New Quantum Spin Perspective and Space-Time of Mind-Stuff

Rakshit P. Vyas[1], Mihir J. Joshi[2]

[1] Department of Physics, Saurashtra University, Rajkot, India
[2] Department of Physics, Saurashtra University, Rajkot, India

E-Mail ID: *rakshitvyas33@gmail.com*[1]
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Abstract

The fundamental building block of the loop quantum gravity (LQG) is the spin network which is used to quantize the physical space-time in the LQG. Recently, the novel quantum spin is proposed using the basic concepts of the spin network. This perspective redefines the notion of the quantum spin and also introduces the novel definition of the reduced Planck constant. The implication of this perspective is not only limited to the quantum gravity; but also found in the quantum mechanics. Using this perspective, we also propose the quantization of the mind-stuff. Similarity between the physical space-time and the space-time of the mind-stuff provides novel notions to study the space-time scientifically as well philosophically. The comparison between the physical- space-time and the space-time of the mind-stuff is also studied.

Keywords: quantum spin, spin network, quantum gravity, philosophy of physics, philosophy of space-time, space-time of mind-stuff.

Contents

1 Introduction

Since the dawn of the scientific and philosophical study, some questions regarding the origin of the universe, the origin of the life and the nature of the consciousness have baffled the human. At the macroscopic and microscopic scale, the external universe is studied in the physics. After, the discovery of the quantum physics, the philosophy of the physics has played

an important role to solve questions regarding the measurement problem, interpretation of the quantum mechanics, the quantum entanglement. However, the profoundness, uncertainty and the probabilistic nature of the quantum mechanics demands more research. These problems of the quantum physics have removed the boundary between the community of the physics and the community of the philosophers. Physics and the philosophy do not oppose each other; rather, complements each other. Sometimes the solution of the deepest question of the physics is resided in the philosophy; while, the discovery of new phenomenon or a law in the physics furnishes a clue to philosophers to solve the problem regarding the nature in the philosophy.

In the quantum mechanics, the nature of the quantum spin is one of the unsolved question. The study of the quantum spin is very important in the physics; since, the implications of the quantum spin are found almost in the every branch of the modern physics. why nature tends to show the quantum spin at microscopic scale in the unit of $\frac{1}{2}\hbar$?; is itself a biggest question and a research topic. What are the mutual relation of the quantum spin with the temperature, the mass scale, the length scale, is still unknown.

Recently, we [1] proposed novel perspective of quantum spin; whose implications are far-reaching in the field of the quantum gravity, the quantum physics and the yogic philosophy. This proposal establishes the relation of the quantum spin with the physical quantities such as the temperature, the mass and the length. This proposal also redefines the reduced Planck constant in novel way. The basic principle novel perspective of quantum spin can be directly applied to the yogic philosophy. Since, the physics and the philosophy complements each other; here, the order is not important. It means which comes first among the yogic philosophy and the proposed novel perspective of the quantum spin does not matter. Hence with the help of one theory; the other can be explored. In the yogic tradition, everything that is in the outer universe are also resided in the inner being. The yogic philosophy is one of the ancient philosophy as well as the classic philosophy for the psychology. The way it treats *the mind-stuff*, is elegant; because it demystifies the structure of the space-time of the mind-stuff.

2 Brief overview of the loop quantum gravity

Loop quantum gravity (LQG) is one of supposed quantum gravity theory whose one of the integral part is the spin network. The LQG starts with the general theory of relativity (GR), then takes some ideas from quantum field theory (QFT). As an outcome, one can find that the fabric of spacetime is not continuous, but quantized [2 -4].

Moreover, the LQG has three important traits, i.e., (1) it is the non-perturbative theory of the quantum gravity, (2) it is the background independent, and (3) it is also the diffeomorphism invariant theory. Since, the LQG is emerged out from the GR, it does not require background (spacetime), priory; rather it generates the quantized spacetime. The diffeomorphism invariance of the action manifests as the background independence in the LQG [2 -4].

