Article

A Model for the Formation of Galaxies

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Abstract

A qualitative model for the formation of elliptic and spiral galaxies based on the general model of galaxy as a tangle of cosmic string thickened to flux tube in the tangle generating the visible matter of galaxy in process analogous to the decay of inflaton field to particles is discussed. Elliptic galaxies are structurally simple and naturally in some sense building bricks of spiral galaxies with much complex structure. In the case of spiral galaxies the existence of vast polar structures (VPOS) in the plane orthogonal to the galactic plane of spiral galaxy strongly suggest that at least two cosmic strings are involved and that the spiral structure formed as standing wave analogous to traffic jam is associated with dark matter of a long cosmic string. The stars of spiral galaxies are indeed older than those of elliptic galaxies except inside the bulge. The asymmetry between the two planes suggests that the spiral arms are formed as elliptic galaxy identified as a tangle of a long string $S_{||}$ in the galactic plane has collided with a cosmic string $S_{\perp}$ orthogonal to the plane. This would have generated the spiral structure in the galactic plane as $S_{||}$ and ordinary matter formed from it starts to differentially rotate around $S_{\perp}$. $S_{||}$would have also generated the visible spiral arm pair in the transformation of dark energy to ordinary matter. The galactic bar could be analogous to the dipole of dipole magnetic field. Galactic bulge would correspond to the elliptic galaxy and galactic blackhole like entity (BHE) would have formed from the matter in bulge: this conforms with the fact that elliptic galaxies have always galactic blackhole.

1 Introduction

I have proposed a general vision about galaxy formation as formation of tangles on cosmic strings carrying monopole flux. The strings can be long and also short. In the case of long string the model explains flat velocity spectrum of distant stars automatically. For closed short strings the velocity spectrum is not flat. There is however no detailed model for the galaxy formation. In particular, the complex structure of spiral galaxies is poorly understood. Even the question whether there is single long cosmic string orthogonal to the galactic plane or cosmic string parallel to the spiral structure in galactic plane - as proposed decades ago in the original model [6, 7] - or both has remained open. In the sequel I make an attempt to collect the essential facts about elliptic and spiral galaxies and consider a qualitative model for the galaxy formation consistent with these facts. The goal is rather modest: just to develop an internally consistent view about the evolution of galaxies.

1. The simplest model for elliptic galaxy is as a closed string possibly reconnected as a loop from long string or as a tangle of a cosmic string having topology analogous to that of field lines of dipole magnetic field. Quasar would have preceded the formation of the tangle in which string would have thickened to flux tube and dark energy would have transformed to ordinary matter [1] [18]. Quasars would be time reversal of galactic blackhole like entity (GBHE).

2. In the case of spiral galaxies the existence of vast polar structures (VPOS) in the plane orthogonal to the galactic plane of spiral galaxy (`http://tinyurl.com/k553545`) strongly suggest [16] that two cosmic strings are involved and that the spiral structure believed to correspond to a standing wave analogous to traffic jam is associated with dark matter of a long cosmic string. This model

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conforms with the fact that the stars of spiral galaxies are older than those of elliptic galaxies except inside the bulge.

The asymmetry between the two planes suggests that the spiral arms are formed when an elliptic galaxy identified as a tangle of a long string $S_{||}$ formed via a quasar stage [18] in the galactic plane has collided with a cosmic string $S_{\perp}$ orthogonal to the galactic plane. These collisions are unavoidable for non-parallel strings and gravitational attraction causes the needed relative motion.

The differential rotation of portion of $S_{||}$ around $S_{\perp}$ would have deformed $S_{||}$ to a spiral shape. $S_{||}$ would have also generated the visible spiral arm pair in the transformation of dark energy to ordinary matter. Galactic bulge would correspond to the elliptic galaxy and galactic blackhole like entity (GBHE) would have formed from the matter in bulge: this conforms with the fact that elliptic galaxies have always galactic blackhole. The galactic bar could be analogous to the dipole of dipole magnetic field. In principle also the string orthogonal to the galactic plane could produce ordinary matter by thickening.

