Quantum Geometry of Spacetime

Model of Unification of General Relativity and Quantum Mechanics

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Certainty: “Not even human stupidity is infinite, although it seems so, is not physically possible.”

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Physics and the Infinite

Introduction.

For centuries the hypothesis that the universe is continuous that has been considered a clear and unquestionable truth. Not only matter and energy have been considered so but also the proper spacetime which contains them.

With the birth of quantum mechanics, we understood that matter is not continuum (represented by the set of real numbers ($\mathbb{R}$). For example, an iron bar cannot be divided into smaller pieces and these in turn into smaller ones and so on. If we kept dividing it only an atom of iron would remain and this one cannot be divided in “1/n atoms of iron ".

However, since an atom is not elementary, we can even split an atom of iron. (In the context of this work ‘elementary’ means that it has no parts and consequently is indivisible).

The atom can be divided in protons, neutrons and electrons.

There is a strong assumption that protons and neutrons are not elementary. They have an internal structure composed of three quarks. At present, there is no one who has raised the hypothesis that a quark is infinitely divisible.

The electron does not have an internal structure (it has no parts) and is indivisible. We can say that tit is elementary in the sense expressed in this work.

Quantum Mechanics also ensures that energy is emitted and absorbed in the form of all discreet Quantum (represented only by the set of Natural numbers (ℕ)).

We can affirm that the hypothesis of a continuum universe is neither fulfilled with matter nor with energy. When I use the term “continuous”, “continuum” or “continuity”, I mean that the physical reality of the phenomenon to describe can only be represented by the set of the Real numbers (ℝ).

Here a question arises: What would happen if spacetime was not continuum? What will happen if spacetime cannot be represented by (ℝ)?

Hypothesis

The purpose of this work is to unify Quantum Mechanics and the General Theory of Relativity, eliminating the randomness in Quantum Mechanics through a model of geometric variables of curvature Oπ, replacing the set of the Real numbers ℝ [1] by the set of the "Real-natural" numbers $\mathcal{R}(\mathbb{N})$ [2] which would help the physical description of nature. Under the "atomic" hypothesis, that there is a natural physical unit of Spacetime ($VT^{\mathbb{N}}$), tetra dimensional, elementary, indivisible and the smallest one.

Max Planck devised a dimensional procedure to determine the absolute units of the Nature, since they are obtained from universal constants. As the Universe is four-dimensional we seek the unique combination of constants which gives us a Volume-Time (VT) = $G \cdot h \cdot c^{-2} = cm^{+3} \cdot sc^{-1}$.

The hypothesis is that this volume-time is the basic atom of spacetime.

$$VT^{\mathbb{N}} = G \bullet h \bullet c^{-2} = 4{,}9205 \cdot 10E\text{-}55\ cm.^{+3} \cdot sc^{-1}.\ [3]$$

[1] The Real number (ℝ) always has an infinite number of decimal numbers.

[2] The Real - natural number R (ℕ) always has a finite number of decimal numbers.

[3] Fundamental physical constants, (G) of gravity, (h) Planck's constant (c) speed of light.

Geometry of the Spacetime

Foreword

We know that the two fundamental theories on our understanding of the universe, General Relativity and Quantum Mechanics, are not right, since they describe two antagonistic worlds, therefore one of them or perhaps both must be wrong.

The cause for the infinites to appear when we join General Relativity and Quantum Mechanics without the possibility of being eliminated (General Relativity is not renormalizable), has its origin in the use of the set (ℝ) to describe physical nature.

This is in my opinion a fundamental and previous mathematical reason, which must be solved to

achieve the unification of both models, replacing the set of the Real numbers ($\mathbb{R}$) by the set of the Real-Natural numbers $\mathcal{R}(\mathbb{N})$ to represent physical reality.

We use the set of Real numbers, for both theories, in fact for all Physics. This is completely wrong, absurd and unnecessary, since it introduces mathematical concepts into Physics. These are not measurable (Physical) such as moment, point, infinitely small, infinite. We should remember that $\mathbb{R}$ is an "actual infinite" set (Cantor), that is to say that it fulfils the following:

1. Its elements lack "good order", that is, an ordinal number ($\mathbb{N}$) associated with each element of $\mathbb{R}$, which would indicate your order number according to size (number value). This property implies that there is no number $\mathbb{R}$ previous or posterior to any other $\mathbb{R}$ number.

