Some anomalies of astrophysics and cosmology

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Abstract

Some old and also newer anomalies of astrophysics and cosmology will be discussed from the TGD point of view. The precession anomaly of Earth cannot be understood in terms of gravitational fields of Earth and there are strong indications that the entire solar system is precessing and that interactions in a much longer scale are involved. Cold dark matter (CDMΛ) scenario and MOND, which proposes that Newton's law of gravitation is modified for small accelerations, are the competing mainstream scenarios but both have serious problems. The quantization of the redshift along the line of sight ("God's fingers") is an old cosmological anomaly. On the basis of the study of CMB, Luminet et al proposed almost two decades ago that the Universe has the symmetries of dodecahedron. The James Webb telescope has already now detected numerous very distant galaxies challenging the views about formation of galaxies in which galaxies are formed via gravitational condensation.

In the TGD framework, galaxies are formed by decay of the energy liberated in the thickening of cosmic strings to ordinary matter as the counterpart of inflaton decay so that the process proceeds from short to long scales rather than vice versa. This could explain "too old" galaxies. Flux tubes connecting stellar systems could also explain the precession anomaly. The effective dodecahedral geometry of the Universe, could be an illusion produced by a diffraction pattern produced by the so-called local icosa-tetrahedral tessellation (astrophysical analog of crystal) associated with Earth. The diffraction would be made possible because CMB wavelength at the maximum of intensity as function of wavelength is very near to the dark gravitational Compton length of Earth. This might also explain the finding that quadrupole and octupole modes seem to align with each other and with both ecliptic plane and equinoxes, which is in conflict with the cosmological principle.

Contents

1 Introduction

In this article some old and also newer anomalies of astrophysics and cosmology will be discussed from the TGD point of view.

At the level of planetary physics there is an age-old anomaly related to the understanding of the precession of the Earth's rotation axis [E10] (http://tinyurl.com/o7453p5). This anomaly cannot be understood in terms of gravitational fields of Earth and there are strong indications that the entire solar system is precessing and that interactions in a much longer scale are involved. This is difficult to understand in the standard Newtonian view of gravitation.

At the level of galaxies dark matter is the basic problem. Cold dark matter model (CDMΛ) (https://cutt.ly/AZ6DRnh) and MOND [E8] are the competing mainstream scenarios but both have serious problems. MOND proposes that Newton's law of gravitation is modified for small accelerations. The TGD approach, based on the notion of cosmic string (in the TGD sense), replaces the dark matter halo of CDMΛ scenario with the mass density of long cosmic string containing galaxies as tangles with string thickened to a flux tube. TGD does not propose any modification of Newtonian gravitation but explains naturally the success of MOND, and also predicts precise differences between MOND and TGD for which empirical support already exists. The so-called ultra diffuse galaxies represent one challenge for cold dark matter and MOND and TGD also this anomaly.

Also cosmological anomalies are considered. The quantization of the redshift along the line of sight ("God's fingers") is the first such anomaly (for references see the Wikipedia article https://cutt.ly/9Z6hTQZ). Tifft [E11], Karlson [E7], Arp [E5] and and many others suggest that quasars and galaxies have quantized redshifts. Fang-Sato [E4] talks about "God's fingers' with redshift quantization along the line of sight. The TGD inspired proposal is that the quantization reflects the presences of tessellations of cosmic time= constant hyperboloid H^3. Tessellation is made possible by quantum gravitational coherence in astrophysical and possibly even cosmological scales for magnetic bodies carrying dark matter in the TGD sense.

On the basis of the study of CMB, Luminet et al proposed almost two decades ago that the Universe has the symmetries of dodecahedron [E2]. In the TGD framework, the finding could be perhaps understood as an illusion due to a diffraction pattern produced by the so-called local icosa-tetrahedral tessellation [L8] associated with Earth. The diffraction would be made possible because CMB wavelength at the maximum of intensity as function of wavelength is very near to the dark gravitational Compton length of Earth. This might also explain the finding that quadrupole and octupole modes seem to align with each other and with both ecliptic plane and equinoxes, which is in conflict with the cosmological principle.

