers to viral infections [nano-particles] remain elusive.

2. Results

wave	White light	Solar system	Frequency range	Wavelength [meters]	Day
Gamma rays	Red	sun	$>10^{19}$	$<10^{-11}$	Sunday
X - rays	Orange	mercury	$10^{16} - 10^{19}$	$10^{-11} - 10^{-8}$	Monday
Ultra violet	Yellow	Venus	$10^{14} - 10^{16}$	$10^{-8} - 10^{14}$	Tuesday
VISIBLE LIGHT	GREEN	EARTH	$4.3 - 7.5 * 10^{14}$	$4 - 7 * 10^{-7}$	WEDNESDAY
infrared	Blue	mars	$10^9 - 10^{14}$	$10^{-7} - 10^{-3}$	Thursday
Micro waves	Indigo	Jupiter	$10^9 - 10^{11}$	$10^{-3} - 10^{-1}$	Friday
Radio waves	Violet	Saturn	$10^4 - 10^9$	$10^{-1} - 10^4$	Saturday

Table 1: The 4 – 3 [7 seal] electromagnetic spectrum [light system]

Electromagnetic waves are typically described by any of the following 3 physical properties: the frequency, wavelength, or photon energy. Frequencies observed in astronomy range from $2.4 * 10^{23}$ Hz (GeV gamma rays) down to the local plasma frequency of the ionized interstellar medium (~kHz). Wavelength is inversely proportional to the wave frequency, so gamma rays have very short wavelengths that are fractions the size of the atoms, whereas wavelengths on the opposite end of the spectrum can be as long as the universe. Photon energy is directly proportional to the wave frequency, so gamma ray photons have the highest (around a billion volts), while radio wave photons have very low frequency (around femoelectronvolt).

The Earth occupies position 4 of the magnetic field of the visible planet spectrum [as much as visible light occupies position 4 in the wave spectrum] hence the point of symmetry of the magnetic field, and position 3 from the sun in the electric field [mercury, Venus, earth ...] and hence resultant life motion systems on earth are pyramidal [mod 5] as a result of the perpendicular [2nd order] interaction of the mod 4 magnetic field [moon] and the mod 3 electric field [sun]. [$4^2 + 3^2 = 5^2$]. The mod₅ elliptical behavioral motion of all matter observed on earth is inherent in the dual 4 – 3 – 5 magnetic-electric nature of atoms, hence the wave-particle duality observed in atoms subsequently observed in all earthly matter [and systems]. It is the 4 – 3 - 5 3D 2nd order mathematical relationship between the magnetic field [4-moon], the electric field [3-sun] which creates, orders and maintains pyramidal life and life motion systems on earth [radio field].

The 4 quadrants of the moons' revolution around the earth [$4 * 7 = 28$ days] creates the 4 base magnetic field of the earth [the earth is the symmetry of the planetary spectrum – position number 4] and the 3 electric fields of the sun [3rd planet from the sun – electric, heat and light source] creates the height for the resultant pyramidal [mod5] life and life motion systems on earth. Hence the perpendicular interaction of the mod4 magnetic field and mod3 electric field creates the resultant mod5 behavioral motion of life and life motion on earth. [5 continents, 5 fingers, 5 platonic solids etc]. All Earthly matter exhibit electromagnetic radiation properties, with the more pronounced radiation determined by the wavelength [size/bulkiness] of the particles. All matter exhibit gamma ray properties, x ray properties, ultra violet properties, visible light properties, infra-red, microwave and radio properties. The lower the wavelength, the higher the gamma ray end properties and the higher the wavelength the higher the radio end properties. As matter increases in mass [bulkiness], so does the increase in high wavelength-low frequency behavioral motion properties

