

Gravitational Wave Radiation from the Antimatter Universe

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Abstract

Since the advent of gravitational wave astronomy in the second decade of this century—due to the observation of gravitational waves by LIGO detectors in 2015, there are active efforts by many astrophysicists to propose different theoretical models to explain and test this phenomenon. In this article, we study gravitational wave radiation from the previously proposed anti-matter universe. The emitted continuous-gravitational wave radiation from the compact core of the anti-universe and its relativistic rotating outer plasma layer, are considered as perturbative waves in toroidal r-mode oscillations driven by rotation and Coriolis forces. The most prominent toroidal-bulk mode for gravitational wave emission is the $l = 2$, $m = 2$, and its range of frequencies is approximately $\approx 135 - 632$ Hz. This mode is likely detectable by LIGO or VIRGO detectors where their sensitivities are high enough in this range of frequencies. The power radiated from this mode adapted for rapidly rotating compact object (anti-universe) with compactness parameter $C \approx 0.49$, is evaluated to be approximately $\approx 1.4 \times 10^{39}$ W. Gravitational wave-strain amplitudes are calculated using the quadrupole formula adjusted for r-modes, estimating the distance between the antimatter universe and the observer to be of the order of magnitude of the radius of our observable universe which is approximately 46.5 billion lightyears (4.4×10^{36} m), about 0.24×10^{-29} , after incorporating GR frame dragging (Lense Thirring effect) correction. This value is too weak for any currently operating gravitational wave detector to observe. However, the high sensitivity cryogenic LIGO/VIRGO detectors or the future planned laser interferometer space antenna (LISA), could plausibly detect the continuous emitted gravitational waves from the antimatter universe.

Keywords

Astrophysical Cosmology, Antimatter Universe, Gravitational Waves, Dark Energy

1. Introduction

The study of antimatter in the universe offers new perspectives on the physical nature of our universe [1] [2].

In a previous publication [3], we studied the electromagnetic radiation emitted from the antimatter universe that was formed as a result of the ejection of primordial anti-S particles during the **Big Bang** [4].

Following the anti-universe evolution processes, a dense anti-hydrogen gas collapsed under its own gravity and accreted with time forming a compact object (the core of the anti-universe). However, the high surface temperature, pressure and collisions resulted in the ionization of the anti-hydrogen atoms on the surface forming a thin plasma layer of free negatively charged heavy anti-protons and positively charged light positrons. The strong centrifugal force acting on the charged particles leads, together with their ultra-fast rotation, to the emission of a synchrotron type—electromagnetic radiation mainly from the lighter positron layer [3].

In this article, the author investigates the possibility of gravitational wave (GW) emission by the anti-matter universe. The article will be structured as follows: in Section 2, the spectrum of toroidal oscillations is discussed; then in Section 3, the power of gravitational wave is calculated, and the gravitational strain is evaluated; finally the conclusions are given in Section 4.

The author has previously proposed [3], that the radius of the core of the anti-universe, in the early phase, is about 150 Km. However, in the present article, which is a continuation to the previous one, he found that the proposed value is smaller than the corresponding Schwarzschild radius (about 295 Km), suggesting that the compact object (the anti-universe) could be a black hole that might not support toroidal oscillations, and hence no gravitational wave radiation will be emitted. Therefore, in this study the author proposes that the radius is 300 Km.

2. The Spectrum of Toroidal Oscillations

Toroidal oscillations of rotating celestial objects draw the attention of many astrophysicists and is the subject of much research nowadays [5] [6].

We consider the small-amplitude oscillations of a stellar spherical object due to perturbations that can be described in terms of the spherical harmonics $Y(\vartheta, \phi)$ given by [7]:

$$Y_l^m(\vartheta, \phi) = (-1)^m c_{lm} P_l^m(\cos \vartheta) \exp(im\phi), \quad (1)$$

where, ϑ is the co-latitude (measured from the z-axis) and ϕ is the longitude measured from the x axis in the equator. P_l^m is the associate Legendre function of order (l, m) , c_{lm} is the normalization constant.