The James Webb telescope has already now detected numerous very distant galaxies [E12]. This challenges the view about formation of galaxies by gravitational condensation. In the TGD framework, galaxies are formed by decay of the energy liberated in the thickening of cosmic strings to ordinary matter as the counterpart of inflaton decay so that the process proceeds from short to long scales rather than vice versa. This could explain these kinds of anomalies.

2 Anomalies in the physics of stars and galaxies

2.1 Precession problem

These comments were inspired by two interesting Youtube videos by Sören Backman (https://cutt.ly/yZ9CNgt and https://cutt.ly/nZ9C3QB) with a provocative title "Gravity's biggest failure - precession, what is it hiding". The precession of the Earth's spin axis cannot be explained as an effect caused by other planets and Sun and even the nearest stars are too far in order to explain the precession as an effect caused by them. Precession is therefore a real problem for the standard view of gravitation [E10] (http://tinyurl.com/o7453p5).

The proposal for the explanation of the precession of Earth discussed in the videos is inspired by the notion of Electric Universe, and has several similarities with the TGD inspired model. I could expect this from my earlier discussions with the proponents of Electric Universe. About 3 years ago, I wrote a chapter inspired by these discussions [L3].

My view is that the extremist view that gravitation reduces to electromagnetism is wrong but that electromagnetism, in particular magnetic fields, have an important role even in cosmological scales. In standard physics, magnetic fields in long scales would require coherent currents, which tend to be random and dissipate. Even the understanding of the stability of the magnetic field of Earth is a challenge, to say nothing of the magnetic fields able to survive in cosmological scales. In TGD, monopole flux tubes define magnetic fields which need no currents as sources.

Consider first monopole flux tubes, which are present in all length scales in the TGD Universe and distinguish TGD from both Maxwell's electrodynamics and general relativity.

1. Flux tubes can carry monopole flux, in which case they are highly stable. The cross section is not a disk but a closed 2-surface so that no current is needed to create the magnetic flux. The flux tubes with vanishing flux are not stable against splitting.

2. Flux tubes relate to the model for the emergence of galaxies [L2, L4] and explain galactic jets propagating along flux tubes [L10]. Dark energy and possible matter assignable to the cosmic strings predicts correctly the flat velocity spectrum of stars around galaxies.

3. In the MOND model it is assumed that the gravitational force transforms for certain critical acceleration from $1/r^2$ to $1/r$ force. In TGD this would mean that the $1/\rho$ force caused by the cosmic string would begin to dominate over the $1/\rho^2$ force (ρ denotes transversal distance from string). The predictions of MOND TGD are different since in TGD the motion takes place in the plane orthogonal to the cosmic string.

4. The flux tubes can appear as torus-like circular loops. Also flux tube pairs carrying opposite fluxes, resembling a DNA double strand, are possible and might be favoured by stability. Flux tubes are possible in all scales and connect astrophysical structures to a fractal quantum network. The flux tubes could connect to each other nodes, which are deformations of membrane-like entities having 3-D M^4 projections and 2-D E^3 projections (time= constant) (also an example of "non-Einsteinian" space-time surface).

5. Pairs of monopole flux tubes with opposite direction of fluxes can connect two objects: this could serve as a prerequisite of entanglement. The splitting of a flux tube pair to a pair of U-shaped flux tubes by a reconnection in a state function reduction destroying the entanglement. Reconnection would play an essential role in bio-catalysis.

6. Flux tube pairs can form helical structures and stability probably requires helical structure. Cosmic analog of DNA could be in question: fractality and gravitational quantum coherence in arbitrarily long scales are a basic prediction of TGD so that monopole flux tubes should appear in all scales. Also flux tubes inside flux tubes inside and hierarchical coilings as for DNA are possible.

A possible TGD inspired solution of the precession problem relies on the TGD view about the formation of galaxies and stellar systems.

1. Just like galaxies, also the stellar systems would have been formed as local tangles of a long monopole flux tube (thickened cosmic string), which itself could be part of or have been reconnected from a tangle of flux tube giving rise to the galaxy. The thickening liberates dark energy of cosmic strings and gives rise to the ordinary matter and is the TGD counterpart of inflation involving no inflaton fields.