The LQG unifies the GR (that defines gravity as the spacetime deformation whose space is dynamic) and the QFTs (that tells that every field must be quantized)[2 -4].

2.1 Introduction to the spin network

In 1971, Penrose [5, 6] gave a discrete model of space that relies on the concept of the quantized angular momentum with the purpose to create a consistent model from which continuous, classical geometry emerged out in a limit. The spin network can recreate a 3D Euclidean space, that is known as the spin-geometry theorem.

Thus, the basic idea is to create both space-time and quantum mechanics simultaneously from combinatorial principles pf the angular momentum [5, 6].
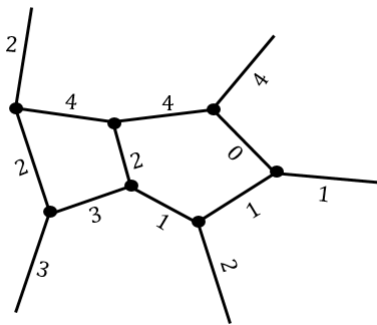
Fig. 1: The 2D diagram of the spin network.

Quantum physics implies that a quantity that is discrete, and connected with the spacetime structure intimately, is the angular momentum [5, 6].

In other words, the spin network is the theory of the quantized spacetime in which the quantized spacetime is created; hence, the concept of the direction of the macroscopic space is not known priory due to quantum indeterminacy. Therefore, one has to deal with the total angular momentum (j-value) instead of specific direction (m-value of the angular momentum). Hence, the total angular momentum is more important than the concept of angular momentum in the spin network [5, 6].

The lines of the spin network creates the quantized spacetime and this spacetime is necessary to create the classical geometry of the universe. These lines can be also seen as the world line of particles (analogous to the QFTs) [5, 6].

By assigning a number to each line and it is known as a spin number. The spin number should be an integer number. This spin number is defined as twice of the actual angular momentum value ($n\frac{\hbar}{2}$) in terms of the reduced Planck $\hbar$ [5, 6].

$$J = 2 \times \frac{n\hbar}{2} \tag{1}$$

Where, $n = 1, 3, 5, ...$ for fermions and $n = 2, 4, 6, ...$ for bosons. In the 2D diagram of the spin network, the time flows in one direction. For instance, from the bottom to the top. However, any other direction can also be assigned for the time [5, 6].

Each line of the spin network represents any compound system that distinguish itself from other system. In the spin network, the particles or systems transfer the angular momentum by regrouping into different subsystems, by annihilating one another or by producing new units [5, 6].

In fig. 1, the 3-unit at the bottom on the left splits into a 2-unit and another 3-unit. It is the topological sort of relationship between the various segments, with the values of the spin number [5, 6].

In the spin network, the relation between the edges are important. Single spin network line has no meaning. Hence, the spin network follows the relational approach of the GR. In fig. 2, the given spin network has trivalent vertex in which the dashed circle implies the structure of the spin network at the vertex with internal labels j, k, l being positive integers governed by the external labels b, c, d [5, 6].

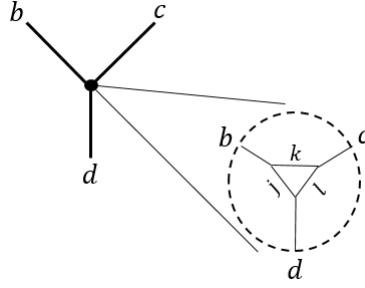$$j = \frac{b+d-c}{2}, k = \frac{c+d-b}{2}, l = \frac{b+c-d}{2} \tag{2}$$

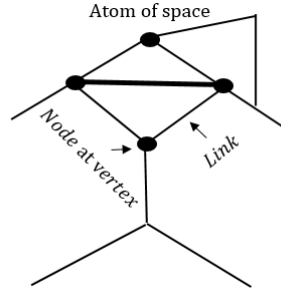Fig. 2: The vertex of the trivalent spin network.

Fig. 3: a schematic diagram of atom of space.