For studying the stellar oscillations, it is necessary to solve the equation of motion of the perturbation and to define its spectrum to determine the amplitude of the oscillation. Stellar objects are usually treated as a continuum of gas (or fluid) [6] [8], where their properties can be specified as functions of position $\mathbf{r}$ and time

t (these include local density $\rho(r, t)$, local pressure $p(r, t)$ and local instantaneous velocity $\mathbf{v}(r, t)$). In the *Eulerian* description $\mathbf{r}$ denotes the position vector to a given point in space as seen by stationary observer. It is also convenient to use the *Lagrangian* description where the observer follows the motion of the gas.

More often stellar objects are rotating objects; hence, it is straight forward to notice that rotation might affect the observed frequencies. We assume that the angular frequency Ω is uniform and consider an oscillation with a frequency ω independent of m , in the frame rotating with the object. Let a coordinate system in this frame with coordinates (r', ϑ', ϕ') which are related to the coordinates (r, ϑ, ϕ) in an inertial frame through, $(r', \vartheta', \phi') = (r, \vartheta, \phi - \Omega t)$. It follows that, in the rotating frame, the perturbation depends on ϕ' and t as $\cos(m\phi' - \omega_0 t)$; hence the dependence in the inertial frame is $\cos(m\phi - \omega_m t)$ where $\omega_m = \omega_0 + m\Omega$. Thus, an observer in the inertial frame finds that the frequency is split uniformly [8] according to m .

The toroidal (sometimes called torsional) oscillations, typically occurring in fast rotating spherically symmetric stellar objects, are non-radial, shear-like oscillations where the displacement is primarily in the azimuthal direction. This type of oscillation mode arises in the core of our proposed anti-universe model, via two kind of mechanisms: 1) The first one is characterized by those displacements that lie on the surface of the constant radius's core of the anti-universe, similar to r-modes or inertial modes of oscillations usually studied in rotating stars [5] [9], 2) The second exists at the surface of the core due to the thin plasma layer formed by the negatively-charged heavy anti-protons together with the positively-charged light positrons [10] and which are regarded as two-fluid plasma model. The geometry of the model leads to toroidal Alfvén eigen modes arising from magnetic field geometry, similar to that in fusion devices like-tokamaks [11].

The toroidal spectrum generated refers to the eigen frequencies of these oscillation modes and is dependent on the system's physical properties, for example rotation, density and magnetic field. The spectrum can be found by solving the linearized equation of motion for perturbations in the two systems discussed above, namely, 1) Bulk oscillations, and 2) surface plasma oscillations.

2.1. Bulk Oscillations

The bulk (core) can be considered as neutral relativistic fluid. We assume a small perturbation or displacement ζ of the form,

$$\zeta(\mathbf{r}, t) = \zeta(r) \exp(-i\omega t), \quad (2)$$

where, ω is the eigen frequency of the mode (oscillation frequency in rotating frame). For toroidal modes the displacement is primarily in the azimuthal direction (ζ_ϕ in spherical coordinates). Substitute Equation (2) into Euler's equation for ideal fluid in a rotating reference frame, we obtain the linearized momentum equation [6] [10],

$$-\omega^2 \zeta + 2i\omega(\mathbf{\Omega} \times \zeta) = -(1/\rho_0) \nabla P' - \nabla \phi' + g(\rho'/\rho_0), \quad (3)$$

where, p' is the perturbation pressure, ϕ' is the gravitational perturbation, ρ' is the density perturbation, g is the gravitational acceleration and Ω is the rotation velocity. For toroidal modes, the radial displacement is often negligible, and perturbation is divergence-free ($\nabla \cdot \boldsymbol{\zeta} = 0$). The second term in the L. H. S. of Equation (3) is the Coriolis force which is considered as the restoring force for the oscillations and lifts the degeneracy in m due to rotation. In rotating stellar objects where oscillations dominate, the r-mode for ultra-fast rotation is considered as one of the most important types of modes relevant to astrophysical studies and having oscillation frequencies proportion to the rotation velocity given by [6],

$$\omega_r \approx 2\Omega m / l(l+1), \quad (4)$$

in the rotating frame [8], where $\omega_r = \omega_{\text{iner}} + \Omega m$ [6], and is driven by the Coriolis force in the bulk of the rotating core. The r-mode eigen frequencies in the inertial frame and after considering the relativistic effect, is given by,

$$\omega_B \approx \Omega m - 2\Omega m / (l(l+1)\gamma), \quad (5)$$

where, γ is the Lorentz factor $\gamma = 1 / \left(1 - (v/c)^2\right)^{1/2}$, and ω_B is the bulk frequency due to relativistic rotations in inertial frame.