One open question relates to the fact that TGD predicts two kinds of cosmic strings with closed transverse cross section and having vanishing induced Kähler field or non-vanishing induced Kähler form carrying monopole flux. The latter are stable against splitting by the conservation of the monopole flux and have no counterpart in Maxwellian electrodynamics [19]. The monopole flux tubes could correspond to the cosmic strings giving rise to galaxies, stars, and even planets as tangles. Non-monopole flux tubes might serve as gravitational flux tubes mediating gravitational interactions. Presumably both kinds of flux tubes are involved but their precise roles are not well-understood.

2 Some basic facts about galaxies

In the following I collect basic facts about galaxies.

2.1 Elliptic galaxies

The following facts about elliptic galaxies (`http://tinyurl.com/ayyvg9n`) are relevant for what follows.

1. 10-15 per cent of all galaxies are elliptic. The stars of elliptic galaxies are old and older than those of spiral galaxies outside the bulge.

2. The size of elliptic galaxies is typically 1-2 pc and therefore more than by order of magnitude smaller than that of spiral galaxies. Elliptic galaxies are essentially 3-D structures without sub-structures, and the central bulge of spiral galaxies resembles elliptical galaxy. There is no preferred galactic plane. Large enough elliptic galaxies have supermassive blackhole-like entity (BHE) at their center. Elliptic galaxies are populated by globular clusters. The motions of stars in elliptic galaxies are mostly radial.

3. Whether elliptic galaxies contain dark matter is not clear and the non-existence of dark matter cannot be excluded for elliptic galaxies (`http://tinyurl.com/s2wrd26`).

2.2 Basic structures for spiral galaxies

Most galaxies 85-90 per cent of galaxies are spiral galaxies. Spiral galaxies are highly structured.

Consider first the visible structure taking Milky Way as a representative example (also so called mini-spirals exist [16]).

1. Stellar disk of spiral galaxy (`http://tinyurl.com/vx2hams`) has radius $R_D = 23 - 30$ kpc. In the case of Milky Way one can distinguish 3 different disks. The young thin disk contains young stars

and has thickness of .1 kpc, which is also the size scale of globular clusters. The old thin disk has thickness of .325 pc. The thick disk has a thickness of 1.5 kpc. This gives some hints about the formation of the Milky Way.

2. Milky Way has 4 spiral arms. The arms begin from the ends of galactic bar with length 1-5 kpc. The interpretation of arms is as standing waves. Traffic jam is used analogy for arms: the stars rotating around the center of galaxy would slow down at the arm. The question is what causes the jam. For the second arm pair the number of stars is larger than for the second pair.

3. Spiral galaxies do not have bulge always (`http://tinyurl.com/tb7ca72` and `http://tinyurl.com/uv79o9x`). The bulge can contain also spiral sub-bulge in the galactic plane. The bulge is few kpc thick. Galactic blackhole (like entity) is present only if bulge is present and has in the case of Milky Way size scale of 10^4 ls (10^{-4} pc).

4. Vast polar structure - VPOS (`http://tinyurl.com/k553545`) is a disk in the plane orthogonal to the galactic plane containing satellites, which are dwarf galaxies and globular clusters and streams of stars and gas. The disk has radius 250 kpc considerably larger than stellar disk in galactic plane. Its thickness is 50-60 kpc whereas the components of galactic disk have much smaller thickness.

5. There are also stellar nebulae containing hydrogen and acting as stellar nurseries.

6. Cold dark matter scenario (`http://tinyurl.com/zv6wg4s`) leads to the conclusion that galaxy involves dense dark core radius 2-3 times that of stellar disk and having constant density and behaving like rigid body in good approximation. Dark matter halo predicts that the density is peaked and this leads to core-cusp problem [3]. The dark matter core could relate to the VPOS having the same thickness. Inside the core region rotation velocity should be constant if dark matter dominates.

Milky Way has a pair of Fermi bubbles located symmetrically at the opposite sides of the galactic plane and touching it. The diameter of bubble is 7.7 kpc. By the way, Earth is at the boundary of Fermi bubble (`http://tinyurl.com/r9f8nee`). The bubbles expand at velocity $v = 3.2 \times 10^{-3}c$. It is believed that the bubbles are a remnant of a very energetic event occurred for millions of years ago in the galactic center. The bubbles would not be a dynamical phenomenon rather than a morphological feature.

