Cosmic spinning filaments that are too long

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Abstract

A long filament with length of order 10^8 ly characterizing the sizes of large cosmic voids has been studied. The filament consists of galaxies and the surprising finding is that besides moving along the filament, the galaxies associated with the filaments spin around the filament axis.

This finding suggests a network of filaments of length of order 10^8 ly and thickness of order 10^6 ly intersecting at the nodes formed by large galaxy clusters. The larger the masses at the ends of the filament are, the larger the spin is.

How angular momentum is generated is the problem. In Newtonian and General Relativistic frameworks it is very difficult to imagine any plausible mechanism. TGD suggests a mechanism in which the compensating angular momentum associated with visible objects is associated with the dark matter associated with the cosmic strings and the flux tubes resulting as they thicken. Dark matter would therefore have a fundamental role in the gravitational dynamics in all scales.

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1 Introduction

The inspiration for writing this article came from a highly interesting popular article (https://cutt.ly/inMODTT) providing new information about the cosmic filaments (thanks to Jebin Larosh for the link). The popular article tells about the article published in Nature [E3] (https://cutt.ly/HnMOGcP) and telling about the work of a team led by Noam Libeskind.

What has been studied is a long filament with length of order 10^8 ly characterizing the sizes of large cosmic voids. The filament consists of galaxies and the surprising finding is that besides moving along the filament, the galaxies associated with the filaments spin around the filament axis.

This finding suggests a network of filaments of length of order 10^8 ly and thickness of order 10^6 ly intersecting at nodes formed by large galaxy clusters. The larger the masses at the ends of the filament are, the larger the spin is.

How angular momentum is generated is the problem. The problem is quite general and is shared by both Newtonian and General Relativistic Universes. The natural assumption is that angular momentum vanishes in the original situation. Angular momentum conservation requires a generation of compensating angular momentum. This should happen in the case of all rotating structures. Already the case of galaxies is problematic but if the length scale of the structure is 10^8 ly, the situation becomes really difficult.

Gravitationally bound states have as a rule angular momentum preventing gravitational collapse but how the angular momentum is generated in a process believed to be a concentration of a homogeneous matter density to astrophysical objects? The basic problem is that the Newtonian description relies on scalar potential so that the field lines of the Newtonian gravitational field are never closed. It is difficult to imagine mechanisms for the generation of angular momentum by rotation. In the GRT based description gravi-magnetic fields, which are rotational, emerge but they are extremely weak. The proposal is that tidal forces could generate angular momentum but the generation of angular momentum remains poorly understood.

2 TGD view about the angular momentum generation

Could one understand the recent finding, and more generally, the generation of angular momentum, in the TGD framework? What raises hope is that in the TGD framework Kähler magnetic fields, whose flux tubes can be regarded as space-time quanta, are key players of dynamics in all scales besides gravitation.

2.1 Cosmic strings as carriers of dark matter and energy

The basic difference between GRT and TGD are cosmic strings and flux tubes resulting from their thickening. Cosmic strings are preferred extremals which are space-time surfaces with 2-D string world sheet as M^4 projection and complex surface of CP_2 as CP_2 projection.

1. The presence of the long filaments is one of the many pieces of support for the fractal web of cosmic strings thickened to flux tubes predicted by TGD. The scale is the scale of large voids 10^8 ly forming a kind of honeycomb like structure. The density of matter would be fractal in the TGD Universe [L2, L3] (`http://tgdtheory.fi/public_html/articles/meco.pdf` and `http://tgdtheory.fi/public_html/articles/galaxystars.pdf`).

2. Long cosmic string has a gravitational potential proportional to $1/\rho$, ρ the transverse distance. This predicts a flat velocity spectrum for the stars rotating around the galaxy. No dark matter halo is needed. The model contains only a single parameter, string tension, and also this can be understood in terms of the energy density of the cosmic string. The motion along the string is essentially free motion which allows to distinguish the model from the halo model. In fact, the article [E3] reports linear motion along the filament.

   Amusingly, the same day that I learned about the spinning filaments, I learned about a new evidence for the absence of the galactic halo from a popular article (`https://cutt.ly/MnMOI7F` telling about the article by Shen et al [E2] (`https://cutt.ly/HnMOPNA`).

2.2 Compensating angular moment as angular momentum of dark matter at cosmic string

Consider now the problem of how the compensating angular momentum is generated as visible matter starts to rotate.

In the TGD framework the picture is just the opposite.

1. The basic assumption of the Newtonian and GRT based models for the generation of angular momentum is that all astrophysical objects are formed by a condensation of matter along perturbations of the mass density. The flow of mass occurs from long scales to short scales.

2. Cosmic strings are the basic objects present already in primordial cosmology [K6, K3, K2]. Long cosmic strings form tangles along them in a local thickening, which gives rise to flux

tubes [L2, L3, L4]. This involves the decay of dark energy and matter at cosmic string to ordinary matter around them as the string tension is reduced in a phase transition decreasing the coefficient of the volume term present in the action besides Kähler action as predicted by twistor lift of TGD [K4, K7]. This parameter corresponds to length scale dependent cosmological constant Λ.

