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# Two Proposed Experiments for the Tachyon-Neutrino Theory of Dark Matter

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**Abstract:** Recent theory of tachyon neutrinos, providing an explanation for Dark Matter, leads to two sets of experiments for testing that theory. One predicts an enhanced signal in detection of the Cosmic Neutrino Background. The other compares models of Dark Matter used to fit data on galaxy rotation curves and also gravitational lensing. In addition, an apparent contradiction within the new theory, related to Dark Energy, is identified and addressed.

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## 1. Introduction

A series of papers of mine, published over the past dozen years show remarkable theoretical results for the hypothesis that neutrinos are tachyons (faster than light particles) with a mass around 0.1 eV. That work starts with the recognition that low energy tachyons can make strong gravitational fields through their contribution to the spatial components of the energy-momentum tensor. The Cosmic Neutrino Background (CNB) provides the physical substance for application of this theory.

These collective papers offer:

* a consistent theory of tachyons [1]
* an explanation for Dark Energy [2]
* an explanation for Dark Matter [3]
* an explanation for the chirality selection rule in weak interactions [4]

In this paper I want to outline two sets of experiments that might verify (or negate) this theory.

In Section 2 I examine the Ptolemy experiment that is planned to detect the absorption of CNB neutrinos and show that its signal should be several orders of magnitude greater than expected if this Tachyon-Neutrino theory of Dark Matter is correct.

In Section 3 I ask about data on Dark Matter (DM) configurations in galaxies that are postulated to explain both the observations of the velocity vs radius curve and also the lensing attributed to that DM. The Tachyon-Neutrino theory predicts a ratio of 2/3 in comparing these data sets. (By comparison, the usual Newtonian theories of DM give a ratio of 2.) This section includes a discussion of how the present work stands in regard to the mainstream literature about Dark Matter.

In Section 4 I summarize the results.

In Appendix A I present a distinct but related discussion of an apparent challenge to the theory that Tachyon-Neutrinos may also explain "Dark Energy"; and I offer a qualitative explanation to resolve that challenge, which calls for further theoretical developments to become quantitative.

## 2. Ptolemy

This name (for Princeton Tritium Observatory...) is a proposal to detect the Cosmic Neutrino Background (CNB) through the induced beta decay of Tritium: $\nu + T \to \; ^3He + e^-$. According to standard cosmological theory, there is a great sea of neutrinos left over from the big bang: their density is $56/cm^3$ (for each type of neutrino) and their temperature is around $1^o K$. It is expected to find a very sharp spike in the emitted electron energies at the endpoint of the usual beta decay spectrum. If the neutrinos are ordinary particles with a small mass, the location of this spike will be slightly beyond the expected end point. If they are tachyons, there is no such displacement.

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Ptolemy [5] is expected to be a very difficult experiment: seeing a small effect with a high resolution electron detector. The KATRIN [6] experiment now in progress is not likely to reach the sensitivity needed to see the CNB.

### 2.1. My Surprise

My recent paper [3] on Dark Matter proposes that a large portion of the CNB, rather than being dispersed throughout the universe, is condensed about most galaxies. This increased density - by a factor of the order of $10^3$ - provides the extra gravitational field to explain Dark Matter effects in galaxies.

*If true, this increase in neutrino density within a galaxy (our galaxy in particular) would make the expected signal in the Ptolemy experiment considerably larger than originally expected.*

But wait, there is more!

My theory separates neutrinos from antineutrinos according to their helicity. The two helicity types behave differently in General Relativity - only one type explains Dark Matter. They also behave differently in beta decay (with lepton number conservation, as in my latest paper [4]). I do not know which way these two markings are connected. So, the Ptolemy experiment with Tritium should either show a big enhancement or no effect at all.

And then one should find an alternative source for Ptolemy - an $e^+$ emitter - to see the opposite behavior.

This seems like an exciting possibility. I look forward to reactions from other physicists.

## 3. Dark Matter Data

The most common type of theory offered to explain Dark Matter - called CDM - is based upon Newton's theory of gravitation. I want to start with Einstein's theory of gravitation. To make things easy I'll use the linear approximation to General Relativity. The metric tensor $g_{\mu\nu}(x)$ is expanded in powers of the gravitational constant G.

