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TOPOLOGICAL INTENSITY SHIFTS OF ELECTROMAGNETIC FIELD IN LOBACHEVSKIAN SPACES. Olbers Paradox Solved, Deep Space Communication, and the New Electromagnetic Method of Gravitational Wave Detection

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Abstract—The major new result is the behavior of the intensity of electromagnetic radiation in Lobachevskian (hyperbolic) spaces. Equation (2) expresses change in intensity vs. space curvature and distance. Non existence of Olbers paradox in a Lobachevskian universe is shown. A new electromagnetic method for detection of gravitational waves is proposed. Explanation of observed perioditicy in redshifts is given. Problems of deep space communications are discussed.

1 Introduction

2 Intensity of Light in Lobachevskian Spaces. Equation of Horosphere

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1. INTRODUCTION

This paper is a continuation of our research presented in [2]. Since a considerable portion of mathematical and geometrical foundation is in detail presented in [2], those readers who want to see more mathematics and non euclidean geometry are encouraged to take a look at [2]. In our paper [2], using simple computations in non Euclidean space, we showed that **shifts in spectra** of electromagnetic radiation **follow from the negative curvature of space** (either velocity or configuration), and that the Hubble **distance velocity hypothesis is not needed** to explain experimental data regarding observed redshifts. It was shown that a Lobachevskian space (space of constant negative curvature) transforms the wavelength of light accordingly to the equation $\xi = \tanh(\ln \zeta)$, where $\xi = \frac{r}{R}$ is the radial separation between transmitter and receiver in Poincare ball model of Lobachevskian space normalized to the ball radius R, and $\zeta = 1 + z$ is the wavelength ratio $\frac{\lambda_D}{\lambda_T}$ measured at detector D and transmitter T respectively, and z is the experimentally measured redshift. Also in [2], the extension of a spatial domain beyond which calculations based on Euclidean physics are invalid was calculated. Finally, the **existence and properties of Cosmic Microwave Background Radiation (CMBR)** were promptly deduced from Lobachevskian geometry. CMBR, which is identified with a (homogeneous) space of horospheres in Lobachevskian space is inherently built into Lobachevskian geometry, and so the called **Big Bang cosmology is entirely not required to explain its existence and its properties (homogeneity, isotropy)**. It is worth noting that our model of **Lobachevskian physics agrees with all already observed experimental data recorded via the electromagnetic spectrum**, it gives a formula for all values of z (Hubble experimentally found only the "linear" part for small z), it naturally explains the new findings, e.g., **redshift periodicity** [13], and it has **only one assumption** — the space is a 3D static Lobachevskian space.

There are however other equally important parameters which characterize the state of an electromagnetic wave, namely its polarization and intensity. Those are of the upmost importance. Almost every branch of science and technology, in one or another way, depends on our ability to distinguish between intensities of electromagnetic radiation. The behavior of the intensity of electromagnetic radiation in Euclidean space is well known and there is no need to consider it any further here. However, **as the geometry starts to deviate from Euclidean, new phenomena come into play**. We showed by direct calculation that the existence of a cosmological redshift and of CMBR is an immediate consequence of the hyperbolicity of static Lobachevskian space, and we calculated the size of the spatial domain beyond which Euclidean physics becomes invalid. In the case of astronomy and astrophysics, almost all our information about the universe is related, directly or indirectly, to the intensity of electromagnetic radiation received, and all of our photometric techniques are at the very base of astrophysics and astronomy.

We already showed [2] that the **energy of a photon decreases as it travels through the Lobachevskian space**. Naturally, it would be entirely unacceptable if Lobachevskian geometry would change the energy of the photon, but it would not affect the energy of an electromagnetic wave treated in a classic way. It should be expected therefore that we will be able to explain, in a coherent way, how the hyperbolicity of space will affect the polarization and intensity of light treated as a classic electromagnetic wave. We will show that both parameters, **intensity and polarization, are indeed affected by Lobachevskian geometry.** Below we will give precise equations which govern intensity of electromagnetic radiation in Lobachevskian spaces. Polarization, however, will be discussed in great detail in a separate paper. Occasionally in the text we will use the term "light" but it is obvious that our analysis applies to the whole spectrum of electromagnetic radiation and it is not restricted to any particular spectral range.