To conserve the angular momentum, some condition regarding the triangular inequalities is compulsory. For instance, the triangle inequalities has to be satisfied by the external labels and it is added up to an even integer [5, 6].

In the LQG, the spin network is useful to understand the physical significance of the Wheeler Dewitt equation $\mathcal{H}|\psi\rangle = 0$ through loop representation. The Wheeler-Dewitt equation is a Schrödinger's equation without time variable [2 - 4].

The closed line (loop) in space is necessary to understand these solutions [7 - 8]. The LQG can solve the Wheeler Dewitt equation through loop space representation for every loop with the aid of the spin network [2 - 4].

The LQG also studies that how these lines weave in 3D space. In the quantum space generated by the LQG, the lines of the spin network intersects and create nodes at this points of intersection. These lines in the LQG are known as links. A set of intersecting lines produces a graph [7-8]. Similar to the quantum of light, quantum of matter and other quantum; the quantum of space in LQG is known as the atom of space [2 - 4].

In the LQG, two nodes are separated by a small surface and the size of this considered surface is the area. The area and the volume operator are associated with this atom of space [9-11]. If one consider the evolution of the spin network one gets spin foam that is the result of summing over geometries generated by the spin network of the LQG (covariant approach) [2 - 4].

The spin network defines the quantized state of the field of gravity, i.e., the quantum space in which the area and the volume are also quantized [9 -11].

The other quanta of physics resides on the space; while the quanta generated by the spin network in the LQG is itself creates space [2 - 4].

The space quanta exhibits only the information that characterizes it spatially. In other words, the information about which other quanta of space it is adjacent to and which is next

to another. In short, single quantum of space has no important; but, it becomes important relative to another quantum of space [2-6].

2.2   New quantum spin perspective

Thermodynamically speaking, the motion of small particles in the isolated system makes the system chaotic or agitated. The measurement of energy of each particle is not possible for such systems. Therefore, the average kinetic energy of the system of particles is measured. Due to this probabilistic nature of system, the statistical mechanics is needed. In statistical mechanics, the temperature is defined as the average kinetic energy for any considered system of particles [12]; i.e.,

$$\frac{1}{2}mv^2 = \frac{3}{2}k_\beta T \tag{3}$$

Where k_β is the Boltzmann constant. If the equi-partition theorem is used; then, the kinetic energy is $\frac{1}{2}k_\beta T$ for each degrees of freedom ($1D$). Here, multiplying the numerator and denominator of left hand side by mass m and, after, multiply both sides by r^2; one obtains [1]

$$\frac{p^2 r^2}{2m} = \frac{k_\beta T r^2}{2} \tag{4}$$

In the scalar form, the angular momentum is given as $l = rp$; Hence, the equation becomes [1],

$$\therefore l^2 = k_\beta T r^2 m \tag{5}$$

This discussion is only applicable to the classical domain. By considering the Bohr's hypothesis [13] regarding the quantization of the angular momentum ; one gets into the quantum realm. i.e.,

$$l^2 = n^2 \hbar^2 = k_\beta T r^2 m \tag{6}$$

Where, $\hbar = \frac{h}{2\pi}$, is the reduced Planck constant. At the Planck scale [14-16], r, T and m are replaced by $r = l_P$, $T = T_P$ and $m = m_P$ respectively; Hence, one gets into the realm of the quantum gravity. Thus, the equation becomes,

$$l^2 = n^2 \hbar^2 = k_\beta T_P l_P^2 m_P \tag{7}$$

In the spin network, the total angular momentum J is more emphasized than the angular momentum l; because, z-direction is unknown priory. So, the total angular momentum J is necessary. Therefore, from equation (1), one gets [1],

$$J^2 = 2^2 \times \left(\frac{n^2 \hbar^2}{2^2} \right) = k_\beta T_P l_P^2 m_P \tag{8}$$

This formula is validated in [1]. Hence, in the spin network, the quantum spin J is defined as the square root of product of the Planck temperature T_P, the Boltzmann constant k_β, the Planck area l_P^2 and the Planck mass m_P [1].