2.2. Surface Plasma Oscillations

At the surface where the anti-hydrogen atoms are ionized and a thin plasma layer of negatively-charged anti-protons and positively-charged positrons are formed, the magneto-hydrodynamic (MHD) effects play a significant role. The linearized (MHD) equation for the plasma is given by [7] [10],

$$\rho \left(\partial^2 \boldsymbol{\zeta} / \partial^2 t \right) = -\nabla P' + 1/\mu_0 (\nabla \times \mathbf{B}') \times \mathbf{B}_0 + 1/\mu_0 (\nabla \times \mathbf{B}_0) \times \mathbf{B}', \quad (6)$$

where, $\mathbf{B}_0$ is the background-equilibrium magnetic field, $\mathbf{B}'$ is the perturbed magnetic field, related to $\boldsymbol{\zeta}$ via, $\mathbf{B}' = \nabla \times (\boldsymbol{\zeta} \times \mathbf{B}_0)$, and μ_0 is the permeability of free space. The plasma produces “toroidal Alfvén modes”, driven by the plasma’s magnetic field with frequencies determined by the Alfvén speed [10],

$$v_A = B_0 / \left(4\pi \rho_{\text{plasma}} \right)^{1/2}, \quad (7)$$

where,

$$\rho_{\text{plasma}} = n_{\text{anti-p}} m_{\text{anti-p}} + n_{\text{pos}} m_{\text{pos}}, \quad (8)$$

and n , m are the number densities & the masses respectively. The frequency of the toroidal Alfvén mode is,

$\omega_A \approx v_A k_\varnothing$, where $k_\varnothing = m/R$ is the azimuthal wave number. Thus, the toroidal Alfvén frequency is, given by [10],

$$\omega_A \approx m B_0 / R \left(4\pi \rho_{\text{plasma}} \right)^{1/2}, \quad (9)$$

however, a simplified formula for the toroidal plasma Alfvén angular frequency [10] [12],

$$\omega_A \approx (l(l+1))^{1/2} c/R, \quad (10)$$

is used when v approaches c and for strong magnetic field B_0 . This limit can be justified if the plasma is in a force-free (charge-starved regime) leading to wave propagation near the speed of light, which is common in relativistic astrophysics plasmas such as pulsar magnetospheres (e.g. [12] [13]). This simplified formula was derived in the relativistic limit of magnetohydrodynamics (MHD) when v_A approaches c [6]. This occurs when the magnetic energy density dominates over the plasma's effective energy density, where the factor $(l(l+1))^{1/2}/R$ comes from the angular wave number in spherical geometry for toroidal modes (from the spherical harmonic Laplacian eigen values) [14]. The extreme rotation and the interactions between the bulk and the plasma at the surface lead to hybrid modes. The plasma layer couples the bulk mode with the plasma Alfvén mode via boundary conditions at the surface ($r = R$), where the displacement ζ must be continuous and the magnetic stress balances the fluid stress.

The total frequency is then, given approximately by,

$$\omega = (\omega_B^2 + \omega_A^2)^{1/2}, \quad (11)$$

assuming weak coupling between the bulk and the plasma. The frequency in the inertial frame is therefore, given by,

$$\omega_{\text{iner}} = \omega + |m|\Omega, \quad (12)$$

accounting for Doppler shift due to rotation.

2.3. Spectrum Calculations

To calculate the spectrum of toroidal oscillations for the system of the spherically compact object made of anti-hydrogen atoms, we assume the following parameters for the compact object:

Mass M is 100 solar masses $\approx 1.989 \times 10^{32}$ kg

Radius R about 300 km $= 3 \times 10^5$ m.

Tangential velocity at the equatorial plane of $0.99c$.

Angular velocity $\Omega = v/R \approx 0.99 \times 10^3$ rad/s.

Lorentz factor $\gamma = 1/\left(1 - (v/c)^2\right)^{1/2} \approx 7.09$

Plasma layer: Composed of anti-protons ($m_{\text{anti-p}} \approx 1.673 \times 10^{-27}$ kg), and positrons ($m_{\text{pos}} \approx 9.1 \times 10^{-31}$ kg), a charge-neutral plasma with equal number densities $n_{\text{anti-p}} = n_{\text{pos}} \approx 10^{20} \text{ m}^{-3}$, yielding plasma density $\rho_{\text{plasma}} \approx 1.67 \times 10^{-7} \text{ kg/m}^3$.