2. INTENSITY OF LIGHT IN LOBACHEVSKIAN SPACES. EQUATION OF HOROSPHERE

To deal with the intensity of an electromagnetic wave (intensity of light) in a geometric way, we need to have some geometrical model which describes intensity, and we note that such a model already exists. Intensity (and polarization) of light can be described in terms of so called Stokes parameters s_0, s_1, s_2, s_3, which in turn are derived from the density matrix [6, 11]. In that setting s_0 component is equal to the total intensity I_0, while the tip of the vector $\mathbf{s}$ (s_1, s_2, s_3) points to the specific polarization state on the Poincare sphere. In homogeneous coordinates, normalization condition $[s, s] = s_0^2 - s_1^2 - s_2^2 - s_3^2 = 0$ [4] tells us that **Stokes vector** s_0, s_1, s_2, $s_3 (s_0 > 0)$ lies on the (forward) **cone**. We have therefore a natural identification of **Stokes parameters** with **homogeneous coordinates** in Lobachevskian 3D space

We consider a generic model of Lobachevskian negatively curved space as an interior of 3D ball in Euclidean space E^3. In that way we can deal both with the Lobachevskian velocity space and/or the

Lobachevskian configuration space. In the first case, if we need to be more specific, we set to c to 1, and in the second case we set R to 1. Therefore, the normalized distances will be $\frac{v}{c}$, and $\frac{r}{R}$,respectively, (in velocity space signed distance between two points means relative uniform velocity). We introduce homogeneous Weierstrass coordinates [3], $\sigma_0, \sigma_1, \sigma_2, \sigma_3$, normalized by $[\sigma, \sigma] = 1$, $\sigma_0 > 0$. The explicit expression for the Weierstrass coordinates are:

$$\sigma_0 = \frac{1}{\sqrt{1-\xi^2}}, \quad \sigma_1 = \frac{\xi_1}{\sqrt{1-\xi^2}}, \quad \sigma_2 = \frac{\xi_2}{\sqrt{1-\xi^2}}, \quad \sigma_3 = \frac{\xi_3}{\sqrt{1-\xi^2}} \quad \text{and,} \quad \xi = \frac{r}{R} \tag{1}$$

if we consider representation of Lobachevskian geometry by configuration space (Lobachevskian universe), or $\xi = \frac{v}{c}$ if we consider representation of Lobachevskian geometry by velocity space [2].

As in [2], we write the equation of horosphere, $[\sigma, s] = const.$, $[s, s] = 0$, $[\sigma, \sigma] = 1$, $\sigma_0 > 0$, $s_0 > 0$ which relates two vectors, one in Lobachevskian space with one at the boundary at infinity, via the horospheres equation $[s, \xi]_T = [s, \xi]_D$. Subscripts T and D refer to homogeneous coordinates in Lobachevskian space of the transmitter and receiver, respectively. Doing the same mathematics as in [2], we will come to the same functional relation, but this time between the intensity of light and distance in Lobachevskian negatively curved space, either static or kinematic.

$$\xi = \tanh(\ln \iota) \tag{2}$$

here $\iota = \frac{s_{0T}}{s_{0D}} = \frac{|\mathbf{s}_T|}{|\mathbf{s}_D|} = \frac{I_T}{I_D} = 1 + p$, in configuration static space, and in velocity space: $\iota = \frac{s_{0T}}{s_{0D}} = \frac{|\mathbf{s}_T|}{|\mathbf{s}_D|} = \frac{I_T}{I_D} = p + 1 > 0$, dimmer light for the recession case, or $\iota = \frac{I_D}{I_T} = \frac{s_{0D}}{s_{0T}} = \frac{|\mathbf{s}_D|}{|\mathbf{s}_T|} = p + 1 > 0$ brighter light for approach case.

For $\xi = \frac{v}{c}$,we see that the intensity of the detected light will be lower when the transmitter moves outward, and it will be higher when transmitter moves toward the receiver. In other words, approaching sources will look brighter and receding sources will look fainter. For $\xi = \frac{v}{c}$ equation (2), gives the change in recorded intensity versus relative velocity normalized to the curvature radius of velocity space c. On top of that, there will also be a change in frequency (Doppler shift), so **approaching sources will look brighter and bluish, while receding ones will appear fainter and reddish**.