2. The use of $\mathbb{R}$ implies that any physical measurement, such as distance, is infinitely divisible. It means that a distance can take any value.

3. In $\mathbb{R}$ the part is equal to the whole

All these properties, in my opinion, do not exist in nature. If we use the Real - natural numbers R($\mathbb{N}$) these three unnatural properties disappear. For this purpose, it is enough if we give up the idea that real numbers have infinite decimal places (that physically we do not need) and we replace it by R($\mathbb{N}$) which has a sufficiently large number of decimal places.

This choice ($\mathbb{R}$) allows a physical variable to take any value, but it also implies that the value of the variable may be worth infinite (singularity) and be confined to a point that lacks dimensions.

Gravitational and electromagnetic forces are inversely proportional to the square of the distance between the masses and the electrical particles. These forces increase when distance decreases. If distance is zero, the value of the Physical variable (gravitational force or electromagnetic force) is infinite (division by zero). These are the infinites that prevent the unification, this is the error that we continue to make, an error in the essence of Logic.

This error appears through the mathematical procedure of abstraction, which causes geometric objects of smaller dimensions than those of Physical Nature to appear, that is to say four, three spatial dimensions and a temporary dimension. I mean the mathematical concepts of point, zero dimension, line (dimension one), plane (dimension two)... I also mean the mathematical concepts and physical meaning of zero and infinite.

This Error is in the ambiguity of the mathematical point, when applied to physical concepts as distance, speed, acceleration...

The concept of point is physically absurd, since it has two exclusive properties; it exists or does not exist.

It is absurd to think that physical objects exist and do not exist. However, the mathematical concept of point of dimension = 0, when it is applied to the physics presents this paradox:

The point exists (physically). Because it has a real and exact position in any system of spacetime reference which is determined by its four coordinates in space time. In fact the point is used to indicate a position in spacetime (ℝ4).

The point does not exist (physically). Because it does not have dimensions (dimension = 0). It has no height, no length, no width, and does not exist in time. This incoherence is subtle, but clear after a brief reflection.

Physical Hypotheses and Prediction Model

The universe and all his contents has four dimensions.

Spacetime has four dimensions.

Matter has always has three spatial dimensions (volume) and exists in time; energy always occupies a volume of space and exists in time, therefore both of them have four dimensions.

Absolute vacuum lacking both matter and energy does not exist, since there is no way to isolate the gravity of a “spacetime volume”.

Relative vacuum, which at least contains gravity, has therefore, four dimensions. There is no physical example, (that exists and could be measured), of objects in our universe which has not four dimensions.

Following Euclides, it is not possible to construct, simply by adding (addition, sum), geometric objects of a different dimension from its construction elements, for example, it is not possible to build a line adding a large enough number of points.

If in Nature there are only four dimensions elements, the smallest and indivisible element of our universe must have four dimensions, that is, a volume that changes with time.

There are no objects in ℕature of less than four dimensions; they only exist in the Platonic world of ideas as mathematical abstractions of reality.

To calculate the value of the lowest spacetime we use the fundamental constants of nature, c, h, y G, in the same way as Max Karl Ernst Ludwig Planck did a century ago. We combined them looking in this case for a time volume, i.e. the volume of a box during an hour, for example, a unit of volume during a unit of time. This can be done with the following combination of fundamental constants, which is also unique:

$$G \cdot h \cdot c^{-2} = 4{,}920\ 551\ 532\ 644\ 910 \cdot 10\text{-}55\ \text{cm}^{+3} \cdot \text{sc}^{-1}$$

Smallest volume-time (without parts), indivisible, elementary.

As we know, the universe is isotropic, does not have favourite spatial directions, it presents the

same appearance and properties in any directions. The distinctions we make between length, width and height are merely semantic, since we can share their names and they still represent the same physical reality.

If we associate the idea of isotropy to the elementary and lowest order of the universe, this can only be a sphere.

As a sphere it is easy to calculate the radio: Lmo = 4,897 506 921 037 260E-19 centimeters minimum distance and any measurement of distance is equal to the Lmo product by a Natural number (ℕ)

This distance is covered at the speed of light in Tmo = 1,633 632 464 842 480 E-29 seconds. This is the lowest time interval, and any measurement of time is equal to the product of Tmo by a Natural number (ℕ).