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} - 1/2\ \eta_{\mu\nu} h + O(G^2). \tag{3.1}$$

Here $\eta_{\mu\nu}$ is the Minkowski metric tensor (1, -1, -1, -1); and h is the contraction $h^\mu_\mu = h_{00} - \Sigma_{i=1,3}\ h_{ii}$. The tensor $h_{\mu\nu}$ obeys a wave equation with $T_{\mu\nu}$, the energy-momentum tensor, as its source. If we have a static situation (not interested in gravitational radiation here), then we have,

$$h_{\mu\nu}(\mathbf{x}) = 4G \int d^3x'\ \ T_{\mu\nu}(\mathbf{x}')/|\mathbf{x} - \mathbf{x}'|. \tag{3.2}$$

This gives us the gravitational field, the metric $g_{\mu\nu}$, in terms of the sources $T_{\mu\nu}$. Now we need the geodesic equation to see how particles move in this field.

$$\ddot{\xi}^\mu = -\Gamma^\mu_{\alpha\beta}\ \dot{\xi}^\alpha\ \dot{\xi}^\beta, \tag{3.3}$$

where $\xi^\mu(\tau)$ is the trajectory of the particle in spacetime, the dot means $d/d\tau$, and $\Gamma$ is the connection, given in terms of derivatives of the metric $g_{\mu\nu}$.

### 3.1. Slow Matter

Let's first ask about the motion of non-relativistic masses in this gravitational field - motion of stars in galaxies or clustering of galaxies. We start by approximating the right hand side of Eq.(3.3): $\dot{\xi}^\alpha = (1, 0, 0, 0)$. Then the geodesic equation becomes simply,

$$d^2\mathbf{x}/dt^2 = -1/2\ \nabla g_{00}, \tag{3.4}$$

which we recognize as Newton's second law of motion (F=ma).

We usually write the F/m as the negative gradient of a potential, V. So we have,

$$V(\mathbf{x}) = -G \int d^3x' S(\mathbf{x}')/|\mathbf{x} - \mathbf{x}'|, \quad (3.5)$$

$$S = 2T_{00} - [T_{00} - \Sigma_i \, T_{ii}) = \rho + p. \quad (3.6)$$

Here we introduce the familiar terms $\rho$ (energy density or rest mass) and $p$ (pressure) for the two major parts of the energy momentum tensor.

If you forget about p, then you have Newtonian gravity. What could give you a large pressure? Low energy Tachyons; neutrinos present in large numbers throughout the universe. And they look just like a Newtonian source of gravity in the equation above; but they are physically very different.

### 3.2. *Light*

Now we look at gravitational lensing - the deflection of light passing through a given gravitational field. Here we start the geodesic equation (3.3) with the input velocity 4-vector $\dot{\xi}^{\alpha} = (1, 0, 0, 1)$, for the light beam traveling initially in the z-direction. The equation of motion in the transverse directions is then,

$$\ddot{x}^i = -\Gamma^i_{00} - \Gamma^i_{33} = -1/2 \, \partial_i [g_{00} + g_{33}], \quad i = 1, 2. \quad (3.7)$$

This leads to an effective potential, as seen above, with the source,

$$S = 2[T_{00} - 1/2T + T_{33} + 1/2T] = 2(\rho + p/3), \quad (3.8)$$

assuming that the pressure is isotropic. This again shows how tachyon-neutrinos can mimic (through their "pressure") the effects of Newtonian gravity.

### 3.3. *A Glance at the DM Literature*

Dark Matter has been a major issue for physics researchers for some time and readers may ask how the work presented above fits into that literature. I cannot offer a comprehensive review but will take a quick look at two books that represent milestones in the history of this subject. The first is Weinberg's "Cosmology" (2008) [7], which is a deep theoretical review of the whole subject with much mathematics and physical analysis; the second is Fisher's "What is Dark Matter" (2022) [8], an experimentalist's review of the most recent ideas and experiments on this particular topic, written for a general audience.

I stated at the outset of Section 3 that the prevailing approach to Dark Matter was based upon Newtonian theory of Gravity. My departure is to look at Einstein's theory of gravitation, include the effects of "pressure" in the energy-momentum tensor, and consider the possibility of tachyons, especially ascribing this property to neutrinos. So I ask: Do either of those two words, "pressure" and "tachyon" appear in those books?

Fisher's book is a small printed volume; and the subject index shows neither word present. Weinberg's book is a huge tome, which I have on my computer; so I can do a full text search and find no mention of tachyon. Weinberg does use the word "pressure" on several occasions but it is never in connection with discussions about Dark Matter.