From below Nanometer range, to the nanometer [10^{-9}m], micrometer [10^{-6}m], meter [10^0m], kilometer [10^3m] etc., as matter increases in bulk [mass] so does the increase in high wavelength-low frequency properties. Low wavelength particles [low mass] exhibit more gamma, x-ray, ultraviolet properties as opposed to infrared, microwave and radio properties, hence higher penetration power, ionization power and stability at low energy levels. Gamma rays, x-rays and ultra violet rays are blocked by the ozone layer [earth's atmosphere] to protect earth life from their high frequency high energy effects. Electromagnetic radiation interacts with matter in different ways in different parts of the

spectrum. The types of interaction can be so different that it seems to be justified to refer to different types of radiation. At the same time, there is a continuum containing all these “different kinds” of electromagnetic radiation. Thus we refer to the spectrum, but divide it up based on the different interactions with matter.

Region of the spectrum	Main interactions with matter
High-energy gamma rays	Creation of particle-antiparticle pairs
Gamma rays	Energetic ejection of core electrons in heavy elements, Compton scattering (for all atomic numbers), excitation of atomic nuclei, including dissociation of nuclei.
X rays	Excitation and ejection of core atomic electrons, Compton scattering (for low atomic numbers)
Ultra violet	Excitation of molecular and atomic valence electrons, including ejection of the electrons
Visible light	Molecular electron excitation (including pigment molecules found in the human retina), plasma oscillations (in metals only)
infrared	Molecular vibration, plasma oscillation (in metals only)
radio	Collective oscillation of charge carriers in bulk material (plasma oscillation). An example would be oscillatory travels of the electrons in the antenna.

Table 2: [Electromagnetic spectrum: Wikipedia]

2.1. Quantum theory: $[4+3=7]$, $[4^2 + 3^2 = 5^2]$, $[4^3 + 3^3 + 5^3 = 6^3]$

All earthly matter is pyramidal [mod 5] because it is the resultant creation of the mod 4 magnetic field [4 phases] and the modular 3 electric field $[4^2 + 3^2 = 5^2]$. Hence all matter is electromagnetic particulate in mass and exhibits both magnetic [wave] and electric [particle] properties in their earthly modular 5 elliptical behavioral motion. Wave-particle dualism exists in all matter, the horizontal circular magnetic field force and the perpendicular vertical linear electric field force to create resultant elliptical mod 5 quantum/earth field.

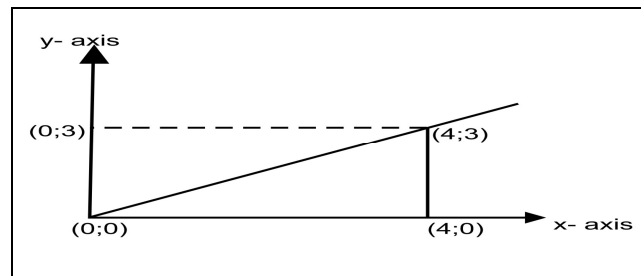


Figure 1: Cartesian plane

Hence 3D life and life motion systems on earth are governed by the electromagnetic law of the universe, $4^2 + 3^2 = 5^2$, where 4 is the magnetic field [moon], 3 the electric field [sun] and 5 the radio earth field. 2nd order is the relationship of the moon and the sun [horizontal and vertical]. 4 + 3 gives us the total of the electromagnetic spectrum, visible light spectrum, reflected in the days of the week. The resultant 5 is the pyramidal life and life motion systems on earth hence 5 continents, 5 fingers, 5 senses, 5 platonic solids etc.

2.2. The 4 – 3 [Electromagnetic] Nature of Atoms and Carbon-12 [gr. 4]

An atom consists of 3 fundamental particles namely electrons [negative charge], neutron [neutral] and proton [positive charge]. Different atoms exhibit different atomic and mass numbers measured with respect to the mass of one atom of carbon 12 [group 4 atom, forms 3 bond types to form pyramidal structures e.g. CH₄]. The atomic number of an atom represents the number of protons in the nucleus of an element. The mass number is equal to the sum of numbers of protons and no. of neutrons in the atom.