As the distance is very small, there cannot exist a wavelength shorter than Lmo, 4,897 506 921 037 260E-19 centimeters. As it is the smallest wavelength it is the highest value of energy,

Emo = 253,177 660 585 902 TeV.

Any wavelength is equal to the product of Lmo by a Natural number (ℕ).

The value of any measurement of a quantity of energy is achieved dividing Emo by a Natural number (ℕ).

According the equivalence between mass and energy of Einstein $E = m \bullet c^2$, we have to divide by c^2 we obtain the biggest mass of a event (elementary, without parts) Mmo = 4,512 946 783 762 060E-19 grams.

Table of Energy Levels Predicted by the Model

First hundred levels of energy, predicted by the model, in colour energy levels detected in the LHC (CERN). Maximum 7 Tev (1st phase) and 14 Tev (2nd phase).

Nivel de Energía	Energía en TeV	Nivel de Energía		Nivel de Energía	Energía en TeV	Nivel de Energía	Energía en TeV
1	253,17766058590	26	9,73760233	51	4,964267855	76	3,331285008
2	126,58883029295	27	9,376950392	52	4,868801165	77	3,288021566
3	84,392553528634	28	9,042059307	53	4,776936992	78	3,245867443
4	63,294415146476	29	8,730264158	54	4,688475196	79	3,204780514
5	50,635532117180	30	8,439255353	55	4,603230192	80	3,164720757
6	42,196276764317	31	8,167021309	56	4,521029653	81	3,125650131
7	36,168237226557	32	7,911801893	57	4,441713344	82	3,087532446
8	31,647207573238	33	7,672050321	58	4,365132079	83	3,05033326
9	28,130851176211	34	7,446401782	59	4,29114679	84	3,014019769
10	25,317766058590	35	7,233647445	60	4,219627676	85	2,978560713
11	23,016150962355	36	7,032712794	61	4,150453452	86	2,943926286
12	21,098138382159	37	6,842639475	62	4,083510655	87	2,910088053
13	19,475204660454	38	6,662570015	63	4,018693025	88	2,87701887
14	18,084118613279	39	6,491734887	64	3,955900947	89	2,844692816
15	16,878510705727	40	6,329441515	65	3,895040932	90	2,813085118
16	15,823603786619	41	6,175064892	66	3,83602516	91	2,782172094
17	14,892803563877	42	6,028039538	67	3,778771054	92	2,751931093
18	14,065425588106	43	5,887852572	68	3,723200891	93	2,722340436
19	13,325140030837	44	5,754037741	69	3,669241458	94	2,693379368
20	12,658883029295	45	5,626170235	70	3,616823723	95	2,665028006
21	12,056079075519	46	5,503862187	71	3,565882543	96	2,637267298
22	11,508075481177	47	5,386758736	72	3,516356397	97	2,610078975
23	11,007724373300	48	5,274534596	73	3,468187131	98	2,583445516
24	10,549069191079	49	5,166891032	74	3,421319738	99	2,557350107
25	10,127106423436	50	5,063553212	75	3,375702141	100	2,531776606

Notice how the energy levels are closer to each other as the number of energy level increases. We can see that there are 21 levels of energy in the range of 3 TeV (from level 64 to 84) and only a level of 13 TeV (19 in red), according to the above, these discreet levels of energy (if we look for them) will become more evident in the second phase (yellow levels). I suggest the search of the level 19 as it is the only level that exists in the status of 13 TeV. These levels are so close to the energy levels in our daily life that they are not detectable and they seem to have the continuity that real numbers idealize**.** Remember that these energies are of quantum elementary events.

A century ago Max Planck took into account length, mass, time, the electrical load and the temperature as fundamental elements to describe Nature, using Coulomb's constant and Boltzmann's constant in addition to *c, h, G*.

These last two constants are not used in this work, since they are considered unnecessary for the

description of Quantum Geometry (elementary = not divisible) of the Spacetime.

The difference between Max Planck's dimensional procedure and that established in this work, is in what we consider elementary. For Planck these were length, mass and time.

This can be argued about, against the idea accepted at present, as it is reflected in the following paragraph:

"The system measures several of the fundamental magnitudes of the universe: time, length, mass, electrical charge and temperature. Planck's units are often called (in joke) "God's units" by physicists. This eliminates any anthropocentric arbitrariness of the system of units".

Extracted from Wikipedia, Planck's units.

This work considers a four dimension "spacetime volume" to be an elementary magnitude (without parts, indivisible.