A toroidal magnetic field $B_0 = 10^6$ T.

Bulk density: Average density $\rho = M/(4/3)\pi R^3 \approx 1.7 \times 10^{15} \text{ kg/m}^3$.

The results of the spectrum calculations are listed in **Table 1**, for $l = 1$ to 3 and $m = -2, -1, 0, 1, 2$.

The table contains the calculated frequencies of the toroidal bulk, Alfvén, hybrid modes, to provide insights into the oscillatory behavior of the relativistic rotating compact anti-universe. The model assumes a uniform density, simplified

Table 1. The values of toroidal oscillation frequencies in (rad/s), the bulk modes ω_B , plasma Alfvén modes ω_A , and hybrid modes ω_H , for $l = 1$ to 3 and $m = -2, -1, 0, 1, 2$.

l	m	ω_B	ω_A	ω_H
1	-1	850	1414	1650
1	0	0	1414	1414
1	1	850	1414	1650
2	-2	1887	2450	3092
2	-1	943	2450	2625
2	0	0	2450	2450
2	1	943	2450	2625
2	2	1887	2450	3092
3	-2	1933	3464	3967
3	-1	296	3464	3597
3	0	0	3464	3464
3	1	967	3464	3597
3	2	1933	3464	3967

by weak coupling via the thin plasma layer, and relativistic modification through the Lorentz factor γ , which effectively boosts the inertial effects in the co-rotating frame. The bulk modes are like r-modes in neutron stars, driven by rotation and Coriolis forces. The Alfvén modes arise from strong magnetic field tensions in the plasma layer, leading to near-light-speed wave propagation. The hybrid mode is dominated by the stronger component.

The bulk modes depend strongly on the azimuthal number m and the rotational angular velocity Ω , while frequencies increase with the absolute value of m for a given l reflecting stronger restoring Coriolis force for higher azimuthal orders. The Alfvén modes are independent of m (due to the assumed axisymmetric magnetic field) and scale with $[l(l+1)]^{1/2}/R$, yielding higher frequencies for larger l (e.g., 1414 rad/s at $l=1$ to 3464 rad/s at $l=3$). With $v_A \approx c$ in this high- B_0 , low-density plasma, these modes propagate rapidly, resulting in short periods (between 4.4×10^{-3} s and 1.8×10^{-3} s), consistent with strong-field compact objects like magnetars [15], and compactness $C = GM/Rc^2 \approx 0.493$. The hybrid modes have always higher frequencies than both the individual bulk and Alfvén modes.

Table 1 shows that the toroidal oscillation angular velocities vary from 850 to 3967 in rad/s corresponding to approximate frequencies between ~ 135 Hz to ~ 632 Hz.

In general, the frequencies range from ~ 135 Hz to ~ 632 Hz, corresponding to periods of ~ 0.0016 - 0.0074 s *i.e.*, in the millisecond timescales typical for compact object dynamics.

There are several relevant observatories (ground-based GW interferometers),

sensitive to the detection of GW in our range of frequencies, namely: Advanced LIGO (Laser Interferometer Gravitational-Wave Observatory) in USA; VIRGO in Italy, collaborating with LIGO for triangulation; KAGRA in Japan; GEO600 in Germany, often used for testing and continuous wave searches.

Based on astrophysical literature for similar oscillations as in our compact object model, the most prominent toroidal mode for GW emission is typically the $l=2$, $m=2$ inertial (r-mode-like) mode. It is the primary channel for the Chandrasekhar-Friedman-Schutz (CFS) instability [6] [16], leading to potentially strong GW radiation in rotating systems. In our model, this corresponds to the bulk mode at $l=2$, $m=2$, with $f \approx 300$ Hz ($\omega \approx 1887$ rad/s), as it aligns with the frequency range where such modes are expected to saturate and emit continuously if excited (e.g., via accretion or spin-up). This mode is likely more detectable than higher-frequency hybrids (e.g., 492 Hz) because LIGO/Virgo/KAGRA sensitivity is better at ~ 100 - 300 Hz, where seismic and thermal noise is lower. Alfvén modes may couple weakly to GWs due to their magnetic nature, but the hybrid could enhance emission with increasing coupling. However, the bulk mode remains the baseline for prominence in relativistic rotating objects.