For $\xi = \frac{r}{R}$, **the same decreasing brightness effect (Figure 1), of distant sources will be observed in a static**

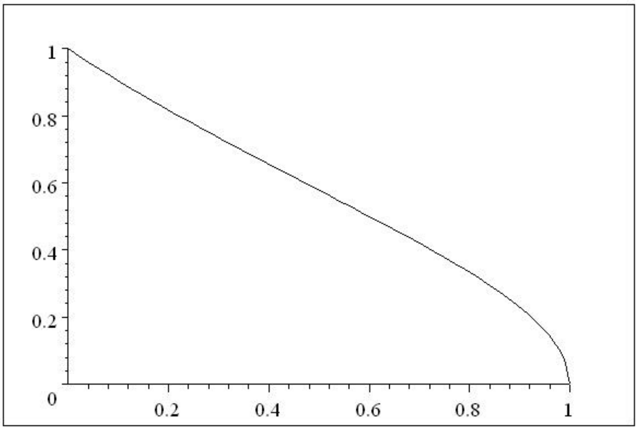

Figure 1. $I_D = \sqrt{\frac{1-\rho}{1+\rho}}$. Unit ball model of Lobachevskian spaces — either velocity or configuration. Intensity of light at detector versus distance traveled. Intensity at transmitter is normalized to unity (vertical axis). The curve describes a static geometry (Lobachevskian universe) or recession case (Lobachevskian velocity space). Approach case will result in a curve: $I_D = \sqrt{\frac{1+\rho}{1-\rho}}$, $\rho = v$. **This effect is not present in Euclidean space due to zero curvature of Euclidean space**. For changes in polarization we have the same plot.

Universe with Lobachevskian geometry, where the source and the detector are at a fixed separation (relatively motionless). As we mentioned in [2], there will also be a redshift due to static Lobachevskian geometry. **So a distant (motionless) source embedded in a Lobachevskian space will appear reddish and fainter than it would appear in Euclidean space.**

We see that by photometric recording techniques alone it is impossible to discriminate between distance and velocity of a radiating object in a Lobachevskian vacuum. The same ambiguity applies to recorded redshifts [2].

In a Lobachevskian universe, the apparent intensity of a source and/or its measured redshift cannot be uniquely decomposed into a distance related component and a velocity related component by photometric and/or spectral measurement alone.

This poses a major difficulty in correlating distances with photometric and spectral measurements since both are affected by negative curvature of both spaces: velocity and configuration.

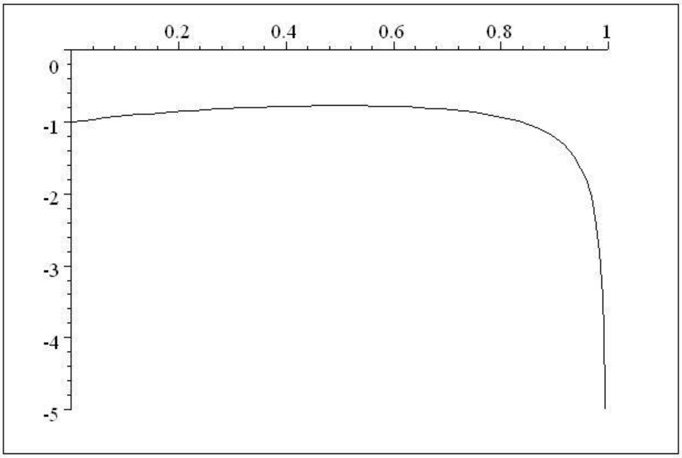

Figure 2. $\frac{dI_D}{d\rho} = -\frac{1}{\sqrt{1-\rho^2}(1+\rho)}$. Unit ball model of Lobachevskian spaces — either velocity or configuration. Rate of intensity (or polarization) change versus radial distance. Distance is either distance in configuration space (Lobachevskian universe) or in Lobachevskian velocity space (relative velocity). The case pictured is of a static space, or of the case of recession, and corresponds to rate of loss. For case of approach (gain), the curve is: $\frac{dI_D}{d\rho} = +\frac{1}{\sqrt{1-\rho^2}(1-\rho)}$ (normalized radial coordinate).

