Article

Mesostratum Geometrodynamic Gravitation

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Abstract

We discuss the cosmic spacetime tapestry upon which mesostratum geometrodynamic emanations weave the material content of the physiostratum. We invoke the idea of adjacent realities - the mesostratum and physiostratum - and the interaction of geometrodynamics with the adjacent realities - to help clarify and understand gravitational cohesion and the origin of inertial matter and the concordant role of spacetime voxel assemblages in modulating spacetime to generate mass and gravitational fields.

Keywords: Inertial mass, gravitational field, geometrodynamics, mesostratum.

Introduction

Spacetime deformation, prescribed by Einstein's general theory of relativity, prompted astrophysicist John Archibald Wheeler to infer that "matter tells spacetime how to curve." We accept Wheeler's inference and adapt mathematically imagined and validated spacetime as foundational in governing the gravitational dynamics of matter [1]. We expect the development of topological geometrodynamics to corroborate our assumptions regarding the nature of spacetime deformation and complementary gravitational fields.

Wheeler formulated the concept of geometrodynamics, to describe spacetime and physical phenomena in terms of geometrics. The goal was to reformulate general relativity and to unify fundamental forces in terms of coordinate systems and a configuration space. Among Wheeler's goals was that of laying a foundation for quantum gravity and the notion of the graviton - a hypothetical particle that mediates the force of gravitation in the framework of quantum field theory. The conjecture is that gravitational interaction is mediated by gravitons that modify the shape of spacetime and that gravity is a result of spacetime deformation.

Wheeler envisaged the foundational fabric of the cosmos as a sub-atomic realm of quantum fluctuations, which he called quantum foam. Wheeler wanted to reduce relativistic and quantum physics to a dynamic geometry involving three abstract but fundamental concepts: mass without mass, charge without charge, and field without field [2]. Our development of Wheeler's concept adds: time without time and space without space, with all five embraced within the context of the mesostratum abstract reality.

To lay a foundation for quantum gravity and unification of gravitation with electromagnetism, Wheeler introduced the notion of geons, gravitational wave packets confined to a compact region of spacetime and held together by the gravitational attraction of the field energy of the wave itself. Wheeler proposed the possibility that geons could affect physical test particles much *like a*

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massive object, hence mass without mass [3]. Wheeler's geon is conceptually like an electromagnetic wave confined geometrodynamically within mesostratum hyperspacetime by the gravitational attraction of its own field energy.

Topological geometrodynamics (TGD) is a modification of Wheeler's concept, a generalization of string theory models in which physical space-time is reckoned as a four-dimensional surface in an eight-dimensional space [4]. This allows re-interpretation of the structure/fabric of the cosmos in terms of sub-macroscopic space-time topology. TGD representation of physical space-time as a four-dimensional surface in a higher-dimensional hyper spacetime simply replaces points of Minkowski space with a compact internal space. Minkowski space that contains an imbedded complex subspace allows the concept of Penrose twistor space, which by our reckoning is a subset of mesostratum hyperspace [5].

Given the TGD concept, a novel and complex physics emerges. Traditional Standard Model quantum chromodynamics (QCD) is replaced with an imbedded sub-space-time geometry. The TGD cosmos is purely a mathematical world. The main tools are appropriate choices of mathematical instruments and conditions that serve as constraints. What distinguishes TGD from other theoretical physics is the range of innovations on how these mathematical tools should be found and applied.

According to TGD theory, mathematics is applied to everything without exception: e.g., replacing particles with *partonic facades*, where the parton is a model of hadrons (such as protons and neutrons) proposed by Richard Feynman [6]. High energy experiments showed quarks are virtual particles, so Feynman called them partons since they were parts of hadrons. The parton model is useful for interpreting radiation cascades (parton showers) produced from QCD processes. The Parson magneton, is a similar hypothetical geometrical object suggested by Alfred Lauck Parson in 1915: an electron ring that generates a magnetic field [7]. The Parson's concept of the electron ring inspired several other toroidal ring models.