3 TGD based model

In the sequel the TGD inspired cosmology and model for the formation of galaxies is first briefly summarized, and after that a possible qualitative model for the formation of galaxies is discussed.

3.1 TGD inspired view about cosmology

TGD based model to be discussed relies on the general vision about cosmology.

1. Einsteinian space-time corresponds to space-time surfaces with 4-D M^4 projection. The many-sheetedness of space-time surface is lost at the QFT-GRT limit replacing the sheets with single region of M^4, whose metric is slightly deformed. The sums of the induced gauge potentials *resp.* deviations of the metric from M^4 metric define gauge fields of the standard model *resp.* metric of GRT space-time. This approximation fails for cosmic strings.

2. Cosmic strings come in two different varieties having closed transversal cross section as 2-D CP_2 projection and string world sheet as M^4 projection. The 2-D cross section can carry non-trivial monopole type Kähler flux or vanishing Kähler flux but non-vanishing electroweak gauge fields. Neither flux tube needs current to create the magnetic field since cross section is closed.

In primordial cosmology cosmic strings of both types dominate. The cosmic strings are unstable against thickening of M^4 projection and during the analog of inflationary period meaning transition to a radiation dominated cosmology the M^4 projection becomes 4-D and Einsteinian space-time becomes a reasonable approximation in long length scales.

Cosmic strings and thin flux tubes are however present also during Einsteinian period and cannot be completely neglected. For instance, monopole flux tubes explain the existence of magnetic fields in cosmic scales and also solve the maintenance problem of Earth's magnetic field [14]. There are many open questions. For instance, it is not clear whether the flux tubes mediating gravitational interaction have nearly vanishing induced Kähler form and vanishing Kähler magnetic flux. It is assumed that long cosmic strings having galaxies as tangles carry monopole flux but even this assumption can be challenged.

3. Twistor lift of TGD plays a central role in the scenario. It predicts that the dimensionally reduced 6-D Kähler action for the 12-D product of twistor spaces of M^4 and CP_2 decomposes to a sum of 4-D Kähler action and volume term having cosmological constant Λ as a coefficient. Dimensional reduction is required by the induction of the twistor structure to the space-time surface as S^2 bundle.

   Λ has spectrum and is proportional to the inverse square of the p-adic length scale assumed to satisfy p-adic length scale hypothesis $p \simeq 2^k$: one can write $\Lambda = \Lambda(k)$. Thus any astrophysical system (say galaxy,star, or planet) as space-time sheet inside causal diamond (CD) is characterized by $\Lambda(k)$. This solves the basic problem due to the huge size of cosmological constant since cosmological constant goes to zero in long length scales. This also predicts the thickness of flux tubes. For "cosmological" cosmological constant the thickness is that of large neuron.

4. The thickness of the flux tube remains piecewise constant in cosmic evolution and increases in phase transitions reducing the value of $\Lambda(k)$. The simplest assumption is that the phase transitions are induced by the expansion of the larger space-time sheet at which the sub-system is glued by CP_2 sized wormhole contacts. In the formation of blackholes these phase transition would take place in opposite direction leading to contraction. For instance, in stars the thickness of flux tubes would be larger than in blackhole like entities (BHEs) defined by the volume filling flux tubes with thickness of proton Compton length [20].

   For cosmic strings and primordial flux tubes the thickness would be presumably smaller and protons could be replaced with those of hadron physics characterized by a Mersenne prime smaller than M_{107} characterizing ordinary hadron physics. M_{89} is the Mersenne labelling the fractal copy of hadron physics in LHC energy scale and there are indications for the mesons of M_{89} hadron physics at LHC [12, 13].

3.2 TGD based model for the formation of galaxies

In TGD framework the presence of VPOS (`http://tinyurl.com/k553545`) [16] suggests the presence of long cosmic string $S_\perp$ orthogonal to the galactic plane containing dark matter and energy and at least one cosmic string $S_{||}$ thickened to flux tube parallel to the galactic plane. Single $S_{||}$ would suggest two spiral arms but there are four. Also the existence of 3 disks suggest that there are actually 2 flux tubes $S_{||,i}$, $i = 1, 2$, which would collided with $S_\perp$. Could gravitational force between cosmic strings have caused the formation of spiral structures and could visible galactic matter be generated from the thickening of these flux tubes?