3. SOLUTION OF OLBERS PARADOX — NIGHT SKY DARKNESS EXPLAINED

Olbers paradox is a result of applying Euclidean geometry to the space around us in an effort to deal with the clearly visible darkness of the surrounding space. We need to say up front that there is **no Olbers Paradox in a Lobachevskian universe** and in fact **the darkness of the night sky is yet another proof of hyperbolicity and the active nature of Lobachevskian vacuum.**

It was shown (equation (2)) that a Lobachevskian universe acts as an attenuator of EM radiation. From the graph of the Fig. 1, it is easy to see that intensity of **electromagnetic radiation in any spectral range** coming to us e.g., from a point at distance $\rho = 0.6$ is reduced roughly by a half. **This effect is purely due to the hyperbolicity of the space, and is not present in Euclidean space**. Now we calculate the **ratio of intensities** at the detector in **Lobachevskian versus Euclidean** spaces. This ratio will be equal

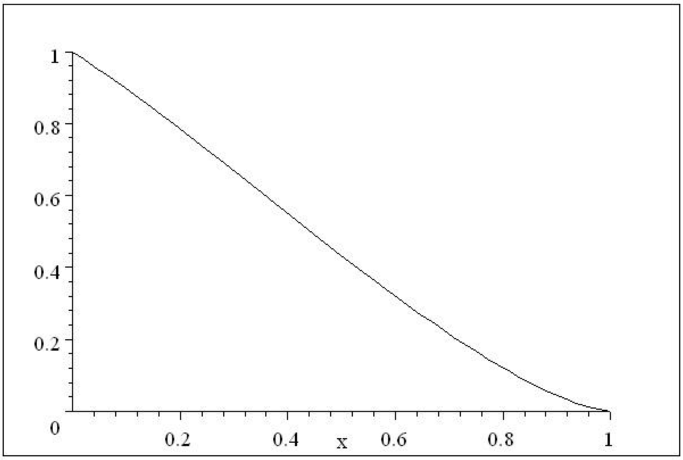

Figure 3. $I_L = I_E \sqrt{1-\rho^2}(1-\rho)$. Lobachevskian geometry at work. The ratio of intensities $\frac{I_L}{I_E}$ of electromagnetic radiation in Lobachevskian universe versus Euclidean universe,plotted against normalized radial distance. At radial distances (horizontal axis) close to zero intensities are comparable, but e.g., from the shell at $\rho = 0.8$, we receive only 12% of that intensity what we would be exposed to in Euclidean space.

to the **non-Euclidean attenuation factor** as in Figure 1, times the **ratio of surface areas of Euclidean to Lobachevskian spheres.** If we take the unit ball model, then from a geometrical consideration [4], the sought ratio is $1-\rho^2$, and the intensity ratio is $\sqrt{1-\rho^2}\,(1-\rho)$, $0 \leq \rho < 1$. At this point one can argue, why not simply use a formula for a hyperbolic sphere instead of an Eulidean sphere to obtain the hyperbolic analog of $(4\pi r^2)^{-1}$ law. The answer is that, this would be the case if the centers of Euclidean and Lobachevskian spheres coincided. **A Lobachevskian sphere is also an Euclidean sphere but their centers do not coincide** [4].

The plot of this function is given on Figure 3. Please note that close to zero (at distances small with respect to characteristic length), shown in Figure 4, intensities are practically equal, which reflects the fact that Lobachevskian space "in small domains" produces "the same" physics as the one in Euclidean space. In [2] we showed that a "small domain" means a domain in order of 10E-6 (in a normalized ball of radius 1), which is roughly of the size of our own galaxy. So within our own galaxy (Figure 4), photometry will be based on Euclidean

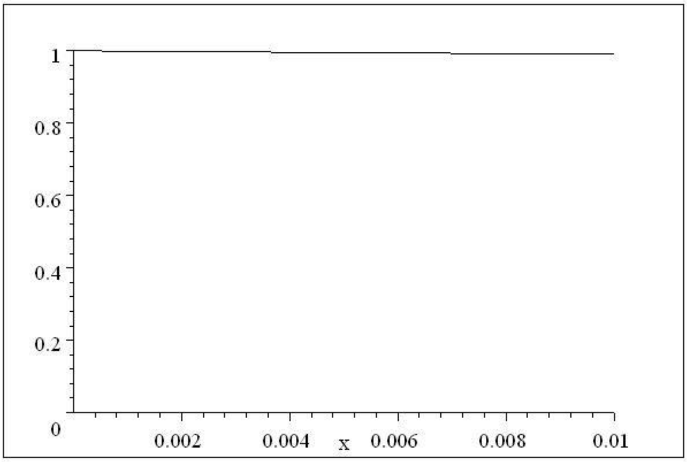

Figure 4. The same plot as in Figure 3, but normalized radial distance is now 0.01. This means, assuming that the radius of the Poincare ball is 15 billion light years, 0.01 corresponds to 150 million light years. This is 1500 times diameter of our own galaxy. It is clear that photometric measurements within such a domain will coincide with Euclidean law of $\frac{1}{4\pi\rho^2}$. This is not the case for deep space.