In the following table we see the differences between both calculations.

Max Planck		**This Work**	
Dimensional formulae	Values (System c, g, s)	Dimensional formulae	Values(System c, g, s)
$t_p = \sqrt{\frac{G\hbar}{c^5}}$	=5.39121·10^{-44} seconds	$VT = \frac{Gh}{c^2}$	>>t = 1,63363·10^{-29} seconds
$l_p = \sqrt{\frac{G\hbar}{c^3}}$	=1.61624·10^{-33}centimeters	$VT = \frac{Gh}{c^2}$	>>l = 4,89750·10^{-19} centimeters
$m_p = \sqrt{\frac{c\hbar}{G}}$	=2.17645·10^{-5} grams	$VT = \frac{Gh}{c^2}$	>>*m* = 4,51294·10^{-19} grams

The magnitudes calculated by Max Planck for length and time are extremely small and they involve quantities of inaccessible energy to our technology.

On the contrary the magnitudes calculated in this work are experimentally contrasted at the levels of energy of the current particle accelerators (14 TeV LHC; CERN).

The highest quantity of energy 253,177 TeV is only to two orders of magnitude from the previous particle accelerators, quantum geometry has probably been photographed, but it has remained unnoticed between the trillions of events and data obtained in the experiments of these big accelerators.

For the first time, Quantum Gravitation will be within reach of the experimental physicists, particularly those currently working at the CERN (LHC), which are those that will be able to determine if the prophecies of this work are in accordance with Nature or are wrong

Details

On the words and concepts that I use I would like to avoid any ambiguity, firstly because these terms are easily mistaken due to their colloquial use, secondly the smallest because this ambiguity is also implicit in the physical - mathematical concepts of continuum, infinite and vacuum (zero), which we handle in General Relativity and Quantum Mechanics, when we refer to Space or to Time (Quantum), or to Spacetime (Relativity).

1st This text is essentially mathematical. When I say 'point' I refer to its physical-mathematical concept, geometric object of zero dimension [0,0,0,0]. In this geometrical object it has neither height, width, nor depth and does not exist in time.

2nd When I use the term continuous, continuum or continuity, I mean that the physical reality of the phenomenon to describe, can only be represented by the set of Real numbers ($\mathbb{R}$).

3rd For all matters concerning the concept of infinite, types of infinite sets, sets of Real numbers ($\mathbb{R}$) and Natural numbers ($\mathbb{N}$), I base on the work "The Theory of Transfinite Sets" by Georg Cantor.

Extract of the model.

If we understand the Differential calculus as a Physical Theory (reality), not as a mathematical model, which brings us near to that one infinitely, but without reaching it using the Mythological and physically absurd set of Real numbers ($\mathbb{R}$), we will verify that that is the logical way that the elementary and quantum nature of Spacetime Geometry shows us. Its elementary components (without parts), are volumes in time (VT). They have four dimensions (D4) and are smallest ($\varepsilon > 0$), of curved topology (π). They can only be represented by the set of natural numbers $\mathbb{R}$ ($\mathbb{N}$).

This route based on the Differential calculus is what I call the Quantum Geometry of Spacetime.

The work tries to lay the foundations and theoretical essentials for this route, which unifies the experimental results of Quantum Mechanics with the theory of the General Relativity, by including the hidden variable Oπ (Model of hidden variables).

Op= spacetime curvature of an elementary quantum event.

The model is relational and independent from the system of reference (Quantum Relativity), where both the General Theory of Relativity and Quantum Mechanics are modified. Neither the structure, nor the variables or the results of both models can be expressed as belonging to the set of the Real numbers ($\mathbb{R}$), all these belong to the set of the numbers $\mathcal{R}(\mathbb{N})$.

General Relativity can be expressed as an elliptical geometry with spherical topology (π) and radial dynamics. Quantum Mechanics is completed introducing causality, replacing the statistical treatment (chance, randomness) by a geometric treatment (causal, determinist) since we include the variable Oπ. This variable Oπ gives a causal explanation of Quantum Mechanics, since it establishes one to one (Bijection) connection, between the statistical results and the elementary geometries (without parts) of Spacetime that contain the above mentioned quantum events.

Likewise, it also determines the geometry (its form) and the metrics of Nature in its elementary, smallest or indivisible scale. It specifies a model of Quantum Relativity (to give geometrical form to Quantum Mechanics).