Λ depends on p-adic length scale $L_p \propto \sqrt{p}$, $p \simeq 2^k$ and satisfies $\Lambda(k) \propto 1/L^2(k)^2$. $\Lambda(k)$ approaches zero in long p-adic length scales characterizing the transversal size of flux tubes. This solves the cosmological constant problem. The thickness $d \sim L(k)$ of the flux tube, which is rather small, determines the string tension. To $L(k)$ there is associated a long p-adic length scale which is of order size of observed cosmology if $d \sim L(k)$ is of order of 10^{-4} meters, which happens to be the size of a large neuron.

3. The phase transitions reducing Λ reduce string tension are analogous to the decay of the inflaton field vacuum energy to ordinary matter. Now inflaton field vacuum energy is replaced with the dark energy and matter associated with the thickening cosmic string. Each phase transition is accompanied by an accelerated expansion. The period known as inflation in stanaard cosmology is the first phase transition of this kind. The recent accelerated expansion would correspond to a particular period of this kind and will eventually slow down.

What could happen in the decay of the energy of a flux tube tangle of a cosmic string to visible matter?

1. The visible matter resulting in the decay of the cosmic string must start to rotate around the cosmic string since otherwise it would fall back to the cosmic string like matter into a blackhole. The cosmic string must somehow generate a spin compensating the angular momentum of the visible matter.

2. One should understand angular momentum conservation. Generation of visible matter with angular momentum is possible only if the dark cosmic string is helical or becomes (increasingly) helical in the phase transitions. The angular momentum would be accompanied by the longitudinal motion along the string: this motion has been observed for the filaments [E3] .

   The helical structure could be present from the beginning or be generated during the decay of energy of the cosmic string leading to the local thickenings to flux tube giving rise to galaxies as tangles along a long cosmic string. Also the dark matter and energy at the cosmic string already have angular momentum so that the dark matter that transforms to visible matter would inherit this angular momentum.

   The reported correlation between the masses at the ends of the filament and the spin of the filament [E3] could be understood if the masses at the ends are formed from the dark energy and mass of the filament having angular momentum. The amount of spin and mass at the ends would be the larger, the longer the decay process has lasted.

3. The identification of the galaxies as tangles along long cosmic strings explains the flatness of the galactic velocity spectrum. Galaxy rotates and also now the angular momentum conservation is the problem. The simplest solution is that the cosmic string portions between the tangles generate the angular momentum opposite to that of the visible matter.

   This would happen not only for the portions of cosmic string between galaxies but also those between stars in the galactic tangle. Stars would be flux tube spaghettis and the angular momentum of the star would be compensated by the angular momentum associated with the helical cosmic string continuing outside the star and connecting it to other stars.

The illustration of the popular article brings in mind a DNA double strand and inspires a consideration of an alternative, perhaps unnecessarily complex, model.

1. Suppose one has a double helix of cosmic strings, call them Alice and Bob. Two stellar objects can form a gravitationally stable state only if relative rotation is present. This would be true also for a cosmic double strand to prevent gravitational collapse in 2-D sense.

2. Alice could remain a cosmic string and thus dark so that we would not see it. Bob would thicken to a flux tube and produce ordinary matter as galaxies as ordinary matter realized tangles along it. The matter would inherit the angular momentum the dark matter and energy producing it already has. The string tension of Bob would be reduced in this process. Of course, both Alice and Bob could have tangles along them. The experiments however support the view that spin direction is the same along the filament.

3. If the helical pair of cosmic strings is actually a closed loop in which the second strand is a piece of the same string, the motion of matter along strands is automatically in opposite directions and spins are opposite. The rotational motion as a stabilizer of a gravitationally bound state is transformed to a helical motion. The problem is however why only the other strand decays to ordinary matter (in the case of ordinary DNA there is an analogous problem due to the passivity of the second strand).

2.3 Is quantum gravitation cosmic scales involved?

There is an interesting connection to atomic physics suggesting that quantum effects are associated with gravitationally bound dark matter even in astrophysical scales.

1. The basic problem was that the electron should radiate its energy and fall into the atomic nucleus. The Bohr model of the atom solved the problem and non-radiating stationary states prevented the infrared catastrophe. Also in the gravitational case something similar is expected to happen for gravitational interaction.

2. The Bohr model of solar system [K5, K1], originally introduced by Nottale [E1], relies on the notion of gravitational Planck constant $hbar_{gr} = GMm/\beta_0$ predicts angular momentum quantization [L1, L5].

3. Angular momentum quantization as multiples of $\hbar_{gr}$ could occur also for the matter rotating around the cosmic string. In the case of the filament, the mass M could be replaced with the mass of the cosmic string (or possibly several of parallel cosmic strings) and m could correspond to the mass of a galaxy rotating around it. The velocity parameter $\beta_0 = v_0/c$ has a spectrum of values [L5] proposed to come as inverse integers.

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