3. The Radiated Power and the Gravitational Wave Strain

For a rotating compact object with toroidal oscillations, GWs are primarily generated by time varying mass quadrupole moments [17] (or higher multipoles) induced by the oscillations. Since, the spectrum of the toroidal modes computed in Section (2) are non-radial and shear-like, their GW emission is weaker than the spheroidal modes [18], however, the fast rotation and the relativistic effects largely enhance the GWs signals. As the r-mode discussed in the previous section grows and evolves with time, it emits a continuous gravitational radiation. In this section we shall calculate the order of magnitude of the power radiated. Then, the amplitude of the wave strain h_0 , of the most prominent mode for gravitational wave emission in Table 1, will be evaluated, namely, $l=2$ and $m=2$ (which was the primary channel for Chandrasekhar-Friedman-Schutz (CFS) instability) that leads to potentially strong GW radiation in rotating systems. This will be followed by the discussion of the possibility of measuring and detecting the GWs with the available devices.

3.1. Power Radiated from the Toroidal R-Mode

The power radiated by the GWs is given by the mass quadrupole formula [17] in general relativity overall directions. However, for the r-modes in a rotating celestial object, the quadrupole moment perturbation is driven by the mode displacement equation, given by [8],

$$\zeta(t) = \alpha R(r/R)^l Y_l^m(\vartheta, \phi) \mathbf{r} \times \nabla Y_l^m(\vartheta, \phi) e^{-i\omega t}, \quad (13)$$

where, α is the dimensionless amplitude of the mode, and ω is the mode frequency. The r-mode instability grows and radiates gravitational waves away from

the bulk of the angular momentum of the rapidly rotating compact object [5]. They are generally defined as solutions of the perturbed fluid equations having, Eulerian-velocity perturbations [10]. The r-modes evolve with time dependence $e^{i\omega t - t/\tau}$, according to the equations of hydrodynamics [5] [10] together with the effects of dissipative processes such as shear and bulk viscosities. In our model we ignore these dissipative processes, since they have minor influence on the oscillations, and we consider only the effect of the gravitational radiation of the compact core $\tau \approx \tau_G$. Hence, we express the power as the time derivative of the average energy $\bar{E}$ of the mode (as measured in the rotating frame), and is given approximately by [5],

$$d\bar{E}/dt \approx -2\bar{E}/\tau_G, \quad (14)$$

where, $\bar{E}$ for $l = 2$, is given by (Owen *et al.* 1998),

$$\bar{E} = (1/2)\alpha^2\Omega^2MR^2\hat{j}, \quad (15)$$

where, $\hat{j}$ is the average angular momentum of the r-mode, which is defined for $l = 2$ by [5],

$$\hat{j} = (1/MR^4) \int_0^R \rho r^6 dr, \quad (16)$$

therefore, $\hat{j} \approx 3/28\pi$ and hence, $\bar{E} \approx 3 \times 10^{35} \text{ J}$. For the gravitational radiation emission of the r-mode and $l = 2$, we use Equation (17) of Ref. [19], which gives $1/\tau_G$ by,

$$1/\tau_G = - \left[(32\pi G \Omega^6 / c^7) \times (1/(5!))^2 \times (4/3)^6 \right] \int_0^R \rho r^6 dr. \quad (17)$$

For $l = 2$, $1/\tau_G \approx -38 \text{ Hz}$. Substituting in Equation (14), we get,

$P_{22} \approx -2\bar{E}/\tau_G \approx -2(3 \times 10^{35})(-38) = 2.3 \times 10^{37} \text{ W}$. If we include general relativistic (GR) effects (frame dragging correction), $(1 - R_s/R)^{-1} \approx 60$, we get,

$$P_{22} \approx 60 \times 2.3 \times 10^{37} \approx 1.4 \times 10^{39} \text{ W}. \quad (18)$$

This is the gravitational wave power for an r-mode with angular degree $l = 2$ and azimuthal number $m = l$.