Space and time have been assigned aspects of empirical reality by mathematicians who invented the language and algebra of dimensionality. Euclid and other ancient geometers gave spatial dimensions axiomatic meaning by positing mathematical objects such as lines, triangles, circles, spheres, cubes and other regular and irregular geometric solids. Descartes recognized relations among geometric points and temporal instances, giving them meaning by means of algebraical coordinates and equations. This was followed by the notion of multi-dimensional spaces and synthetical spaces that ostensibly produce quantum particles, quantum waves and force fields that interact energetically. Theoreticians imbued space and time with dimensionality, material attributes and properties. The inevitable consequence is Wheeler's formulation of geometrodynamics to describe spacetime and physical phenomena in terms of geometrics.

Mathematical as well as logical reasoning make explicit what is implicit in a set of premises while contributing insights to the content of our knowledge of empirical matters. Mathematics is indispensable as an instrument for the validation of such knowledge. Mathematical truths echo empirical observations and discoveries of experimental science and often illuminate and predict them [8]. Likewise, we attempt to discern truths and/or potentialities revealed by geometrodynamics and topological geometrodynamics.

Nature of Mesostratum Reality

The mesostratum is real and verifiable; we cannot avoid being aware of the mesostratum reality. Physiostratum phenomena arise prominently as results of mesostratum phenomena. Mesostratum geometrodynamic emanations are observable in the physiostratum. A concrete example is the experimental revelation of magnetic fields by their effect on iron filings. A magnetic field is a geometrodynamic thing that exists solely in the mesostratum. The presence and geometry of a magnetic field is demonstrated by the alignment of iron filings that were originally randomly scattered on a cardboard sheet just before being placed over a magnet. The tiny particles of iron line up along imaginary lines of force, filling the space between the magnet's north and south poles.

The mesostratum reality may be described as a hyperspace, as a *conceptual entity*, like all the infinitude of geometrodynamic concepts that presumably exist therein. We are certain that these mesostratum concepts, ideas, and all related geometrodynamic mathematical objects exist but evidently do not occupy space or time as do material objects within the physiostratum.

Physiostratum space and time appear to be self-referential and axiomatic in a cosmos filled with material objects in constant motion. Space and time establish location and duration within the physiostratum. Space and time are, in a sense, constructs of consciousness. Consciousness assigns locations in space and an arrow or flow of time between localized events. Displacement in space and the flow of time is related to the continuity of consciousness. The objective reality of our material world is seemingly a self-referential, consciousness-generated assignment of loci and instants in physiostratum space and time.

Mesostratum hyperspace is devoid of time as we measure it in the physiostratum. Communication in mesostratum hyperspace is instantaneous and reversible. Measurements in hyperspace are undefined by and unrelated to physiostratum space and time. The theorized dynamics of mesostratum mathematical objects are abstract attributes until they emanate and influence physiostratum material objects.

We argue that the mesostratum is the transcendent foundation of the material world we experience. We argue further that physiostratum spacetime is granular and that it consists of oceanic array of tessellated spacetime parcels - cubic voxels [9]. The voxels form the cosmic physiostratum spacetime discontinuum shown in Figure 1. The mesostratum is conceived as the geometrodynamic source that generates the granular spacetime foundation of the physiostratum, i.e. the cosmos, which is intrinsically a subset of the mesostratum.

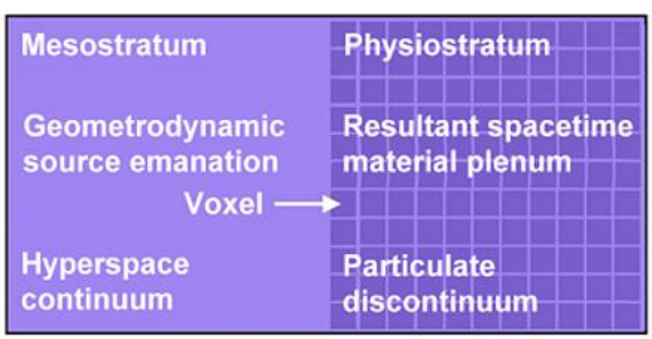

Figure 1 - Geometrodynamic enamation of physiostratum.