physics, but for so called **deep space astronomy we need to apply different calculations based on Lobachevskian physics.**

From the formula and from Figure 3 it is clearly seen that almost no light will reach us if the distance is big enough, and **no light will reach us from the boundary at infinity. That is why the sky is dark at night. It is amazing how Lobachevskian geometry of the Universe made life on the Earth possible.** Since the Earth is not by any reason positioned in some privileged place in the universe, it follows that in Euclidean universe, infinite brightness of sky will exist at every point. This implies (due to Olbers scenario in Euclidean space) that were the universe Euclidean, everything would be turned into a hot plasma state, or perhaps into pure radiation.

We already showed [2] how Lobachevskian space produce cosmological redshifts and how CMBR is identified with the homogeneous space of horospheres in Lobachevskian universe. **The darkness of the night sky is yet another proof of hyperbolicity of the vacuum.**

4. APPLICATION TO ASTROPHYSICS. FAINT SOURCE COUNT PROBLEM

Suppose we investigate some very distant objects in the Universe. To be more precise we consider an inner shell ("boundary layer") near the surface at infinity in the unit ball model of Lobachevskian Universe. As we showed, due to Lobachevskian geometry itself, light coming to us will be redshifted and dimmer. Now, if those far objects have some random distribution of velocities we can assume that number of those objects with velocities toward us i.e., blueshifted, and a number of those objects having velocities away of us, i.e., redshifted, roughly speaking, are equal. It may happen that those **redshifted and dimmer** ones will **fall behind the information horizon** (information horizon, among the other things, depends on our ability to detect and to process information in a meaningful way) and **will disappear from detection**. On the other hand, those **kinematically blueshifted and kinematically brightened** will **reappear from the information horizon** and that will change for us the **balance from red to blue, in favor of blue.** If we adopt that 10% of galaxies migrate in and out of information horizon, then the ratio of blue to red will shifts will change from 50 : 50 to 55 : 45 (1.2), and there will be more faint blue galaxies. The volume of the inner shell can be calculated due to Lobachevskian geometry, and from the count of faint blue galaxies, we can estimate the total number of galaxies in the internal spherical shell near "the edge" of the Universe. Since Lobachevskian space is a homogeneous space, this may allow us to estimate the number of galaxies within the ball of radius R, where R is the radius of Poincare ball model of Lobachevskian space. We need to add that **the physical unit ball model** (due to the existence of a random velocity field of radiating objects) will appear to us as having no sharply defined boundary at infinity, but rather some kind of diffuse transition shell. In that "twilight zone", only those objects which have favorable intensity shifts and redshift/blueshift combinations due to both static and kinematic shifts will be detected. **We will see objects which are not there;** these will be "ghosts" coming to us from over the horizon.

To classify shifts resulting from the configuration space and from the velocity space as well (which are both Lobachevskian spaces of a different curvature), we call those shifts static and kinematic respectively, and note that while **kinematic** shifts can be **blue-bright** or **red-faint**, **static** ones are always **red-faint**. This creates several possibilities and to a high degree obscures reality. For example, based on **photometric** measurements, a distant galaxy approaching us will

look closer than it really is, while one receding from us will appear even **further** from us.