3.2. Gravitational Wave Strain for R-Modes

The spacetime is distorted by the passage of GWs, therefore, it is important to measure the strain caused by the wave for studying celestial objects in the universe (gravitational wave astronomy). The gravitational wave strain h is given by $\Delta L/L$, where, L is the distance between two test masses and ΔL is the change in separation L caused by the GW. The r-mode oscillations which are known to produce GWs from rapidly rotating, celestial compact objects, has a displacement given by Equation (13). The GW strain has the form $h(t)$ that, represents the strain as function of time. However, the strain amplitude h_0 is calculated using the quadrupole formula adjusted for r-modes which is given approximately by [5],

$$h_0 \approx (G/c^4) (R^3 M \Omega^2 / d) \alpha \left(\frac{\omega}{\Omega} \right)^2 J_{lm}, \quad (19)$$

where, J_{lm} is a dimensionless angular integral approximately ≈ 1 for the $l = m = 2$ r-mode. General relativity (GR) strain correction is calculated by modifying the r-mode frequencies for space-time curvature. For a Kerr-like object, the inertial-frame frequency is approximated as,

$$\omega \approx (2m\Omega/\gamma l(l+1))(1 - R_s/R)^{1/2} + m\Omega, \quad (20)$$

where R_s is the Schwarzschild radius given by, $R_s = 2GM/c^2$. The frequency is reduced while the GW amplitude is enhanced by GR effects due to “frame dragging”, approximately with the factor $\sim (1 - R_s/R)^{-1}$.

We calculate the strain amplitude for the $l = 2$ and $m = 2$ toroidal r-mode, by substituting in Equation (19), the following values are assigned to our compact model: $\omega \approx 1887$ rad/s with $f \approx 300$ Hz (from **Table 1**), $\alpha \approx 10^{-6}$ (mode amplitude depends on r-mode excitation), $J_{lm} \approx 1$ (angular integral for $l = 2$ and $m = 2$), $c \approx 3 \times 10^8$ m/s, G (gravitational constant) $\approx 6.67 \times 10^{-11}$ m³·Kg⁻¹·s⁻², estimating the distance d between the antimatter universe and the observer to be of the order of magnitude of the radius of our observable universe which is approximately 46.5 billion light years (4.4×10^{36} m). After substituting in Equations. (19, 20) we get: $\omega \approx 1992$ rad/s, $h_0 \approx 0.4 \times 10^{-31}$ m, and for the strain amplitude after incorporating GR frame dragging (Lense Thirring effect) correction, we get:

$$h_0 \approx 0.42 \times 10^{-29}. \quad (21)$$

This strain amplitude is too weak to be readily observed by any currently operating gravitational wave detector. However, the high sensitivity cryogenic LIGO/ VIRGO detectors or the future planned laser interferometer space antenna (LISA) (e.g. [20]), could plausibly detect the continuous emitted gravitational waves from the antimatter universe. In addition, this ultra-high precision interferometric detection of GWs, could provide the definitive test for general relativity, and whether it is the only theory of relativity, see the illuminating article [21].

4. Conclusions

In this article, we have presented the possibility of gravitational wave radiation from the proposed antimatter-universe [3]. The radiation is emitted from the anti-hydrogen compact core and its relativistic rotating outer-plasma layer. The radiation resulted from the r-modes instability, which is referred to as (CFS) instabilities [16], that grows and radiates the angular momentum of the compact core [5] as gravitational waves. The eigen frequencies of the radiation modes were calculated and given in **Table 1**, where the most prominent toroidal bulk mode for the continuous GW emission [22] [23] was found to be the $l = m = 2$ mode which is likely detectable by LIGO/ VIRGO detectors. The GW-power emitted from the $l = m = 2$ r-mode adapted for the rapidly rotating compact core of the anti-universe, with compactness parameter of ≈ 0.49 , was found to be $\approx 1.4 \times 10^{39}$ W. This continuous emitted radiation might cause tiny background space fluctuations that fill our universe and would confirm the existence of the dual anti-universe.

The GW-strain amplitude is evaluated to be about 0.24×10^{-29} , which might be

too weak to be observed by currently operated gravitational wave detectors. However, the Laser Interferometer Space Antenna (LISA), having flexible 2.5 million Km length arms, which is expected to be launched in space at the beginning of 2030s [20], would provide even higher sensitivities and is much more suitable for longer wavelength detection. This will enable measuring space disturbances with longer wavelengths caused by gravitational or anti-gravitational waves and could potentially provide more information about the constant-continuous disturbances in the spacetime fabric from the dual antimatter universe, and further determine the distance between our universe and its dual antimatter counterpart.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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