The attempts of unification of both theories, have always failed due to the appearance of the infinites. The origin of these indeterminacies is in a mistaken reading of the "Calculus" as a consequence of the error of expressing the continuity from points of zero dimension (D = 0; $\mathbb{R}$).

The set of real numbers ($\mathbb{R}$) has allowed us to represent the physical reality to our scale, but it is not right in the description of the elementary or indivisible nature of "Spacetime"; this can only be described in elementary terms, by four dimensional geometric objects, Volume-Time (VT) and only represented by the set of the natural numbers ($\mathbb{N}$).

The term continuous is only opposed to discreet if we use the concept of mathematical point to create the continuum (D=0; $\mathbb{R}$) (infinite divisibility).

There are no physical singularities in Nature; they are the result of using the set of the real numbers out of context (quantum scale). There are therefore mathematical singularities (division by zero) and not physical.

Other Predictions

1. - Quantum Mechanics describes the universe when the radio of volume-times containing the event, stretches to 4,897506921037260 E-19 cm. lowest Lmo distance. At this distance of an elementary mass Mmo, the universe has the highest curvature, or equivalently, is the highest energy of a quantum event. This wavelength corresponds at an energy level of 253,177660585902000 TeV. This level of energy has an asymptotic nature as unattainable or supreme.

The highest energy of a quantum elementary event = 253,177660585902 TeV

2.-The hidden variables of Quantum Mechanics are in the geometry, a very small scale, of the

spacetime that contains the quantum event. Up to date we have thought that the spacetime curvature on this scale was almost flat, therefore with very little influence. On the contrary, the Quantum Geometry places the origin of the curvature and therefore of geometry, in any particle with mass. Consequently, the highest curvature or maximum energy is at a Lmo smallest distance, of any "volume-time" occupied by an elementary mass (Mmo). The highest curvature is: $1/Lmo = 4{,}897\ 506\ 921\ 037\ 260 \cdot E{+}19\ cm^{-1}$

3.-As we know from Feynman, the quantum electrodynamics (Q.E.D.) was characterised in its beginnings because all its results were infinite. The reason for this is that the sum of stories must bear in mind all the possible ways, and these ways depend on the distance between particles. This distance becomes zero; the zero introduces the infinite in the results.

Feynman determined not to take the calculations up to zero to avoid the indeterminacy, replacing it by a very small number 10E-100 cm. and stopping the sums on stories on this value. This supposed a solution to indeterminations, but other problems arised. The uniqueness of the probability is lost and infinitesimal terms with negative energy appear.

These problems disappear, if instead of using a very small and arbitrary distance, we use the nature lowest distance. Lmo=4,897506921037470·E-19 cm. to interrupt the sums on stories. Both problems appear when adding probabilities of nonexistent interactions, particularly all those calculated for distances lower than 4,8975·E-19 cm.

4.-The tetra dimensional geometry at a quantum level behaves as if it were two-dimensional, (only two grades of freedom), since the radio determines three spatial dimensions and time the dynamic evolution. Moreover, the radio has the same ordinal that as time, (the tag of the spherical ring and the time since when it was radiated coincide).

History

Historically this incoherence has appeared before us three times. It is always concealed under the concept of continuity.

The first time that the incoherence showed itself was in the four sophisms by Zeno of Elea, 2.600 years ago. His logic is perfect, closed and conclusive. These sophisms were presented to the local philosophers in Athens, perhaps before the proper Socrates. We know that Aristotle and Plato knew the speech given by Zeno perfectly well.

The second time that the contradiction appeared again, was with the invention of the infinitesimal calculation. At that time many intellectuals were against the logic of such a theory, since there is no way of explaining the movement or its associated variables, speed and acceleration, in term of zero dimensional points

The mathematical point does not have another point coming after it, neither a previous one. There is no second point neither a fifth one, no previous one to any given point. Because the set

of the Real number (ℝ) lacks an ordinal number associated to its elements. In spite of being a completely tidy set, it lacks good order. How can we explain the movement from the point A, to the point B, if we cannot go out of A because the following point does not exist?

This contradiction is implicit in the incoherence of the mathematical point (dimensional = zero) with which the mathematical "continuum" is created (ℝ).

But since the calculation worked and it still works, and the subtle contradiction was not discovered, those who did not agree had to keep silent unwillingly.