2.3. Atoms as dual 4 – 3 Electromagnetic [solar] Systems.

Atoms are made up of 2 subsystems, the nuclear field [mod 3 electric] and the orbital [mod 4 magnetic] field. Hence the wave particle duality of the atoms and subsequently all matter [life and life motion systems]

The 4 quadrant spherical electron orbital [magnetic field]

The 3 vertical linear electric nuclear field – particle charges [+ , 0, -]

There are 4 quantum numbers as a result of Schrödinger wave equation.

- i. Principle quantum number – ‘n’
- ii. Azimuthal or angular quantum number – ‘l’
- iii. Magnetic quantum number – ‘m’
- iv. Spin quantum number

3 rules of orbital filling

- i. Pauli Exclusion Principle – no 2 electrons in an atom may have all the four quantum numbers alike. Thus, 3 quantum numbers for 2 electrons in an atom can be identical at the most, but the fourth quantum number must be different, e.g. if quantum number ‘n’, ‘l’ and ‘m’ are alike, the 4th quantum number ‘s’ must be different.
- ii. Aufbau principle – electrons occupy various orbitals of an atom in the order of their increasing energy.
- iii. Hund’s rules – if filling a group of orbitals of equal energy [or subshells] it is preferred to assign electrons to empty orbitals rather than pair them in a particular subshell, because the former arrangement leads to a lower energy level.

Orbitals as 4 – 3 Electromagnetic quantum systems.

There are 4 types of orbitals, i.e

1. s orbitals – spherical, as n increases size increases.
2. p orbitals – “Dumbbell” shapes, 1 nodal plane, 3 orientations, node at nucleus
3. d orbitals – 2 nodal surfaces, 5 orientations and
4. f orbitals – 3 nodal surfaces, 7 orientation
3 nodes
 - I. s – p = 1 nodal plane
 - II. p – d = 2 nodal surfaces
 - III. d – f = 3 nodal surfaces.

[The 3 orbital orientations [3, 5 and 7] are analogous to the 3 perfect harmonic ratios observed in the music system i.e. 3 = 1:2 octave, 5 = 3:2 perfect 5th, 7 = 4:3 perfect 4th], same scenario observed in the chemistry of living things, i.e. H₂O – octave, N₂O₃ – perfect 5th, C₃N₄ – perfect 4th.

2.4. 4 – 3 – 5 and Nanotechnology in Nature: DNA, Virus capsid model and Quasi Equivalence Theory.

DNA, a Nano molecule [with 2.1nm and length 3.4nm] is a 4 – 3 – 5 system, i.e. 4 elements [H⁺, O²⁻, N³⁻, C⁴⁺] and 3 modes [single, double and triple bond] to form the pyramidal bases, A, C, T, G. The 4 bases [A, C, T, and G] relate in a triplet code [3] to form pyramidal amino acid [5]. Amino acids transform from primary-secondary, secondary to tertiary, and tertiary to quaternary structures [4 elements and 3 modes of transformation] to form specialized tissue.

The size and bulk transition from DNA to cells [Nano to micro], cells to organs [micro to milli] and organs to organs systems [milli to meter] creates earthly bodies. Hence electromagnetic radiation properties exhibited by atoms/molecules in the different ‘wave-length’ change from gamma to x-ray, x-ray to ultra violet and ultra violet to visible light as bulkiness [size] increases.

DNA is double helical [3D-2nd order- elliptical], and the terminals are known as 3’ [3 * 20 - icosahedron] or 5’ [5 * 12 - dodecahedron] ends, hence it is an icosahedron and dodecahedron dual. 3 is the octave [1+2] and 5 is the perfect 5th [2+3]. 4³ is the genetic code.