In equation (8), if $n = 1$ is chosen; then, the one gets an equation for the reduced Planck constant $\hbar$ [1]; i.e.,

$$\hbar = \sqrt{k_\beta T_P l_P^2 m_P} \tag{9}$$

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3 The space-time of the mind-stuff

In this section, firstly, the introduction to various space-time of the universe are given. Thereafter, the space-time of mind-stuff and its quantization are explained. this is the junction point of the physics and the yoga philosophy. Then, the comparison between the physical space-time and the space-time of the mind-stuff are given.

3.1 Various sort of space-time

In yogic philosophy, there are three sort of the space-time i.e., (1) the physical space-time, (2) the space-time of mind-stuff, and (3) the space-time of consciousness. Here, some characteristics of these space-time are explained [17].

1. *The physical space-time.* The space-time of five basic elements (space, gas, fire, water, earth(matter)). In other words, it is made of space, time, matter and radiation. All physical phenomenon are occurred at this level. This is the boundary of modern science based on five elements. It covers the study of macroscopic objects such as the universe, galaxies, stars, planets, other stellar objects, earth-based science and many others. It also covers microscopic object such as molecules. atoms, fundamental particles, quarks and many others. whatever is perceived by human being at sensory levels belong to this space-time. All the phenomenon that under study in the physical space-time are local (it follows the constancy of the speed of light). Careful study of the structure of the physical space-time leads towards the study of the space-time of the mind-stuff. As mentioned, the LQG unifies the GR (the study of classical space-time) and the QFTs (the study of the various quantum field). Hence, by unification, one gets the quantum of space-time in which various other field (defined by QFTs) are resided on the gravitational field (that is quantized by LQG and it is relativistic in nature). In essence, In LQG, loops of 1D objects forms the quantum space. It means that before the formation of the quantum space by loops; nothing exists (physical point of view). Therefore, the LQG is itself background independent that is mentioned earlier. The quantized space-time is subjected to the uncertainty, probability, granularity, discreteness and many other quantum characteristics. Beyond this space-time, the space-time of the mind-stuff begins. The physical space-time is governed by the space-time of mind-stuff. The quantum enigma can be understood if the relational quantum mechanics is considered for its comprehension. In the relational quantum mechanics, the quantum states are observer dependent. There are many similarities between the physical space-time and the space-time of the mind-stuff that is covered in the next section.

2. *The space-time of mind-stuff.* All psychological events happens at this level. Everything that is there in the physical space-time, is also there in the space-time of the mind-stuff; however, its form is different. In other words, every physical object is resided in the space-time of the mind-stuff [18] without physical manifestation. In the philosophy of Yoga, there are three sort of bodies of observers i.e., (1) the physical (or macroscopic) body, (2) the microscopic body (the creator of the physical body), and (3) the causal body. Here, the causal body is the polarizing agency for rest of the bodies. the physical world can not be comprehended without these bodies. (macro, micro and causal). This emerging picture is analogous *QBism* i.e., the approach regarding the interpretation of the quantum mechanics in which the agent's action and experience is the crucial guiding principle. In the presence of the consciousness, the mind-stuff begins to create these all physical object that were once without physical manifestation. This space-time is the boundary of the intellect that govern the mind and the ego on the mind-stuff. The space-time of the
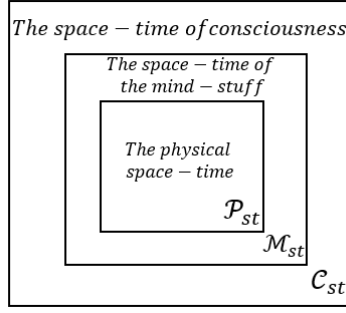
Fig. 4: A schematic Venn diagram for $\mathcal{P}_{st} \subset \mathcal{M}_{st} \subset \mathcal{C}_{st}$.

mind-stuff can also be quantized in which all characteristics of the quantum physics can be applied; however, the methodology of the mind-stuff differs from the quantization of the physical space-time. Each and every phenomenon that is occurred at the space-time of the mind-stuff is non-local. Similar to the physical space-time, this space-time is also background independent. The space-time of mind-stuff is governed by the space-time of consciousness.