It follows that there is an information horizon in Lobachevskian space. **Light traveling through the Lobachevskian space will be frequency redshifted** [2], **and its intensity will diminish.** Light will become fainter and reddish and at some point will become undetectable. In a quantum treatment of light, intensity is related to number of photons and the frequency to the photon energy. It follows (in a quantum framework), that a photon **moving through (empty) Lobachevskian space loses its energy, and that the number of photons in a flow is not conserved.** This leads to an absolute information horizon. We would like to emphasize here again that the **above effects are solely due to the hyperbolicity of an empty 3 dimensional Lobachevskian space and not due to any other factor(s).**

5. OBJECT ROTATION IN LOBACHEVSKIAN SPACES

To make the total picture even more complicated we make a simple observation that the whole curved Lobachevskian space can be reconstructed from e.g., Euclidean cubes (cells) of about $15KLy$ or so in size. In [2] we showed that, if the radius of Lobachevskian space assumed as an interior of a 3D ball in Euclidean space, such a cell can be regarded as Euclidean space since we can't detect any deviation from flatness in such a domain. We can "**wrap**" the 3D Lobachevskian negatively curved universe in 3D Euclidean cells of the above size, but each Euclidean cell will be "slightly rotated" with respect to the previous one. It is an obvious fact that the further the cell is from the reference point, the more it will be rotated (this can be calculated by standard methods of differential geometry). For a **Lobachevskian velocity space such rotation effect was described by Terrel** [12]. It follows that **in an extreme case** of a large static distance and high recession velocity, the remote cell containing e.g., a galaxy, **might be rotated almost** 180 **degrees**. Hence, **in that case we will see galaxy from its rear**. On the other hand for velocity in the opposite direction, the velocity space rotation will cancel the configuration space rotation and we will see an object more "am face". There will be an endless combination of cases in between. It seems therefore that separating all the effects resulting from the **double hyperbolicity** (velocity and configuration spaces) and restoring the correct picture is an extremely difficult task. One good thing about is that **being in one place,** we have the possibility of seeing objects in the Lobachevskian Universe from "**different views**". Space itself rotates object for us. This is in a way similar with the principle of how a Hertzsprung-Russel (HR) diagram is constructed. We can't follow the life of the star because of incompatibility with our own life. But we can see stars at different ages and if we assume that stars are more or less typical objects, we can reconstruct ("synthesize") the life history of a star. **Thanks to Lobachevskian geometry, we can see the universe and objects in it from the different angles, while not moving anywhere from our observatory.**

All considered effects **(wavelength shift** [2]**, intensity shift, and object rotation)** make it very difficult to decipher the information and to restore the simple picture of our Lobachevskian universe, and we still did not include any (local) effects caused by gravitation.

Our results (including those in [2]) are summarized in Table 1 below:

Table 1. Topological imprints of negatively curved spaces on electromagnetic radiation.

Lobachevskian universe	
wavelength change	$\lambda_D > \lambda_T$
intensity change	$I_D < I_T$
object rotation	$0 < \varphi\left(\frac{r}{R}\right) < 90^o$

Lobachevskian velocity space	
$\lambda_D > \lambda_T$ recession,	or $\lambda_D < \lambda_T$ approach
$I_D < I_T$ recession,	or $I_D > I_T$ approach
$0 < \varphi\left(\frac{v}{c}\right) < 90^o$ recession,	or $-90 < \varphi\left(\frac{v}{c}\right) < 0$ approach

In fact what we see in Table 1 is a **direct manifestation of Anosov flows** [1] on hyperbolic manifolds and clearly suggest that Lobachevskian universe can be studied with powerful and rigorous methods of symbolic dynamics and ergodic theory.

6. INELASTIC SCATTERING OF ELECTROMAGNETIC WAVES ON LOCAL VARIATION OF VACUUM CURVATURE. ELECTROMAGNETIC DETECTION OF GRAVITATIONAL WAVES

As we understand, the problem with detection of gravitational waves is that they are extremely weak. This is not so bad at all. Strong gravitational waves would shake and easily destroy the entire solar system. Another important thing is that the impedance mismatch at the receiver is so huge that it practically prevents making any reliable detection in a direct way. The outcome of the Weber/Braginsky detection scheme in the early days seems to confirm those unfavorable conditions. The new hope for direct detection is based on interferometric techniques [9], but it seems that difficulties are just shifted from one area to another [8]. We will not comment on them. Instead, **we propose to circumvent the direct detection problems and to get (indirect) evidence of existence of gravitational waves in the following set up.**

We showed that **curvature** (either static or kinematic) will affect the flux and **will cause changes in apparent brightness** of the object we are looking at. This can be employed for (indirect) detection of gravitational waves (if any exist). Suppose that in the space between transmitter and detector a gravitational wave is passing perpendicularly (or so) to the line of sight. Then **the curvature of space due to the passage of gravitational wave will fluctuate**, say from -1 (negative vacuum) to $+K$ (maximum curvature inflicted by gravitational wave). We can say that a **negatively curved space plus a gravitational wave is a light intensity modulator** (frequency modulator as well). Optical communications engineers use this concept routinely in so called acousto-optical modulators [5]. Of course they do not use gravitational waves, but rather acoustic waves to modulate density of a medium (index of refraction) in which light propagates. By this analogy, we call the proposed scheme of detecting gravitational waves **G**ravito-**E**lectro**M**agnetic (**GEM**) detection.