One should also understand the flat velocity spectrum of distant stars. $S_\perp$ creates such a spectrum. Also $S_{||}$ creates such as spectrum for objects rotating in VPOS plane. Same is approximately true for the stars rotating in galactic plane since the dark mass of string plus its decay products within ball of given radius R (distance from the galactic center) is expected to be proportional to R. As a matter fact, the original proposal [6, 7] was that there is only string in the galactic plane and corresponds to the spiral structure.

One should understand the morphologies of elliptic and spiral galaxies and how they were formed.

1. Elliptic galaxies are simple and older than spiral galaxies. A good guess is that they represent the primordial galaxies and are formed as tangles along cosmic strings thickening locally to flux tubes and producing the ordinary matter as dark energy and dark matter of string transforms to ordinary matter. Quasars as time reversals of blackholes would represent the primordial stages of elliptic galaxies [18]. That there are also small elliptic galaxies without GBHE supports the view that time reversal is in question.

2. Spiral galaxies with much complex morphology would be an outcome of dynamical processes involving collisions. The bulge of the spiral galaxy resembles elliptic galaxy, which gives hints about the dynamics involved with the formation of the spiral galaxy.

   The presence of VPOS and strong asymmetry between the VPOS plane orthogonal to the galactic plane strongly suggests a collision of elliptic galaxy assignable to cosmic string $S_{||}$ with some object The simplest identification of this object is as $S_{||}$, which has remained mostly dark but shows itself as a preferred direction for galactic jets. Indeed, two strings not parallel to each other and moving with respect to each other are doomed to intersect and intersection would give rise to spiral galaxy. The relative motion would be caused by the gravitational attraction of the strings.

3. Spiral morphology should be understood. Why 4 spiral arms? Why a pair of dense spiral arms with members connected by galactic bar to connected structure? Why the pair of less dense spiral arms forming similar connected structure? Are the pairs separate structures or parts of the same structure and could bulge show the existence of sub-structure consistent with the fusion of two elliptic bulges. Could the existence the 3 disks with different ages and thicknesses relate to the existence of 3 strings?

   Could the VPOS cosmic string(s) $S_{||}$ ($S_{||,i}$) in the galactic plane have rotated differentially with respect to the cosmic string $S_{\perp}$ orthogonal to the galactic plane and given rise to a pair of spiral arms. Are 2 parallel strings $S_{II,1}$ and $S_{||,2}$ in galactic plane needed to explain both pairs of spiral arms.

   One must understand the asymmetry between $S_{\perp}$ and $S_{||,i}$. Did $S_{||,i}$ contain a tangle giving rise to elliptic galaxy by the transformation of dark matter to ordinary matter. Did the elliptic galaxy become the bulge of the spiral galaxy? Did $S_{\perp}$ collide $S_{||,i}$. Did $S_{||,i}$ start differential rotation around the long string and give rise to spiral structure with two arms connected by the bar?

   The gravitational attraction between $S_{\perp}$ and $S_{||,i}$ should have increased the probability of the collisions - 85-90 per cent of galaxies are spiral galaxies. Gravitational attraction could have made possible also the second collision in which the less dense pair of arms emerged and gave rise to the thin disk.

4. One should understand galactic bar. Bar brings in mind is dipole creating dipole magnetic field. Could one have the analog of dipole field with monopole flux tubes needing not current to generate it and perhaps assignable to $S_{||,i}$. Could dark flux tubes associated with $S_{||,i}$ give rise to flux tube structures with topology resembling that of dipole magnetic field?

   Remark: The dipole nature for dark monopole flux structure is somewhat ad hoc assumption since there would be no current as source. There are also flux tubes carrying vanishing total flux and correspond to thickening of flux tubes. A possible interpretation would be as flux tubes mediating gravitational interaction and characterized by very large value of $h_{eff} = h_{gr} = GMm/v_0$ [2] [10, 11] [17]. The dipole like flux tube structure could correspond to these flux tubes.