Albert Einstein envisioned a 'geometrodynamical universe' where spacetime properties are described by geometry and in which overall spacetime curvature changes with time. Theorists and philosophers suggest that geometrodynamics might eventually mathematically encompass some of the ideas of Descartes and Spinoza concerning the ultimate nature of space. We adopt Einstein's geometrodynamics interpretation of Mach's principle that local inertial frames are determined by the large-scale distribution of matter, and that local inertia is related to the distribution of distant stars and other matter throughout cosmic space.

It is easy to explain Mach's principle and local inertia in terms of the grip of cosmic spacetime on local mass since the curvature, indeed the structure, of spacetime here and throughout the cosmos emanates from the mesostratum. Mesostratum geometrodynamic emanations are by our definition not restricted to immediate surroundings; the mesostratum domain is unbounded, cosmic and influences spacetime curvature and hence mass/inertia in local and distant surroundings. Mesostratum geometrodynamics is ubiquitous and shapes the geometry of spacetime throughout the cosmos. We speculate that *space without space* and *time without time* exist as abstract geometrodynamical potentialities in the mesostratum and these emanate and combine to form the physiostratum spacetime plenum, as illustrated in Figure 1.

Ignazio Ciufolini and John A. Wheeler discuss the origin of inertia (local inertial frames) in terms of Einstein's general relativity [10]. They describe numerous confirmations of geometrodynamics and some experiments to test its fundamental predictions - in particular, the 'dragging of inertial frames' and gravitational waves. The enigma of how mass originates *masslessly* may be explained in terms of unique assemblages of spacetime parcels that we describe as four-dimensional geometrodynamic voxels [9].

Geometrodynamic Mass without Mass

We postulate that select energetic spacetime parcels (voxels) exhibit mass when combined as components of sub-atomic quantum particles such as electrons, which are initially cubic mathematical objects in the mesostratum [11]. The basic electron, as depicted in Figure 2, is essentially naked and may enjoy only a transitory mesostratum existence. The naked electron is represented by the intersection of three mutually orthogonal strings and branes that carry potential but unmeasurable mass, spin, and charge. These properties are purely energetic potentialities and at this stage are undefined as physically observable, measurable properties. According to our model, after the naked electron is defined by a set of eight cubic spacetime voxels, its electric charge, spin, and mass appear as measurable properties [8]. It then becomes a Generation 1 electron with physically measurable mass of 0.511 MeV, conforming with the Standard Model of particle physics. Consequently, we adopt the idea that *certain assemblages of spacetime voxels appear as massive electrons*.

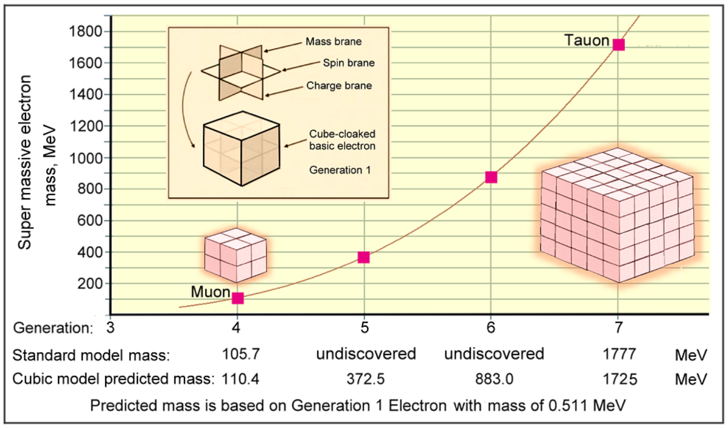

Figure 2 - Massive cubic electrons compared with standard model massive electrons.