We conjecture that **if we record a correlated periodic variation in intensity and wavelength (frequency) of incoming light, we can say with high confidence that we see a periodic change of space curvature,** i.e., **we see a gravitational wave.** If our method will work, it would be **the first reliable way to detect existence of gravitational waves.** Therefore we should **look for correlation between AM and FM** of incoming light, plus correlated variation of its polarization. Such an experiment would be easy to carry out, and perhaps existing observational databases can be used.

It is interesting to note that the **periodicity of** z **already has been observed experimentally** by Tifft [13] and confirmed by Burbidge and others [3]. As it was pointed out by Burbidge [3] this **experimentally recorded** and **unexplained as yet phenomenon** was totally ignored by astrophysical community since **it does not fit into Big Bang cosmology;** however it fits quite naturally into our model of static Lobachevskian universe. We conjecture that evidence of **periodicity of** z **is an evidence of long period** (perhaps as long as 1 BLy to 2 BLy) **curvature waves** in the Lobachevskian universe. Those long range disturbances of Lobachevskian negative curvature

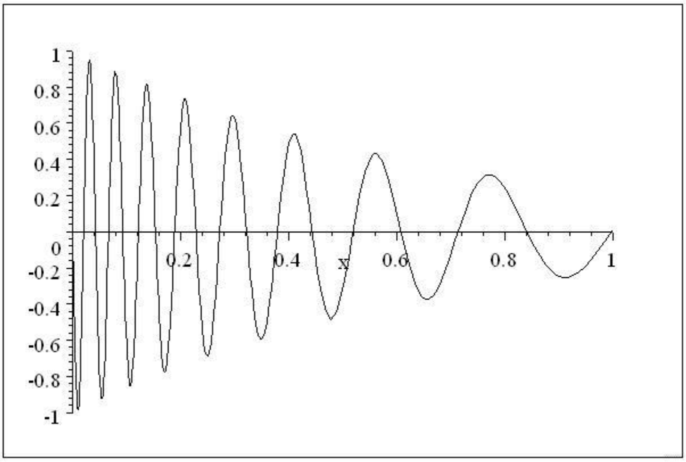

Figure 5. Classical picture. Moving through empty Lobachevskian space, an electromagnetic wave is lengthened [2] and attenuated. In the quantum picture, a stream of photons with high energy, dense at the source, will become less energetic (reddish) and sparser as photons travel through Lobachevskian universe. **In the case, a gravitational wave is detected, the envelope of EM wave in Figure 5 will oscillate, (change in apparent brightness due to envelope AM), and there will be a frequency jitter wander (FM), i.e., will see periodicity in redshift z.**

vacuum might be due to gravitational waves or perhaps due to some kind of self oscillation of the universe as a whole (breathing modes). If we are correct, Tifft might be the first person ever who experimentally observed gravitational waves in the Lobachevskian universe.

7. APPLICATION TO DEEP SPACE COMMUNICATION AND SETI PROBLEM

The electromagnetic wave is the primary and as yet, the only vehicle for space based communication. What does this mean for SETI efforts to establish communications in the universe? The above analysis shows that we live under a **"double lock"** in the universe around us. The first barrier is imposed by the finite speed of light. The speed of light, even incredibly high by our everyday experience, when compared to the vast size of the universe, is just next to nothing. The limitations due to the finite value of c are well known. The second lock is imposed by an absolute information horizon since **hyperbolic space will "erase"**

any information if the propagation distance is long enough.