2. In the same way as galaxies, stellar systems would be like pearls along string. This predicts correlations in the dynamics and positions of distant stars and galaxies and there is evidence for these correlations.

3. The flux tubes could connect the solar system to some distant stellar system. A good candidate for this kind of system is Pleiades, a star cluster located at a distance of 444 light years

(the nearest star has a distance of 4 light years). There would also be an analog of solar wind along this flux tube giving for the solar magnetosphere a bullet-like shape.

4. The transversal gravitational force of the flux tube would cause the precession of the solar system around the flux tube. The entire solar system, as a tangle of the flux tube, would precess like a bullet-like top around the direction of this flux tube [K7, K3].

5. The TGD analogs of Birkeland currents and the analogy of solar wind would flow along the monopole flux tubes, perhaps as dark particles in the TGD sense, that is having effective Planck constant $h_{eff} = nh_0$ which can be much larger than h, even so large that gravitational quantum coherence is possible in astrophysical and even cosmological scales.

2.2 MOND and TGD

The MOND theory (http://tinyurl.com/qt875) [E8] and its variants predict that there is a critical acceleration below which Newtonian gravity fails. This would mean that Newtonian gravitation is modified at large distances. String models and also TGD predict just the opposite since in this regime General Relativity should be a good approximation.

1. The $1/r^2$ force would transform to $1/r$ force at some critical acceleration of about $a = 10^{-10}$ m/s^2: this is a fraction of 10^{-11} about the gravitational acceleration at the Earth's surface.

2. The recent empirical study [E6] (http://tinyurl.com/ychyy3z3) gives support for this kind of transition in the dynamics of stars at large distances and therefore breakdown of Newtonian gravity in MOND like theories.

In TGD framework critical acceleration is predicted but the recent experiment does not force to modify Newton's laws. Since Big Science is like market economy in the sense that funding is more important than truth, the attempts to communicate TGD based view about dark matter [K4, K7, K5, K8, K2] have turned out to be hopeless. Serious Scientist does not read anything not written on silk paper.

1. One manner to produce this spectrum is to assume density of dark matter such that the mass inside sphere of radius R is proportional to R at last distances [K2]. Decay products of and ideal cosmic strings (http://tinyurl.com/y8wbeo4q) would predict this. The value of the string tension predicted correctly by TGD using the constraint that p-adic mass calculations give electron mass correctly [K1].

2. One could also assume that galaxies are distributed along cosmic string like pearls in necklace. The mass of the cosmic string would predict correct value for the velocity of distant stars. In the ideal case there would be no dark matter outside these cosmic strings.

   (a) The difference with respect to the first mechanism is that this case gravitational acceleration would vanish along the direction of string and motion would be free motion. The prediction is that this kind of motions take place along observed linear structures formed by galaxies and also along larger structures.

   (b) An attractive assumption is that dark matter corresponds to phases with large value of Planck constant is concentrated on magnetic flux tubes. Holography would suggest that the density of the magnetic energy is just the density of the matter condensed at wormhole throats associated with the topologically condensed cosmic string.

   (c) Cosmic evolution modifies the ideal cosmic strings and their Minkowski space projection gets gradually thicker and thicker and their energy density - magnetic energy - characterized by string tension could be affected

TGD option differs from MOND in some respects and it is possible to test empirically which option is nearer to the truth.

1. The transition at same critical acceleration is predicted universally by this option for all systems-now stars- with given mass scale if they are distributed along cosmic strings like like pearls in necklace. The gravitational acceleration due the necklace simply wins the gravitational acceleration due to the pearl. Fractality encourages to think like this.

2. The critical acceleration predicted would correspond to acceleration of the same order of magnitude as the acceleration caused by cosmic string. From $M^2/R_{cr} = GM/R_{cr}^2 = TG/R_{cr}$ (assuming that dark matter dominates) one obtains the estimate $R_{cr} = M/T$ and $a_{cr} = GT^2/M$, where M is the visible mass of the object - for instance the ordinary matter of a galaxy. If critical acceleration is always the same, one would have $T = (a_{cr}M/G)^{1/2}$ so that the visible mass would scale like $M \propto T^2$ if a_{cr} is constant of Nature.