There are evidently *strict geometrodynamic rules* concerning spacetime *voxel assemblages* that emerge as massive electrons: The originating geometric/mathematical mesostratum object *must be a perfect cube*. For example, as depicted in Figure 2, an assembly of exactly eight, not seven or fewer voxels, is required to form a cubic Generation 1 electron [8]. We discover that a Generation 2 electron must consist of 8 Generation 1 modules and thereby have a mass = 4.088 MeV, and that a Generation 3 electron must consist of 27 Generation 1 modules and = 13.797 MeV. A cubic Generation 4 electron consists of 8 [2^3] Generation 3 modules and = 110.4 MeV. A Generation 5 electron consists of 27 [3^3] Generation 3 modules and = 372.5 MeV. A Generation 6 electron consists of 64 [4^3] Generation 3 modules and = 883.0 MeV. A Generation 7 electron consists of 125 [5^3] Generation 3 modules and = 1725 MeV.

Fermat's Last Theorem apparently governs the formation of cubic electrons. For example, a Generation 4 and a Generation 5 cubic electron cannot be combined to form a more massive cubic electron - because, according to Fermat's theorem, the sums of cubes of successive integers are not closed under addition can never be a larger cube. Fermat's Last Theorem states that for n = 3 or greater, no integers A, B, C, n can be found such that $A^n + B^n = C^n$.

The voxel-assembly cubic electron model not only predicts the muon and tauon masses, as in Figure 2, but also shows seven generations (with more generations possible) where the Standard Model projects only two generations of heavy electrons. The Standard Model of particle physics holds that there are three generations of electrons: the first generation is the basic electron itself, while the second generation is the heavier muon, and the third, the even heavier tauon. All possess the same charge (-1) and spin (2) as an electron but differ greatly in mass.

Muons were discovered by Carl D. Anderson and Seth Neddermeyer at Caltech in 1936 while studying cosmic radiation. The muon is a theoretically predicted heavy electron with a mass of 105.7 MeV. The tauon was detected in a series of experiments between 1974 and 1977 by Martin Lewis Perl with his colleagues at the SLAC National Accelerator Laboratory and the Lawrence Berkeley Laboratory group. The tauon mass is adduced as 1777 MeV. In their free state, these heavy electrons decay almost instantly.

Some types of heavy electrons are found within some lanthanide and actinide compounds, where they exhibit a large effective mass, comparable to the mass of a muon. Heavy electron mass may reach 1,000 MeV in exotic ‘heavy fermion’ materials. A microscope that was designed to image electron arrangements and interactions in crystals revealed electrons that possess extraordinary mass under certain extreme conditions. These heavy electrons appear to be confined electrons as they interact with crystal lattices that they traverse. Apparently, under extreme conditions, unusual phase transitions occur in particular materials, causing electrons to take on extraordinary mass. These heavy electrons are apparently unstable unless they interact with and acquire mass in certain crystalline lattice structures.

Voxels as Geometrodynamic Objects

Geometrodynamic and TGD view the physical world as a function of space geometry and as generalized number theory. From the TGD viewpoint, this dichotomy combines geometry and number theoretic Langlands programs [12]. Langlands theory incorporates a set of conjectures about connections between number theory and geometry. Proposed by Robert Langlands in 1970, it seeks to relate Galois groups in algebraic number theory to automorphic forms and representation theory of algebraic groups.

An automorphism is geometrodynamically relevant as a symmetry of the mathematical object and as a way of mapping the object to itself while preserving its inherent structure. The set of all automorphisms of a mathematical object forms a group. In Riemann surfaces, an automorphism is a conformal map from a surface to itself. For example, the automorphisms of the Riemann sphere are Möbius transformations. In topology, morphisms between topological spaces are continuous maps, of the space to itself.

Topology, and concurrently TGD, developed as a field of study combining geometry and set theory through analysis of concepts such as space, dimension, and transformation. Topological groups are used to study continuities and symmetries, which are expected to have illuminating applications in physics. Applied to physics, topology is concerned with sets of properties of space that are preserved under continuous deformation. Topology deals with subsets that satisfy properties, such as connectedness and compactness. A topological space may be associated with physical meaning. Among mathematical objects studied in topology are Möbius strips - conceptual mesostratum sheets (branes) - unique in having only one surface and one edge - that appear in the physiostratum as narrow strips of paper that are twisted 180 degrees and have the ends glued together.