5. What about galactic blackhole, which in TGD would correspond to galactic black-hole like entity (GBHE) identifiable as volume filling flux tube structure [20]. TGD actually suggests a hierarchy of BHEs classifiable by the thickness of the volume filling flux tube and ordinary stellar blackholes

would correspond to flux tubes for which proton Compton length would define the thickness. An important empirical input comes from the fact that GBHE is present only if also the galactic bulge is present, and that elliptic galaxies have GBHE as a rule. This also supports the view that GBHE is formed after the formation of elliptic galaxy which could take place via a formation of quasar in which dark matter transforms to ordinary matter in a process which is time reversal for the formation of blackhole: white hole like entity (WHE) might be appropriate term in the case of quasar [18].

6. The presence of old thick disk, thin disk, and young thin disk suggest interpretation as bulge (elliptic galaxy), younger portion of the same string $S_{||,1}$ decaying to ordinary matter and leaving the string, and possibly portion of $S_{||,2}$ suffering similar decay. This interpretation would suggest that the dwarf galaxies and globular clusters in VPOS have been there from the beginning and are not generated from $S_{||,i}$.

7. How satellites - dwarf galaxies and globular clusters - are formed? Are they basically bound states of closed strings with VPOS string. Have they reconnected from VPOS string as separate loops? Did reconnections of this VPOS string produce dwarf galaxies or were they there from beginning as satellites. Note that the number of stars about one thousandth from that for galaxies and globular clusters have size scale .1 kPc.

The core-cusp problem of cold dark matter model [3] gives guidelines for the model building. The existence of dark core (DC) with approximately constant density with radius 2-3 times that of stellar disk is suggestive: it should have density peaked at center instead of constant density: this leads to the halo-cusp problem.

1. TGD suggests that the dark matter of astrophysical objects have as asymptotic states volume filling flux tube spaghettis [20] (`http://tinyurl.com/tkkyyd2`). The size R of the spaghetti correlates with the thickness r of the flux tube. Dark matter dense core associated with strings should form a spaghetti with size $R \sim 90$ kpc few times the size of the stellar disk. GBH would be spaghetti with radius about $R_{GBH} \sim 10^{-4}$ pc with flux tube thickness given by proton Compton wavelength $L_p \sim 10^{-15}$ m.

   By scaling the thickness L_p of flux tube of GBH by factor $R/R_{GBH} \sim 10^9$ one obtains dark flux tube radius about $r \sim 10^{-6}$ m - the size scale of cell nucleus by the way. Recall that flux tube thickness 10^{-4} m corresponding the size scale of large neutron is assignable with "cosmological" cosmological constant Λ. Note that $\Lambda(k)$ is length scale dependent in TGD and characterizes the system's causal diamond as "sub-cosmology".

2. There are several open questions. Either $S_{||,i}$ or $S_\perp$ could give rise DC. Which of them? $S_\perp$ makes itself visible only via the presence of galactic jets and as structures along which galaxies form linear structures. Why so passive role? Does dense core correspond to a flux tube tangle possibly having the topological structure of field lines of a dipole magnetic field? Can the flux tube structure be disjoint from the long string - perhaps formed in reconnection?

4 Support for the proposed model

In the following some empirical support for the proposed model is discussed.

4.1 Evidence for 3 different temperatures at galactic halo

The model for Milky Way suggests the presence of 3 cosmic strings thickened to flux tubes. Galactic disk has indeed 3 components with different thickness. There is support for the presence of 3 components also in the Milky Way halo [5] (http://tinyurl.com/ssxl3ux, thanks to Wes Johnson for the link) as gas at different temperatures, and perhaps assignable to 3 different cosmic strings.

The information was gained by studying X rays from a blazar, very active energetic core of a distant galaxy emitting intense beams of light. The blazar was at distance of 5 billion light years. The light passed through the galactic halo and the temperature of the halo was determined from the properties of light received at Earth.

The halo was expected to have single temperature in the range between $10^4 - 10^6$ K. It was however found to contain 3 components at different temperatures, and the hottest component had temperature about 10^7 K. The unexpectedly high temperature is proposed to be due to the winds emanating from the disc of stars of MW. It was also found that the halo contains besides hydrogen also significant amounts of heavier elements suggesting that the halo has received material created by certain stars during their lifetime and final stages.