3. If $1/r^2$ changes to $1/r$ in the MOND model, one obtains the same predictions as in TGD for the planar orbits orthogonal to the long string along which galaxies correspond to flux tube tangles. The models are not equivalent. In TGD, general orbit of the star corresponds to a helical motion of the star in the plane orthogonal to the cosmic string and along the cosmic string so that the observed concentration of visible matter on a preferred plane is predicted. This concentration of orbits in a single plane has been recently reported as an anomaly of dark matter models [L11].

2.3 Ultradiffuse galaxies as a test for theories of dark matter

The existence of ultra diffuse galaxies for which the velocity of distant rotating stars is extremely low means difficulties for the cold dark matter scenario since in some cases there seems to be no dark matter at all, and in some cases there seems to be only dark matter. Also MOND has grave difficulties with them.

The problem in the case of galaxy AGC 114905 (`https://cutt.ly/AZ9VfNN`) is discussed in a popular article "In a Wild Twist, Physicists Have Revived an Alternative Theory of Gravity" published in Science-Astronomy (`https://cutt.ly/UZ9zBMh`). This galaxy is of the same size as Milky Way and seems to have very small amount of dark matter, if any.

Mancera Pina et al [E3] argue that both cold dark matter scenario and MOND fail to explain the anomalously low value of the rotation velocity of distant stars. The proposal of Banik et al [E1] is that the inclination between the galactic disc and skyplane is overestimated, which leads to a too small estimate for the estimate for the rotation velocity so that MOND could be saved.

In the TGD framework [L2, L4, L10], the rotation velocity is proportional to the square root of the product GT, where T is the string tension of a long magnetic flux tube formed from a cosmic string carrying dark energy and possibly also matter. In the ordinary situation, the flux tube would be considerably thickened only in a tangle associated with the galaxy as part of volume- and magnetic energies would have decayed to ordinary matter, in analogy with the decay of the inflaton field.

If the flux tube itself has a very long thickened portion such that ordinary matter has left this region by free helical motion along the string or by gravitational attraction of some other object, the string tension T is small and very small velocity is possible. Ordinary gravitational bound states of matter are not necessary since the gravitational force of the flux tubes binds the stars. This might explain why the galaxy can be ultra diffuse.

3 Cosmological anomalies

3.1 God's fingers

There is a Wikipedia article ()`https://cutt.ly/9Z6hTQZ`) about te redshift quantization for quasars and galaxies. Tifft [E11], Karlson [E7], Arp [E5] and Fang-Sato [E4] and many others suggest that quasars and galaxies have quantized redshift. This quantization alolines of sight, which has been considered also by Fang-Sato, who talked of "God's fingers". I have considered several explanations for the quantization.

1. To my opinion, the most convincing explanation is in terms of lattice-like structures, tessellations, in hyperbolic space H^3, which corresponds to cosmic time a= constant hyperboloid of future light-one [K8].

2. H^3 allows an infinite number of tessellations, which correspond to discrete subgroups of Lorentz group SO(1,3) having as covering SL(2,C) (spinors). In E^3 only 17 lattices are possible. The so-called icosa-tetrahedral tessellation is in a key role in TGD model of genetic

code realized at a deeper level in terms of dark ($h_{eff} = nh_0 > h$) proton triplets and flux tubes of magnetic body [L8]).

3. For lattices in the Euclidean space E^3, the radial distance from origin is quantized. For H^3 redshift proportional to H^3 distance replaces Euclidian radial distance and the tessellation gives redshift quantization. Astrophysical objects would tend to be associated with the unit cells of the tessellation.

4. The tessellation itself could be associated with the magnetic (/field) body carrying dark matter in the TGD sense as $h_{eff} = nh_0 > h$ phases: this is a prediction of number theoretic vision about physics as dual of geometric vision. Very large values of $h_{eff} = h_{gr} = GMm/v_0$ (Nottale hypothesis for gravitational Planck constant [K7] assignable to gravitational flux tubes are possible, and this makes these tessellations possible as gravitationally quantum coherent structures even in cosmological scales. This is a diametric opposite to what superstring models where quantum gravitation appears only in Planck length scale, suggests.