In the context of abstract algebra, a mathematical object is an algebraic structure such as a ring, vector space, or group. More specifically, in abstract algebra, Galois theory provides a connection between field theory and group theory permutations. The Rubik's Cube is a tangible physiostratum representation of permutation groups. There is an uncanny relation between cubic electron voxel assemblages and Rubik's Cube components when viewed as mesostratum mathematical objects that emerge as measurable, manipulable objects in the physiostratum.

The previously described assemblage of voxels that produce several generations of massive electrons is profoundly related to Einstein's equation, $E = mc^2$, which combines the ratio (E/m) and the space/time ratio $[L/T]^2$. The explicit meaning of the equation is that nuclear binding energies and nuclear mass defects are related - that mass and energy are interchangeable and complementary. The implicit meaning of $E = mc^2$ is that energy and mass are essentially properties of space and time, that is, space-displacement $[\Delta L]^2$ and time-interval $[\Delta T]^2$. We postulate that select space-time parcels (voxels) have energy and contribute mass when assembled in specific arrangements as cubic components of sub-atomic quantum particles, such as cubic electrons.

Geometrodynamic Cubic Lattice Nucleons

The Standard Model of particle physics postulates the existence of the Higgs boson, which imparts to electrons and other elementary particles gravitational mass and inertia. We argue that specific cubic assemblages of spacetime voxels have the properties attributed to the Higgs boson and may incrementally impart mass to elementary particles. As indicated in Figure 3, in the cubic lattice model for protons and neutrons, quarks are structural parts, called plaques. Quarks have substructure where each quark is a plaque consisting of nine energetic spacetime voxels [13]. Consequently, specific assemblages of 27 voxels comprise the cubic lattice structure of neutrons and protons and impart mass.

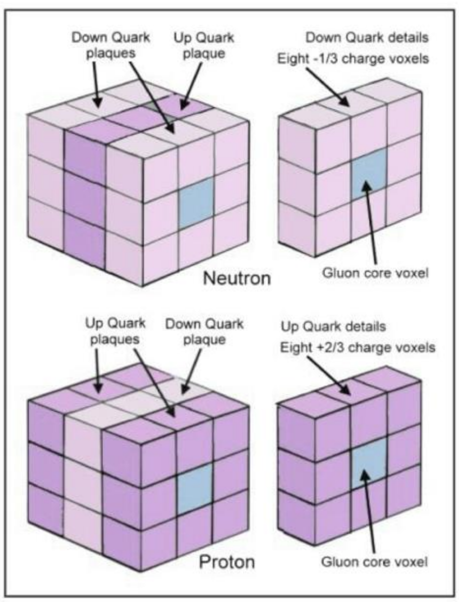

Figure 3 - Cubic lattice primordial nucleons.

The lattice is basic in the modern theory of algebraic structures. The concept of the lattice has applications in several mathematical disciplines (topology, for example). It is the only concept that denotes both an algebraic and a realizable spacetime structure. Recent progress in the development of lattice theory provides a calculational tool for nuclear physics.
Lattice theory promises to provide a foundation for the structure and binding of nuclei, e.g., as a calculational tool for quantum chromodynamics QCD. But it requires continuum approximation approaches wherein the spacing between lattice sites is arbitrarily reduced to near zero and

demands immense computer power for the calculations. Lattice QCD is well established and uses a discrete set of spacetime points to convert the analytically intractable path integrals of the continuum theory to manageable albeit very difficult numerical computation carried out on supercomputers.

Lattice theory is formulated on a grid or lattice of points in space and time. However, in practice its calculation power is limited because of criteria for smoothness of mathematical functions involved. The most basic criterion is that of continuity and differentiability. Lattice discretization means a finite lattice spacing and size, which is not continuous. Currently there is no fully developed formulation of lattice theory that allows simulation of the geometrodynamic approach.