3. *The space-time of consciousness.* The space-time at which the eternal joy or the holy emotion of self-existence only stands. At the space-time of consciousness, the existence of the physical space-time and the space-time of mind-stuff ceases. The consciousness that governs the physical space-time and the space-time of mind-stuff resides here. Due to measurement problem and collapse of the wave function, one can not define the characteristics of the consciousness. In quantum physics, the wave function is collapsed; because of observation or measurement; while, in the space-time of the consciousness, the consciousness disappears when it is being tried to study by the conscious being. In other words, the consciousness (similar to the wave function) can be felt but can not be studied while, the conscious being is involved in its study (in the meditative state). Therefore, modern physics point view, the space-time can only be understood; if, the measurement problem can be solved. Hence, at present, the study of the space-time of the consciousness is beyond the limit of the modern physics. however, it does not mean that the effect of the consciousness can not be observed; but, at present, we do not know that the final quantum physical tool that defines it up to necessary extent. In other words, when particle is observed in the quantum mechanics, its wave function is collapsed; and similar to this, the outcomes of the consciousness can be seen (i.e., the universe and the life); but, when it is being studied to characterize, it behaves such a way that, it can not be comprehended.

Hence, the space-time of the consciousness is the universal set whose subset is the space-time of the mind-stuff and the physical space-time is the subset of the space-time of the mind-stuff as well as the space-time of the consciousness.

$$\mathcal{P}_{st} \subset \mathcal{M}_{st} \subset \mathcal{C}_{st} \tag{10}$$

Where, $\mathcal{P}_{st}$ is the physical space-time, M_{st} is the space-time of the mind-stuff and $\mathcal{C}_{st}$ is the space-time of the consciousness.
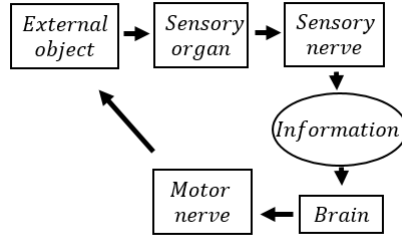
Fig. 5: The functioning of the mind-stuff thorough the physical body.

3.2 The Space-time of mind-stuff and its quantization

Patanjali's yoga aphorism is one of the top most classic text that describes the mind-stuff and its characteristics in concise and lucid way. However, till today, it was only seen as a reference book for practitioners of yoga. But it is a invaluable gem to understand the classical as well the quantum aspects of the space-time of the mind-stuff [17-18]. When the mind-stuff is studied as the space-time (classical as well as quantum; at least, in principle), similar to the physical space-time; it gives birth to a new branch of physics i.e., *Physics of Yoga* (or *Yogic Physics*). The yogic physics differs from the actual physics by its dimensions, the subject of the study, the auxiliary tools and many other way; however, it may bring new concepts to the actual physics and may solve the existing problem of physics (especially in the quantum domain). In other words, in physics, the subjects of study are space, time, matter and radiation; while, in the physics of the yoga, the subject of the study is the mind-stuff (or sometimes, mind).

As per circumstances and upward movement, the mind-stuff transforms into the mind, the intellect and the ego. In yoga philosophy, the observer is the consciousness (or the observer that exhibits consciousness) and the object that is being observed is the nature (external universe, physical body etc.). The function of the mind-stuff is to know or identify the external (and internal) object with the aid of the physical body (brain and i.e., nervous system), in the presence of the consciousness. It happens in three steps; (1) the external object create an information signal for sensory nerve of the particular organ (for instance, music - ear) that brings the information to the brain (the mind-stuff is converted into the mind). (2) The brain checks this information in its database and send a responding information to the sensory organ through the motor nerve (the mind-stuff is converted into the intellect). (3) Thereafter, the mind-stuff identifies or knows particular object in the presence of the consciousness (the mind-stuff for a while, is converted into the ego). In this whole process all three space-time are involved [17]. the physical space-time behaves as external agency to comprehend the space-time of the mind-stuff by the mind-stuff, in the presence of the consciousness. The mind-stuff (or the mind) itself comprehends the space-time of the mind-stuff through this procedure. In other words, the external object creates a form of a word in the mind-stuff that produces a meaning in the presence of the consciousness; at last, it gives the knowledge of particular external object (*word → meaning → knoweldge*!). Hence, to study the space-time of the mind-stuff, the mind-stuff uses the physical space-time to explore its own characteristics; because, nature tends to show similar structure in both the space-time (physical as well the space-time of the mind-stuff). In the whole procedure, the consciousness does nothing; but, without its presence, the mind-stuff can not function properly.