Viruses are 4 – 3 – 5 spherical Nano particles, existing as platonic solids hence exhibiting icosahedron symmetry. When 3 subunits which are intrinsically asymmetric are placed in a triangular surface of an icosahedron with 3 fold symmetry, one could place 60 subunits on the surface of the icosahedron in equivalent manner. This structure can be regarded as built with 12 [4 + 3 + 5] pentamers. There are a number of viruses which consist of 60 [4 * 3 * 5] subunits.

The capsids are made of only one kind of polypeptide chain. According to quasi equivalence theory, the icosahedral virus capsid consists of pentamers and hexamers. Hexamers are basically flat, whereas pentamers have a very convex shape forming the 12 [4 + 3 + 5] apexes in the icosahedron. Generally, the same protein molecule forms both pentamer and hexamers. The bonding relation and their environment in the icosahedron are not identical. It is thought that the subunits retain the relationship to the neighboring subunits with some distortion or “quasi equivalent” relation. The theory is called “quasi-equivalence theory”.

Bucky balls [fullerene] exhibit the same icosahedron structure [C₆₀], and carbon nanotubes exhibit the flat hexamers surface structure.

2.5. 4 – 3 – 5 and the Human Body System.

Life is organic, i.e., life is carbon-12 [group 4 – earth’s position within the spectrum, 3 single, double and triple bonds to form mod 5 structures e.g. CH₄, amino acid and pyramidal bases]. Life systems are 4 elements, H⁺, O²⁻, N³⁻, C⁴⁺ and 3 modes 1:2 [water], 2:3 [blood] and 3:4 [motion]. The human body system is a 4 – 3 – 5 quantum system [phenotypic form of the 4 – 3 – 5 DNA system]. The cardiovascular system is a 4 – 3 – 5 system which comprises the 4 heart chambers and 3 laws [atrial systole, ventricular systole and diastole] to maintain the pyramidal life motion of the body [5 senses, 5 fingers, 5 vowels etc]. Hence the emotional [intuition] is a 4 elements magnetic field; the intellectual [reasoning] is a 3 mode electric field for a resultant mod5 behavior of the body/earth-field.

Human blood pressure is 120mmHg, blood sugar level is 4 – 7 and pH is neutral at 7. It is all embodied in the 4 – 3 – 5 Electromagnetic nature of life and life motion quantum systems on Earth.

3. Discussion

Like all natural systems of the universal 4 - 3 - 5 electromagnetic spectrum [system of light], drug delivery systems are 4 – 3 – 5 systems, aimed at achieving a therapeutic benefit for to the 4 – 3 – 5 human body system.

The drug delivery system has 4 elements;

- i. Absorption
- ii. Distribution,
- iii. Metabolism and
- iv. Excretion

And the 3 modes;

- i. affinity for target site,
- ii. mechanism of action and
- iii. Therapeutic effect.

This 2nd order drug delivery system model defines the dual pharmacokinetic-pharmacodynamic nature of all drug delivery systems [analogous to the magnetic and electric fields].

Nano drug delivery systems, being in the gamma ray/x ray end of the electromagnetic spectrum [by virtue of their almost zero bulk] exhibit different electromagnetic, physical and chemical properties to conventional drug delivery systems and hence different pharmacokinetic, pharmacodynamic and pharmovigilance profiles.

Due to the higher penetration power, higher ionizing power and stability at low energy levels of the Nano phase particles, whatever pharmacodynamic effect the particle/molecule has on bulk matter in milli or micro phase, it is bound to be more pronounced in the Nano phase. Hence therapeutic and pharmacovigilance profiles of molecules are bound to be more pronounced in the Nano phase. As observed within the electromagnetic radiation spectrum, interaction with matter is different along the difference magnetic waves with Nano particle effect on bulk [cells, organs and organ systems] being more pronounced than macro-particles, hence nano drug delivery systems are bound to have a more pronounced pharmacotherapeutic and pharmacodynamic effect on bulk material.