Discussion

We contemplate relations among perfect mathematical mesostratum objects and physical, material, measurable, objects that emerge in the physiostratum. We conceptualize unique, massive cohesive assemblies of spacetime voxels such as cubic electrons and cubic neutrons, cubic protons, and cubic lattice nucleons that fuse and synthesize atomic nuclei. Cubic lattice proton, neutron, deuteron modules are demonstrably viable and essential when modeled as components of nuclei of atoms and isotopes [13]. The transition of a *virtual particle* from the mesostratum in becoming a *physical particle* in the physiostratum involves a complex and poorly understood process. Virtual particles apparently originate abstractly in the mesostratum reality that we define as an intrinsically mathematical continuum. The particles appear in the physiostratum reality that we define as a physical discontinuum.

Mathematical formulations of the needed geometrodynamic and TGD theory are still undeveloped. The main goal is unification of fundamental quantum forces and reformulation of general relativity as a configuration space that captures the geometrodynamic structure of spacetime, including mass, gravitation, inertia, and inherent nuclear binding forces. The goal was promoted by John Wheeler in the 1960s, and work on it continues in the 21st century [14].

The Langlands theory is seen as a prospective advancement in geometrodynamic research. Lattices with discrete geometric coordinates are exhibited in Sobolev spaces that offer substitutes for spaces that require continuity for differential equations. We anticipate a new mathematics that elucidates how mesostratum geometrodynamic emanations weave the material content of the physiostratum, combining geometrodynamics and adjacent realities - the mesostratum and physiostratum [15]. We expect this to lead to clarification of the nature of gravitation, nuclear bonding and the associated stability of spacetime voxel agglomerations of inertial matter [13].

Conclusion

Perhaps the most salient indicator of the origin of gravitational mass is revealed by the arguments concerning spacetime *voxel assemblages* that emerge as massive electrons, as represented by Figure 2. We conclude that emergence of gravitation mass is reciprocally related to localized modulations of spacetime, which are nano-scale versions of spacetime modulations affected by the sun, other stars, and black holes [1, 16]. There are no viable counter-arguments that dispute this notion. This permits the conjecture that gravity, unlike electromagnetic and proposed strong/weak nuclear forces, is a unique and separate phenomenon.

Gravitation is explained by Einstein's theory of general relativity, in which gravity is described as a curvature of spacetime. Electromagnetism is explained by electrostatic or electromagnetic fields between charges and moving charges that exert electrostatic and electromagnetic forces between each. According to Newton, gravitational attraction exists between two point-like mass centers, m_1 and m_2, separated by a distance r. Newtonian gravitational attraction is given by: $F = (G\ m_1\ m_2) / r^2$, where G is the universal gravitational constant.

The gravitational coupling constant α_G is a dimensionless quantity related to G, where $\alpha_G = Gm_e^2/\hbar c = (m_e/m_P)^2 \approx 1.75 \cdot 10^{-45}$ and characterizes the gravitational attraction between electrons, based on electron rest mass m_e, where ħ is the reduced Planck constant, m_P is the Planck mass, c is the speed of light. This shows that gravity is a far weaker force than the electromagnetic interaction since α_G is 42 orders of magnitude smaller than α, the fine structure constant that in natural units equals charge squared: $e^2/2\pi \approx 7.21 \cdot 10^{-3}$ The numerical value of α_G does not vary with the choice of units of measurement, only with the choice of particle. α_G can only be measured with relatively low precision and is seldom mentioned in the physics literature. This does not explain an electron's self-gravitation and the negation of electrostatic self-repulsion unless it is accompanied by a self-generated electromagnetic cohesive vortex, e.g., a Bohr/Parson magneton.