3.2 Universe as a dodecahedron?: two decades later

I encountered a link to a popular article in Physics World with the title "Is the Universe a dodecahedron" (`https://cutt.ly/IZ9VRIs`) telling about the proposal of Luminet et al [E2] that the Universe has a geometry of dodecahedron. I have commented on this finding almost 20 years ago [?] A lot has happened during these two decades and it is interesting to take a fresh TGD inspired view.

In the TGD framework, one can imagine two starting points concerning the explanation of the findings.

1. Could there be a connection with the redshift quantization along the lines (God's fingers) proposed by Halton Arp? In TGD cosmic=time constant surface corresponds to hyperbolic 3-space H^3 of Minkowski space in TGD. H^3 allows an infinite number of tessellations (lattice-like structures).

   I have proposed an explanation for the redshift quantization in terms of tessellations of H^3. The magnetic bodies (MBs) of astrophysical objects and even objects themselves could tend to locate at the unit cells of the tessellation.

2. Icosa-tetrahedral tessellation (lattice-like structure in hyperbolic space H^3) plays a key role in the TGD model of genetic code [L8] suggested to be universal. Lattice-like structures make possible diffraction if the incoming light has a wavelength, which is of the same order as the size of the unit cell.

In the sequel I will consider only the latter option.

1. In X ray diffraction, the diffraction pattern reflects the structure of the dual lattice: the same should be true now. Only the symmetries of the unit cell are reflected in diffraction. If CMB is diffracted in the tessellation, the diffraction pattern reflects the symmetries of the dual of the tessellation and does not depend on the value of the effective Planck constant h_{eff}. Large values of Planck constant make possible large crystal-like structures realized as part of the magnetic body having large enough size, now realized at the magnetic body (MB).

2. Icosa-tetrahedral tessellation plays a key role in the TGD inspired model of the genetic code. Dodecahedron is the dual of icosahedron and tetrahedron is self-dual! [Note however that also the octahedron is involved with the unit cell although "icosa-tetrahedral" does not reflect its presence. Cube is the dual of the octahedron.]

   So: could the gravitational diffraction of CMB on a local crystal having the structure of icosa-tetrahedral tessellation create the illusion that the Universe is a dodecahedron?

Could the possible dark part of the CMB radiation diffract in local tessellations assigned with the local MBs?

1. In diffraction, the wavelength of diffracted radiation must correspond to the size of the unit cell of the lattice-like structure involved. The maximum wavelength of CMB intensity as function of wavelength corresponds to a wavelength of about .5 cm. Can one imagine a tessellation with the unit cell of size about .5 cm?

2. The gravitational Planck constant $\hbar_{gr} = GMm/\beta_0$, where M is large mass and m a small mass, say proton mass [K7, K6] [L1, L7, L13, L14]. Both masses are assignable to the monopole flux tubes mediating gravitational interaction. $\beta_0 = v_0/c$ is velocity parameter and near to unity in the case of Earth.

3. The size scale of the unit cell of the dark gravitational crystal would be naturally given by $\Lambda_{gr} = \hbar_{gr}/m = GM/\beta_0$ and would be depend on M only and would be rather large and depend on the local large mass M, say that of Earth. Λ_{gr} does not depend on m (Equivalence Principle).

4. For Earth, the size scale of the unit cell would be of the order of $\Lambda_{gr} = GM_E/\beta_0 \sim .45$ cm, where $\beta_0 = 0 = v_0/c \sim 1$ is near unity from the experimental inputs emerging from quantum hydrodynamics [L9] and quantum model of EEG [L7] and quantum gravitational model for metabolism [L14, L13]. Λ_{gr} could define the size of the unit cell of the icosa-tetrahedral tessellation. Note that Earth's Schwartschild radius $r_S = 2GM \sim .9$ cm.