It is easy to see from the RRD equation (9) in [2] that the bandwidth at receiver is less than the transmitter bandwidth. **If the propagation distance is long enough, to receive (at receiver site!) one bit of information may take "forever"**. On top of diminishing receiver bandwidth, there will be non Euclidean amplitude attenuation which further deteriorates the signal. Quite similar behavior (but not the same) is observed for guided electromagnetic waves in long haul transoceanic fiber optic lines. To make transmission within acceptable bit error rate (BER) standards, we need to fight chromatic dispersion (CD) and polarization mode dispersion (PMD) which both spread the pulse and attenuation due to propagation medium (fiber). Even with the best design possible, regeneration of the signal is required before it becomes "unreadable".

In Lobachevskian empty space an EM wave will experience all those "unpleasant" things. Shift in spectrum, attenuation, and depolarization. Therefore, to make cosmic transmission BER acceptable, many space based regenerators will be required.

All that makes (meaningful) communications with potential communicators by means of electromagnetic waves highly unlikely, if not totally impossibly unless we employ **free space soliton communication.** This however is subject to our next paper.

8. CONCLUSIONS AND REMARKS

In this paper and [2] we presented a detailed and coherent treatment of observations related to electromagnetic waves i.e., **recorded spectrum** and **intensity**. Using **only one concept,** the concept of a **Lobachevskian static background geometry**, we gave a qualitative and quantitative analysis of:

1. Spectral shifts in Lobachevskian vacuum. Cosmological redshift (distance/curvature/spectral shift equation) for all values of z [2].
2. Redshift periodicity (not explained by Big Bang) with application to GW detection.
3. Intensity of light in Lobachevskian vacuum
4. Darkness of the night sky — Olbers "Paradox"
5. Faint source count problem
6. Properties (and existence) of CMBR [2]
7. Cosmological object rotation.
8. The size of the spatial domain beyond which observation based on Euclidean physics are invalid. [2]

Our analysis **agrees with all existing experimental** (based on EM waves) **observations and extends further into the territory where either Euclidean geometry or/and the Big Bang predictions fail.**

Now we would like to recall again the difference between Lobachevskian physics and Euclidean physics. Lets take only **static Lobachevskian space**. As we have seen from above, Lobachevskian vacuum (contrary to Euclidean vacuum) alters characteristics (measurable parameters) of an electromagnetic field. With respect to the frequency wavelength, it acts as a **frequency/wavelength shifter**. With respect to intensity, it acts as **an attenuator**. So **light received from a distant fixed source in a static Lobachevskian Universe will be reddish, fainter than in flat space. In Euclidean spaces the wavelength will not change, and intensity changes as** $\left(4\pi\rho^2\right)^{-1}$.

Since we did not make any assumptions about the physical nature of vector b in equation (3.1) in [2], we think that the same reasoning applies to **any field which propagates at speed of light in vacuum** $[b, b] = 0$. If that is correct then gravitational waves ("ripples on space") will be attenuated, depolarized and wavelength redshifted as well. That is (partially) the reason, in our understanding, why gravitational waves are weak. Far enough from the source of GW, curvature of space will be solely due to the constant negative curvature of a Lobachevskian vacuum..

The effects described above, imposed on propagating fields by Lobachevskian geometry itself, (and perhaps other factors, e.g., scattering, local gravitational fields etc.) make it very difficult to restore a correct picture from observational data. For example,we detect reddish, faint light. How can we interpret our data now? There are multiple possibilities (Table 1); **the correct state is a mixture of them**. **How will we decompose this mixture?** Is there an unique way to find a contribution of each component? It seems that the situation outlined has a deeper resemblance to the well known **quantum mechanical picture** where **a mixed state can not be uniquely decomposed into pure states** [7], contrary to an orthodox classical physics where any mixed state (superposition) can be uniquely decomposed into its components. Therefore it is **impossible** to "precisely" decode the deep space observational spectral and amplitude data brought to us by electromagnetic waves **due to double hyperbolicity** (velocity and configuration) **of the phase space of the universe**.

A similar ambiguity is already well known [11] and exists in radar signal processing with regards to range-velocity estimation. It is expressed via the so called radar ambiguity function. Analysis is done in the so called information (frequency-time) plane and the range is assumed as $\frac{1}{2}\ ct$. Please note that it doesn't matter whether an EM signal that we detect from somewhere is generated by an excited atom in a star (**wavelength/intensity-space processing** in our case) $10BLy$ away (active transmitter), or it is generated in passive fashion i.e., reflected (frequency -time processing in the radar case) from an aircraft 100 miles away. We refer the interested reader to W. Schempp paper [10] on a mathematical radar signal treatment.

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