According to the definition of the yoga (from Patanjali's yoga aphorism) in the yogic philosophy, the yoga means [17],

To restrain the mind-stuff from taking various sort of forms.

The procedure described in (2.2) also happens in the space-time of the mind-stuff. Various sort of forms are disturbance created in the mind-stuff. In yogic tradition, the mind-stuff is like a pure curtain or a multi faceted diamond or a mirror which takes the form of the body that resides outside it. In other words, the mind-stuff is like the pond. If a stone is thrown inside the pond; the disturbance (in the form of a wave) is created. When this disturbance decays; the pond again becomes stationary. Each form is like a stone which makes the mind-stuff non-stationary. Therefore, the mind-stuff will take various form which is responsible to create the space-time of the mind-stuff [17].

The space-time of the mind-stuff is analogous to the spin network (as mentioned, it is the building block of LQG) which was discovered by Roger Penrose. The form is analogous to the quantum spin of the spin network. As mentioned , the LQG is one of the supposed and convincing theory of quantum gravity that defines the classical space-time in discrete way. The quantum spin of the spin network is the fundamental unit of loop quantum gravity that discretize the classical space-time. While, forms are quantum units of the space-time of the mind-stuff that quantize the mind-stuff.

The formation of each form in the mind-stuff, makes it restless. This restlessness makes the mind-stuff trembled and this trembling generates one sort of force or energy that creates the chain of such sorts forms. Hence, the stationary mind-stuff is now no longer stationary.

3.3 Comparison between physical space-time and space-time of mind-stuff

Here, in the tabular form, the comparison between the physical space-time and the space-time of the mind-stuff is given.

Sr. no.	The physical space-time	The space-time of the mind-stuff
1	The quantum field of massive particle tells the quantized space-time how to curve and the quantized space-time tells the quantum field of the massive particle how to move	Various forms (the quantum of the mind-stuff) tells the quantized mind-stuff how to curve and the quantized mind-stuff tells various forms (the quantum of the mind-stuff) how to move
2	It follows locality	It does not follow locality
3	It is relational in nature	It is also relational in nature
4	The 1D loops creates the quantum space	The forms (the quantum of the mind-stuff) creates the quantum space of the mind-stuff
5	The space-time singularity is occurred when stellar or galactic object is converted into the black hole. it is resolved by the big bounce model in the LQG.	The space-time singularity of the mind-stuff occurred; when the mind-stuff reaches to the superconsciousness state. This singularity can also be resolved by quantization of the space-time of the mind-stuff.

Table 1: The physical space-time *vs.* the space-time of the mind-stuff.

Conclusions

Finally, we conclude that, the new quantum spin perspective of quantum gravity is crucial to comprehend the spin network of the LQG as well as the space-time of the mind-stuff. These are basic results of the quantization of the mind-stuff using the new quantum spin perspective of the spin network. This novel quantum spin perspective not only modifies the present notion of the quantum spin; but it can also quantize the space-time of the mind-stuff. Gradually, the successful quantization of the space-time of the mind-stuff will brings several novel notions in the quantum physics as well in the various branches of the philosophy (QBism, phenomenology, philosophy of the space-time, philosophy of mind, philosophy of consciousness etc.).

Acknowledgement

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