Due to this, the movement and its associated magnitudes, speed and acceleration entered the club of the incoherence, since the set of the numbers Real (ℝ) is continuous (by definition) but the infinitesimal Calculation cannot be demonstrated mathematically in terms of points, dimension = zero, it can only be demonstrated mathematically in terms of intervals ($\varepsilon > 0$, dimension = 1).

The third time the incoherence appeared was with the birth of Quantum Mechanics (Beginning of Heisenberg uncertainty). The incoherent reality of the point concept went unnoticed again and divided Physics in two, introducing randomness in the quantum world.

Since then the universe possesses simultaneously two mutually exclusive properties: it is random and it is causal, depending on the size of the object of the Nature that we are studying. It is random if this one belongs to the microcosm and determinist if the object belongs to the macrocosm.

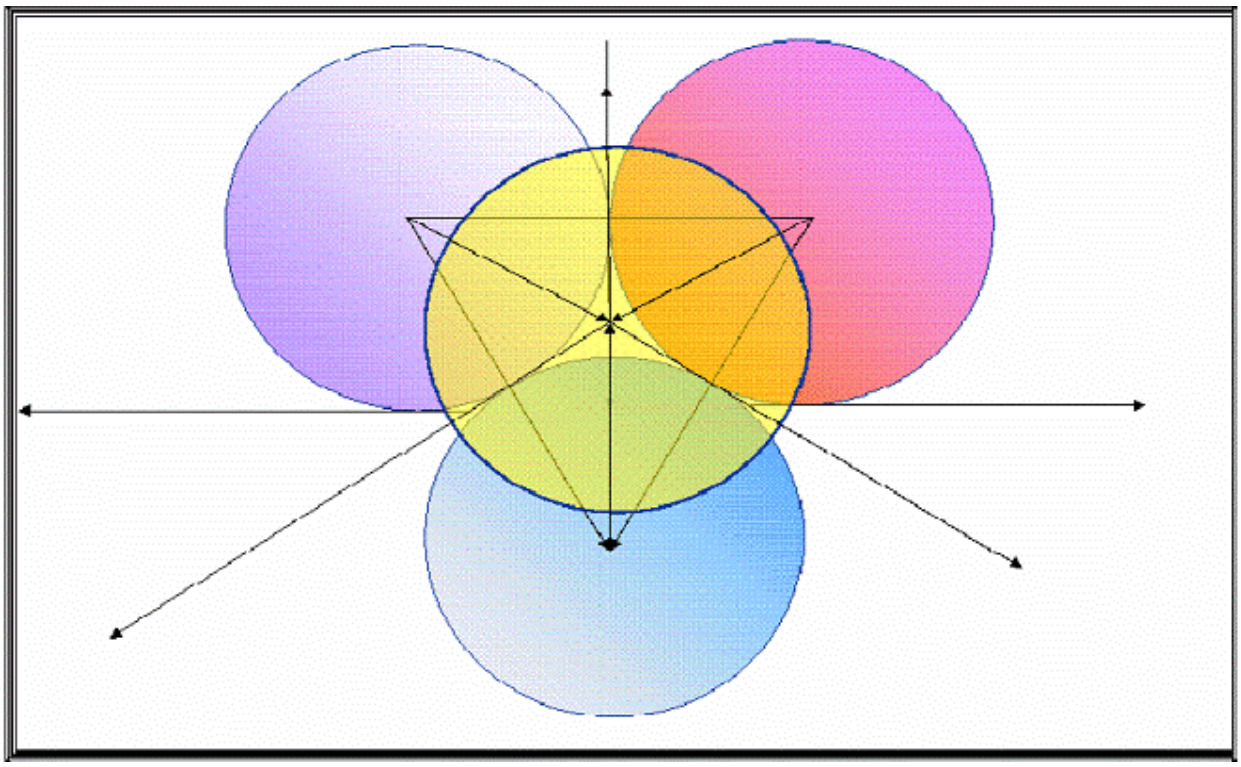
This model is finite, quantitative and predictive. It is experimentally contrastable at levels of energy between 1 and 14 TeV. Level 19=13,325 140 TeV.

The highest level of energy is 253,177 660 585 902 TeV. (Supreme value of energy of an Elementary Quantum event).

Rafael Javier Martínez Olmo

IX. The Quantum Geometry

Espaciotiempo ínfimo de tres quarks en oscuro y su leptón asociado, en claro.



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