We argue that when certain assemblages of spacetime voxels appear as massive entities, they exhibit self-gravitation attraction. Accordingly, agglomerations of quantum particles represent spacetime voxels assemblages that distort adjacent spacetime and thereby manifest self-gravitational mass. We may elaborate with the example of the mass of a Generation 1 electron distorting its local vicinity of spacetime while at the same time acknowledging that the same parcel of spacetime contains an assemblage of voxels that generate the original electron mass. The electron has at least two other measurable properties, however: charge and spin. To account for the electron's structural stability against its self-repulsive negative charge, we need to assume that its self-gravitating mass dominates and assures its stability. Spin implies angular momentum that in turn requires the electron's mass.

We accept the notion that gravitational/inertial mass produces unique modes of spacetime deformation and argue that mass appears when specific voxel assemblages spin, detached from the adjacent spacetime fabric and producing reciprocal localized spacetime gravitational deformation. *Virtual spins of voxel assemblages inherently contain the energy that is measured as the mass of the assembly in the phyiostratum*: the mass of cubic lattice electrons, neutrons, protons. *The accompanying deformation of the surrounding spacetime is sensed as the* *gravitational field of the spinning voxel assemblage*.

We reckon that the spin, and hence angular energy/momentum, of voxel assemblages determines the rest mass of electrons and of atomic agglomerations. Moreover, we conjecture that spin is variable, a function perhaps of the age of the cosmos and of local spacetime geometrodynamics. The electron rest mass m_e may be calculated from the definition of the Rydberg constant R, so that $m_e = (2Rh)/(ca^2)$, where c is light velocity, h is the Planck constant, and a is the fine structure constant. In a previous work, we demonstrate how both the quantities c and h may vary with the age of the cosmos [16].

References

1. Solar Spacetime Topology and Titius-Bode Law, A. Vary, Prespacetime Journal, Vol. 8, No 4 (2017).
2. Geometrodynamics and the Problem of Motion, J. A. Wheeler, *Rev. Mod. Phys.* 44 (1): 63 (1961).
3. Geons, J. A. Wheeler, *Physical Review*. 97 (2): 511 (1955).
4. *Topological Geometrodynamics*, M. Pitkänen, Luniver Press (2006).
5. Mesostratum, Twistor Space & Aether, A. Vary, *Prespacetime Journal*, Vol. 7, No. 13 (2016).
6. The Behavior of Hadron Collisions at Extreme Energies. R. P. Feynman, *High Energy Collisions: Third International Conference at Stony Brook*, pp. 237B249, Gordon & Breach (1969).
7. The Theory of Electromagnetic Mass of the Parson Magneton and other Non-Spherical Systems, D, L. Webster, *Physical Review*, V9, reprinted Pub 2419, V65, N11 (1916).
8. Fibonacci Sunflowers, Mathematical Objects, & Cubic Electrons, A. Vary, *Prespacetime Journal*, Vol. 7, No. 11 (2016).
9. Exploration of Mesostratum Physics, A. Vary, *Prespacetime Journal*, Vol. 7, No. 11 (2016).
10. *Gravitation and Inertia*, I. Ciufolini and J. A. Wheeler, Princeton University Press (1995).
11. Cubic Lattice Nucleus Model & Cryogenic Cosmology, A. Vary, *Prespacetime J*, Vol. 7, No 2, 2016.
12. Langlands Program from TGD Point of View, M. Pitkänen, *Prespacetime Journal*, Vol. 7, No. 11 (2016).
13. Primordial Cubic Lattice Nucleons and van der Waals Bonding Forces, A. Vary, *Prespacetime Journal*, Vol. 8, No. 14 (2017).
14. Curved empty space as the building material of the physical world: an assessment, J. A. Wheeler (1960) in *Logic, Methodology, and Philosophy of Science*, E. Nagel, Stanford University Press (1962).
15. Theoretical Physics between Adjacent Realities, A. Vary, *Prespacetime Journal*, Vol. 8, No. 14 (2017).
16. Redshift, Planck Action & Spacetime Change with Cosmic Age, A. Vary, *Prespacetime Journal*, Vol. 8, No. 7 (2017).