Nano particles take micro particles as host, micro taking milli as host and milli taking meter as host, hence lower wavelength particles 'infect' higher wavelength hosts and express their quantum behavior on host platforms. Besides their size, this ability to infect, manipulate and survive on host platforms is due to their simple structure, high penetrating power, ionizing power and stability at low energy levels.

4. Conclusion

Besides the physicochemical differences observed in Nanophase particles [change in reactivity, change in conduction of electricity, increase in surface area etc.] there are also fundamental electromagnetic radiation differences exhibited by Nano phase matter/particles by virtue of the absence of bulkiness in their structures. Hence Nano phase matter exhibits high gamma-x-ray-ultra violet particle properties as opposed to macro particles which exhibit more infra-red, micro and radio wave properties. This results in Nano phase matter exhibiting quantum properties [high energy, high frequency, stability at low energy levels] as exhibited in atoms [the dual system of the electric nucleus and the magnetic orbitals] different from mechanical properties exhibited in macro particles.

The ability of viruses and bacteria to infect human systems [cell-organ-body] lies in their 'less-bulkiness' and hence exhibiting more properties of the gamma ray end [ionizing power, penetrating power, low energy level stability] in addition to their physico-chemical properties [large surface area, reactivity, high replicative ability].

In the same vein, Nano particles used as drug delivery systems exhibit low wavelength-high frequency properties not exhibited by macro material i.e. higher ionizing and penetration power and stability at low energy levels resulting in their interaction with matter being different from the interaction of macro particles with matter.

The use of Nano drug systems will have to call for the need to revisit laws of pharmaceutical variables e.g. volume of distribution, half-life, clearance, bioavailability, etc. so as to be able to predict therapeutic and clinical effects of Nano systems.

Though Quantum Theory is the language of the creation, ordering and motion of life and life motion systems on planet earth, it is not yet the language of science. Without quantum theory as the language of science, pharmacology will not be prepared to respond to quantum effects of Nano drug delivery systems on matter [cells, organs and organ systems].

This is because physics in itself is locked in classical physics; there is no metaphysics [Quantum Theory]. In metaphysics [Quantum Theory], the inherent electromagnetic properties of particles/matter determine the behavioral motion of the matter phase.

In classical physics, experiment is used to observe the behavioral motion of matter and particles, but experiment proves, but does not explain, the inherent electromagnetic radiation properties [including dualism] of atoms/molecules/particle/matter etc. hence both approaches [Cartesian dualism – Quantum theory/epistemology/basic/metaphysics as x-axis and experiment/ontology/applied/physics as y-axis] are needed to observe, understand and predict the behavioral motion of all matter.

5. Recommendations

Science and Medicine in general, and Pharmacology in particular, have to progress to an understanding of the electromagnetic 4 – 3 - 5 law of the creation, ordering and behavioral motion of life and life motion systems [Quantum Theory] on Earth, the electromagnetic properties of life and life motion systems and the Mathematical Principles of the Natural Philosophy of the Universe, Creation, Nature and Humanity in order to understand the electromagnetic physico-chemical behavioral motion of matter in its different phases [along the electromagnetic wavelength/spectrum].

The conception and application of Quantum Theory to the study of matter and life motion systems will afford pharmacology the ability to predict the therapeutic effects and prevent/prepare for the unwanted effects of Nanosystems on the bulk 4 – 3 – 5 human body system and its organs.

As observed in the 'non-curable' nature of viral and cancer conditions [both are 4 + 3 quantum systems hence viral cycle and cell cycle being 7 stage cycles], pharmacology has not mastered the principles of Quantum Theory [4 - 3 – 5 electromagnetic theory] and its implications and applications to disease and disease management, hence the inability to find cures for viruses [nanoparticles] and cancers [micro particles].

A dual Platonic-Aristotelian [quantum – classical] philosophical approach to science is the answer. The conception and subsequent application of Quantum theory [4 – 3 – 5 Electromagnetic law of life and life motion systems on Earth] in our observation and study of life and life motion systems is long overdue.

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