   Encouragingly, the wavelength of CMB intensity as a function of wavelength around .5 cm to be compared with $\Lambda_{gr} \sim .45$ cm! Quantum gravitational diffraction might take place for dark CMB and give rise to the diffraction peaks!

5. Diffraction pattern would reflect astroscopic quantum coherence, and the findings of Luminet et al could have an explanation in terms of the geometry of local gravitational MB rather than the geometry of the Universe! Diffraction could also explain the strange deviations of CMB correlation functions from predictions for large values of the angular distance.

   It might be also possible to understand the finding that CMB seems to depend on the features of the local environment of Earth, which is in a sharp conflict with the cosmological principle. According to Wikipedia article (`https://cutt.ly/YZXJ7ao`), Even in the COBE map, it was observed that the quadrupole ($l = 2$, spherical harmonic) has a low amplitude compared to the predictions of the Big Bang. In particular, the quadrupole and octupole ($l = 3$) modes appear to have an unexplained alignment with each other and with both the ecliptic plane and equinoxes.

6. Could the CMB photon transform to a gravitationally dark photon in the diffraction? This would be a reversal for the transformation of dark photons to ordinary photons interpreted as biophotons. Also in quantum biology the transformation of ordinary photons to dark ones takes place. If so the wave length for a given CMB photon would be scaled up by the factor $\hbar_{gr}/\hbar = (GM_Em/\beta_0)/\hbar \simeq 3.5 \times 10^{12}$ for proton. This gives $\Lambda_{gr} = 1.75 \times 10^7$ km, to be compared with the radius of Earth about 6.4×10^6 km.

3.3 Is James Webb telescope forcing a revolution in cosmology?

The first preliminary findings of the James Webb telescope, the successor of the Hubble telescope, are in conflict with the standard view of the formation of galaxies. The YouTube video (`https://cutt.ly/OZc4lV7`) "James Webb Found Galaxies That Sort of Break Modern Theories" gives a good summary of these findings. The findings are also summarized in an article in Nature [E12] (`https://cutt.ly/lZc4clq`) with the title "Four revelations from the Webb telescope about distant galaxies".

3.3.1 The official story

The official story of the formation of galaxies goes roughly as follows.

1. Around 3 minutes of cosmic time, the cosmic microwave background emerged as the first atoms formed and radiation decoupled from matter.

2. When the age of the Universe was more than about .1 billion years, the first stars were formed. They lived their life and exploded as supernovas and yielded interstellar hydrogen gas. Galaxies started to form. One can see this process as a gravitational condensation. What is essential is that this process went from long to short scales, just as the formation of stars in the earlier phase.

3. The model gives a stringent upper bound for the age of the galaxies. They should be younger than the oldest observed stars. This limit gives an upper bound for the distance of the galaxy, that is for its redshift.

3.3.2 The findings of James Webb telescope

The first, preliminary, observations of the James Webb telescope were galaxies with redshifts up to 16. Even redsshift extending to 20 have been speculated in arXiv papers. Redshift 16 would correspond to the age of 250 million years and redshift of 20 to the age of 200 million years. They are too far to fit into the official picture. To get some perspective, note that the estimate for the age of the Universe is 13.8 billion years.

The ages of these galaxies were few hundred million years and of the same order as the estimated ages of about 100 million years of the hypothetical population III stars (`https://cutt.ly/eZc4mr1`), which are thought to be the oldest stars but have not not (yet?) detected. The criterion for the age of the star is its metal content: the first stars should have contained only hydrogen and Helium and "metal" here means anything heavier than Helium.

The suggestive conclusion is that there was a significant population of star forming galaxies in the early universe. This challenges the standard view stating that stars came first and led to the formation of galaxies.

Scientific American has an article with title "JWST's First Glimpses of Early Galaxies Could Break Cosmology" (`https://cutt.ly/R0hqYLW`), which provide a nice summary of the first findings of the telescope. This gave an opportunity to sharpen the somewhat fuzzy view of how the findings of James Webb telescope relate to TGD.

What was found first, was a galaxy dubbed as "GLASS-z13". It was found by Rohan Naidu and led to an article published within a few days. The discovery of the GLASS-z13 was followed by a discovery by numerous even more distant galaxies. The very existence and the properties of these galaxies came as a total surprise.