In TGD framework "cold fusion" [15] outside stellar interiors could have generated at least part of the heavier elements. "Cold fusion" proceeds by formation of dark nuclei identifiable as dark nucleon sequences at magnetic flux tubes with $h_{eff}/h \simeq m_p/m_e \sim 2000$ and having radius of electron Compton length. Nuclear binding energy is scaled down by a factor of about 1/2000 to keV range. Dark nuclei would have transformed to ordinary nuclei liberating practically all nuclear binding energy outside stellar nuclei. This process would serve as a kind of warm-up band in the pre-stellar evolution leading eventually to the ordinary fusion [15, 21, 20].

4.2 Any direct evidence for the presence of monopole flux tubes?

Monopole flux is the key property of flux tubes proposed to be behind various astrophysical structures. Is there any direct evidence for this? Evidence has emerged for the existence of giant clouds with size about 100 AU in the vicinity of the supermassive GBHE of Milky Way [4] (http://tinyurl.com/sukomc6 and http://tinyurl.com/tz2hta5). These objects - called G objects - look like gas clouds but behave like stars. G objects stretch longer when nearer to GBHE but get their original shape when farther away. One would expect that they are torn apart by the enormous tidal forces created by GBHE.

The identification could be as visible matter assignable to a spaghetti like structure formed by monopole like flux tube, which could have also produced the visible matter in the thickening of the flux tube. By flux conservation the monopole flux prevents the flux tubes from splitting even in the huge gravitational field of supermassive GBHE. Without monopole flux tubes to which visible matter is gravitationally bound the structure would be torn to pieces. In Maxwellian world monopole flux tubes are not possible. In biology the behavior of gels (the contents of an egg is the basic example) could be based on monopole flux tubes connecting the cells together.

4.3 Cosmic strings and angular momentum problem of General Relativity

Vladimir Nechitailo took contact and asked for comments about his World-Universe model (WUM) (http://tinyurl.com/vm2k7hb). In the following my reaction to the claim

"The angular momentum problem is one of the most critical problems in BBM. Standard Cosmology cannot explain how Galaxies and Extra Solar systems obtained their substantial orbital and rotational angular momenta, and why the orbital momentum of Jupiter is considerably larger than the rotational momentum of the Sun. WUM is the only cosmological model in existence that is consistent with the Law of Conservation of Angular Momentum. "
appearing in the abstract of his article.

I cannot quite agree with this statement.

I have not explicitly considered the problem of large angular momenta in TGD. I do not think that the problem is non-conservation - note however that general relativity has problem with classical conservation laws which led to the idea about space-times as surfaces in $M^4 \times S$.

The challenge is to explain naturally the large angular momenta, which obey the analog of stringy mass formula: mass squared proportional to angular momentum. In TGD framework monopole flux tubes made possible by the homology of CP_2 lead to a picture in which cosmic strings with huge string tension carrying magnetic and volume energy thicken to flux tubes, and in this process lose magnetic energy transform to ordinary matter.

Cosmic strings [6, 7, 8] explain dark matter and energy: galaxies are associated as tangles to long cosmic strings and the gravitational field of long cosmic string explains the flat velocity spectrum of distant stars [9, 20] (`http://tinyurl.com/tkkyyd2`. The rotation of the galactic matter around the long cosmic string explains the large angular momenta. For halo models one does not obtain this prediction. Large angular momenta are of course associated also to distant stars with constant velocity.

WUM as primordial period of cosmology is in TGD replaced with cosmic strings as non-Einsteinian 4-D space-times surfaces with with 2-D M^4 projection and complex manifold of CP_2 as CP_2 projection would dominate the primordial cosmology transforming to radiation dominated cosmology by the thickening of M^4 projection of cosmic string to 4-D [8, 16, 9]. This period would be the analog of inflation in TGD but without inflaton fields. Dark matter would correspond to $h_{eff} = n \times h_0$ phases at flux tubes present in all scales - even biological and also hadronic scales - as remnants of the primordial period.