Chapter 9 of Weinberg's book is all about Gravitational Lenses; and one sees from the start that he considers only gravitational fields produced by stationary masses - Newtonian model of gravity.

Chapter 4 of Fisher's book, entitled, "What Dark Matter is Not", discusses neutrinos, especially those comprising the Cosmic Neutrino Background. He tells readers that the neutrino mass is much too small to account for the gravitational fields attributed to Dark Matter. This is Newtonian thinking.

There are other speculative theories offered to explain Dark Matter, often based upon ideas outside of Einstein/Newton theories of gravitation. Some of those are called MOND - Modification of

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Newtonian Dynamics. Weinberg makes no mention of MOND theories; and Fisher discusses a detailed analysis of astronomical observations (on the Bullet Cluster) that leads to the rejection of MOND.

The mathematics I have presented in the earlier subsections is absolutely standard work within Einstein's theory of gravitation; and it shows how the "pressure" terms in the energy-momentum tensor can exactly mimic the mass (or energy density) term that we identify with Newton's theory. That calculation is easy - although it appears to be something not previously acknowledged. The challenge is to find a large source of matter-in-motion to be that source of pressure - and here the idea of tachyons is essential because at low energies they can produce surprisingly strong gravitational fields. My recent paper [3] provides the detailed quantitative calculations for this model.

Why does the theory of tachyon-neutrinos get no attention from mainstream physics researchers? Tachyons have a bad reputation. There have been a few famous occasions when some big experiment reported to have detected some neutrinos traveling faster than the speed of light – only to have those experimental results retracted due to some false readings on their equipment. Those are all experiments at high energies; and the CNB that we focus on here is very low energy, where no experiments have as yet been able to detect them. (So we wait for Ptolemy.)

But there is more baggage to be noted. If you look up "tachyon" on your favorite computer search engine and follow the link to Wikipedia, you find a morass of misinformation: "Physicists believe that faster-than-light particles cannot exist because they are inconsistent with the known laws of physics. ..." In Section 3 of my paper [1] I provide detailed debunking of numerous anti-tachyon myths.

### *3.4. Data Quest*

The above analysis presents a clear test of the "Newtonian" based theories vs the tachyon based theory about the origin of Dark Matter. This is not just a qualitative challenge ("don't ignore the pressure effects") but a precise quantitative challenge. Comparing the strength of the source as it affects the velocity curve relative to lensing observations [Equation (3.6) vs Eq(3.8)] Newtonian theory shows a simple factor of 2 while the tachyon theory show a factor of 2/3. This should be something to check out and I ask for other experts on this subject to see if the relevant data exists, or could be readily collected, to check this prediction.

## 4. Conclusions

Two sets of measurement are here proposed to check the Tachyon-Neutrino Theory for Dark Matter.

Section 2 presented the proposal that experiments for the direct detection of Cosmic Background Neutrinos should see a signal several orders of magnitude greater than what is expected from the conventional theory.

Section 3 presents the proposal for comparing data on quantitative models for Dark Matter to explain two types of astronomical measurements: the galaxy rotation curves vs the gravitational lensing by individual galaxies.

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## Appendix A. A Challenge re Dark Energy

My theory says: Two types of tachyons - particle and antiparticle - distinguished by helicity, have opposite sign in front of their energy-momentum tensors.

My model has one type condensed around galaxies, giving the large gravitational fields commonly attributed to a mysterious Dark Matter. The other type remains distributed throughout the universe and produces the negative pressure commonly attributed to a mysterious Dark Energy (DE).

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In earlier epochs the two were mixed in the hot stuff that came out of the Big Bang; and their gravitational effects just cancelled out. As the universe expanded, everything cooled, and at some time the first type condensed out, onto the galaxies, leaving the other type spread out.

The Problem: When we look at the whole of the universe (the FLRW model) then we should add up the effects of both types; and it seems that the net gravitational field claimed to produce DE cancells itself out.

A Possible Solution: Maybe, when the one type condenses onto galaxies, the increase in particle density (which I estimated in my paper to be a factor of about $10^3$) implies and increase in "energy" and thus a decrease in the "pressure", due to the particular kinematics of tachyons. Thus the condensed portion of the CNB becomes a weaker gravitational source than the portion left out there; and so the cancellation is not complete, perhaps only a mild diminution. Along with this would be a mild diminution of the DM gravitational field.

This needs a reliable mathematical model to see if the detailed calculations leave both stories credible. My earlier attempt at Statistical Mechanics for Tachyons [9] needs to be reinvestigated.

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