1. From the redshift of about $z = 13$, the GLASS-z13 was dated back 300 million years after the big bang that is thought to have occured 13.8 billion years ago. According to the standard view of galaxy formation (so called Lambda CDM model involving dark matter as exotic particles), galaxies with such a large distance are not expected to even exist. According to the standard model, the formation of galaxies should have begun at the cosmic age of about 400 million years. The galaxy found by Naidu would have emerged more than 70 millions years too early.

2. The images of the galaxies from so early era were expected to be extremely dim. The galaxies discovered were however anomalously bright.

3. The large size of the galaxies came as a total surprise. The age of the galaxies increases with its age and the conclusion was that the galaxies had to be much more mature than the standard model for the formation of galaxies allows. This leads to a paradox since the first galaxies should be very young.

3.3.3 The TGD view of the formation of galaxies

TGD proposes an unofficial view of the formation of galaxies [L2, L4, L10].

1. In the very beginning the Universe was dominated by cosmic strings, which were space-time surfaces in $H = M^4 \times CP_2$ having 2-dimensional M^4 projection. They were not "Einsteinian" space-time surfaces with 4-D M^4 projection and have no counterpart in general relativity.

2. Cosmic strings were unstable against thickening of the M^4 projection to 4-D one. Phase transitions thickening the cosmic strings occurred and increased their thickness and reduced string tension so that part of their energy transformed to ordinary matter. This is the TGD counterpart for inflation.

   This process led to radiation dominated Universe and the local description of the Universe as an Einsteinian 4-surface became a good approximation and is used in standard cosmology based on the standard model as a QFT limit of TGD.

   At this moment the thickness of the thickened strings would be around 100 micrometers, which corresponds to a length scale around large neuron size. Water blob with this size has mass of order Planck mass. The connection with biology is suggestive [L13, L15, L6].

3. The liberated dark energy (and possible dark matter, dark in the TGD sense) assignable to cosmic strings produced quasars, which in the TGD framework are identified as time reversals of the ordinary galactic blackholes. They did not extract matter from the environment but feeded darl energy as matter to the environment as jets. Jets are observed and explained in terms of the magnetic field due to the rotation of the galaxy.

   The jets are somewhat problematic in the GRT based cosmology since the simplest, non-rotating Schwarzschild blackholes do not allow them. The rotating blackholes identifiable as Kerr-Newman blackholes [B1, B2] accompanied by magnetic fields, also have some interpretational problems. For instance, the arrow of time can be said to be different in the nearby and faraway regions and closed time-like geodesics are possible. In TGD, this could have an interpretation in terms of zero energy ontology (ZEO). The matter from the jets would have eventually led to the formation of atoms, stars, and galaxies.

4. What is essential is that the formation of galaxies proceeds from short to long scales rather than vice versa as in the standard cosmology. A second essential point is that the dark energy (and possible dark matter) concentrated at cosmic strings was added to the ordinary matter predicted by the standard model to be present in the radiation dominated cosmology. This led to the formation of galaxies. Therefore this picture is consistent with the standard story as far as the formation of atoms and emergence of CMB is considered.

The possibility considered in [L2, L4, L10] is that quasars are time reversed black-holes (this property can be formulated precisely in zero energy ontology (ZEO), which forms the basis of TGD based quantum measurement theory) [L5, L12] [K9]. Note that the time reversal property would hold true in long time scales at the magnetic body (MB) defined by the monopole flux tubes produced by the thickening of the cosmic strings. For ordinary matter, the scale for the time spent with a given arrow of time is very short but MB with a large gravitational Planck constant can force ordinary matter to effectively behave like its time reversed version.

There is indeed quite recent support for the proposal that quasars are time reversals of blackhole-like objects identified in the TGD framework as monopole flux tube tangles. The Hubble telescope detected a dwarf galaxy at a distance of 30 million light years for which the number of stars is about 10 per cent for that in the Milky Way [E9]. Its center contains a blackhole-like object (https://cutt.ly/kZc77B1), which did not extract matter from the environment but did just the opposite by jets, which gave rise to a formation of stars.