4.4 Too young to be so heavy

The model should also allow to understand quasars and in [?] (`http://tinyurl.com/y2jbru4k`) I considered a model of quasars as predecessors of galaxies. And additional support for the proposed picture came from a rather thought provoking article (`http://tinyurl.com/sz9n72n`) telling about a particular quasar identified as a super-massive blackhole with mass $.780M(Sun)$ ($M(Sun)$ is solar mass). Quite generally quasar masses vary in the range $10^8 - 10^9$ $M(Sun)$. Galactic blackholes have mass in the range $10^5 - 10^9$ $M(Sun)$. Milky Way blackhole has much smaller mass about $4 \times 10^6 M(Sun)$ (`http://tinyurl.com/7wtza99`).

Remark: I prefer to talk about blackhole like entities (BHEs): the TGD view about BHEs see is described in [20] (`http://tinyurl.com/tkkyyd2`).

1. The first question considered by the researches is what burned away the neutral fog around the BHE: it is known that re-ionization (`http://tinyurl.com/y8xodylx`) must have burned away the fog ending the "dark ages" during which the Universe was transparent but there were no sources of light, which we could see (cosmic redhsift). Dark ages ended when re-ionization took place by light burning away the fog - perhaps light coming from dwarf galaxies and high energy photons from quasars did this. Despite re-onization the light could propagate since the density of matter absorbing it was so low.

2. There is also second deep problem: quasar - if indeed BHE - is too massive quite too early. This problem is met for all quasars - the age of the universe is measures using 1 billion years as a natural time unit for the observed quasars. If the galactic blackholes were former quasars, their masses should be larger than for quasars. The mass of Milky Way BHE is however of order $10^6 M(Sun)$ and much smaller than for quasars.

   From the list of blackholes (`http://tinyurl.com/s3e223q`) one gets an idea about the masses of galactic BHEs. Typically masses are considerably lower than quasar masses. There is however lenticular (between elliptic and spiral galaxy having disk but not spiral structure) galaxy NGC 1277 with galactic blackhole with mass about $1.7 \times 10^{10} M(Sun)$.

   The smaller mass scale makes it is difficult to believe that galactic blackholes could be former quasars. One can also ask whether very old lenticular galaxies, which posses neither spiral structure but have galactic plane could be formed from quasars and whether the central object could be quasar.

These problems challenge the interpretation of quasars as BHEs and TGD suggests an interpretation of all quasars as time reversals of BHEs - whitehole like entities (WHEs). Zero energy ontology (ZEO) of TGD indeed allows time reversed states and the arrow of time changes in ordinary, "big" state function reductions (BSFRs), which in TGD Universe can occur even in astrophysical scales so that even BHEs could be time reversals of WHEs. BSFRs would occur routinely in living matter, and self-organization as a process in apparent conflict with second law could be based on time reversal at magnetic body (MB) carrying dark matter as $h_{eff} = n \times h_0$ phases. Self-organization would be based on dissipation with reversed arrow of time at MB and violate standard arrow of time. In accordance with experimental facts, it would require energy feed since the creation of states with non-standard value of h_{eff} requires energy feed.

ZEO allows to imagine two solutions to the problem of "too-young-to- be-so-heavy" problem.

1. Quasars could be WHEs [?] (`http://tinyurl.com/y2jbru4k`) and they would feed matter to environment rather that eating it (there was not much to eat yet!). The dark energy and matter of a tangled of cosmic string would transform to ordinary matter eventually creating the visible galaxy as the tangle thickens to magnetic flux tube and loses its energy. The predecessors of quasars would be generated during inflationary period as tangles of cosmic strings of primordial cosmology started to thicken and Einsteinian space-time with 4-D M^4 projection in $H = M^4 \times CP_2$ was created. Before this it was 2-D string world sheet. The fog, presumably hydrogen around the quasar formed from cosmic string energy, was formed from the energy of cosmic string.

   The huge energy emission by quasars could accompany a reduction of length scale dependent cosmological constant leading to the emission of volume energy whose density is proportional to cosmological constant.

2. One can also imagine that quasars were indeed BHEs which got their mass from the material produced by the decaying cosmic strings before stars were even formed. This would be less radical option than the first one and require that BHEs of galactic nuclei started to form much later than quasars and have therefore much smaller masses. They are however present in all elliptic galaxies except dwarfs. Elliptic galaxies are rather old and could have perhaps formed as self-intersections of the flux tube tangle giving rise to the elliptic galaxy.

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