The observations challenging the basic dogma of blackhole physics are not new and during writing of the article [L10] I got the impression that one of the basic challenges is to explain why some blackholes do just the opposite of what they should do.

This picture leads to ask whether blackhole evaporation could have a counterpart in TGD. The "death" of blachole-like object (BHO) could mean a macroscopic "big" state function reduction (BSFR) in which the arrow of time changes. Since the time reversal occurs at the level of MB, one can observe the behavior of time reversed BHO at the new geometric past of the BHO and finds that BHO feeds matter to the environment and can produce stars. Biological death (and also falling asleep) would correspond to BSFR. Could the time reversed history for BHO correspond to the evaporation of the ordinary blackhole? Could an analog of the decay of a dead organism occur after the geometric time at which time reversal for BHO took place.

3.3.4 TGD based explanation for the three paradoxical findings

One can indeed understand the 3 paradoxical findings described in Scientific American article in the TGD view of galaxy formation.

1. According to the standard model, these galaxies were formed quite too early. The standard mechanism of formation is a gravitational condensation of stars and interstellar to form galaxies. Dark matter halo plays a key role in the process. The model is however plagued by several contradictions. As a matter of fact, empirical facts suggest that there is no dark halo. The MOND model explains many of the anomalies but is in conflict with the Equivalence Principle and in conflict with standard Newtonian gravitation. The TGD based model replaces dark matter halo with long cosmic strings carrying dark energy and possibly also dark matter. One does not lose either Equivalence Principle or Newtonian gravitation.

   The TGD based view of galaxy formation is diametrically opposite to the standard view, being analogous to the generation of ordinary matter via the decay of the inflation field in the inflationary cosmology. Ordinary matter would have been created by the decay of the energy of cosmic strings to ordinary matter as they formed tangles. This led to a thickening of cosmic strings to monopole flux tubes and to a reduction of string tension so that energy was liberated as ordinary matter. In particular, galactic dark matter and the flat velocity spectrum of distant stars find an elegant explanation.

   In this view galaxies started to emerge already during the TGD analogue of the inflationary period.

2. The high apparent luminosity of these galaxies is the second mystery. Are the galaxies indeed so luminous as they seem to be? Or could it be that the standard view of how light emitted by galaxies is distributed is somehow wrong?

   In the TGD framework, the space-time of general relativity is replaced with a fractal network of nodes defined by various structures including galaxies, stars, planets,... Monopole magnetic flux tubes connect the nodes and the light propages as beams of dark photons (in the TGD sense) along these flux tubes. A light beam travelling along a flux tube is not attenuated at all if the cross section of the flux tube stays constant. Therefore the intensity of the light beam is not reduced with distance. In GRT it would be reduced since there would be no splitting to beams. This would explain why the apparent luminosities of the galaxies are anomalously high.

3. The unexpectedly large size of the galaxies implies a long age if one believes in the standard view of galactic evolution. This paradox finds a solution in zero energy ontology (ZEO), which defines the ontology of quantum TGD. ZEO solves the basic paradox of quantum measurement theory and is forced by the holography implied in the TGD framework by 4-D general coordinate invariance.

   In ZEO, the arrow of time changes in ordinary quantum jumps ("big" state function reductions, BSFRs). The repeated change of the arrow of time in the sequence of BSFRs implies that the system can be said to live forth and back in geometric time. Aging does not correspond to "center of mass motion" in time direction but this forth and back motion. In the TGD inspired biology, BSFR is analogous to death or falling asleep.

   In "small" SFRs (SSFRs) the arrow of time is not changed and they are counterparts of weak measurements introduced by quantum opticians. They generalize the quantum measurements associated with the Zeno effect, in which a system is frozen and its state does not change. Now the sequence of SSFRs would define a conscious entity, self.

   In TGD, gravitational quantum coherence is possible in all scales and galaxies would be astrophysical quantum systems performing BSFRs. Even astrophysical objects such as galaxies would live forth and back in time. This would give rise to galaxies and stars older than the Universe if one tries to explain their age using the standard view of the relationship between experienced time and geometric time.

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