Inertia-gravity and general relativity from a fluid-like Higgs space-time

Benjamin de la Fontaine[1]*

[1]Faculty of Natural and Agricultural Sciences, University of Pretoria

Abstract

By interpreting inertia and gravity in terms of both classical electrodynamics and hydrodynamics, novel and accurate formulae for inertia, gravity and the gravitational constant can be derived from a Higgs field with precise geometric properties. Extending these formulae to general relativity, it is shown that the speed of light, the vacuum energy density, the cosmological constant, and 4-dimensional space-time curvature can also be derived from the same assumptions. A new model of general relativity and universal expansion based on a dynamically oscillating space-time is proposed.

Keywords: general relativity, gravity, Higgs boson, inertia, vacuum energy

Introduction

It is well established that the cosmic vacuum is not truly empty, but full of energy and replete with minute particles, the nature of which are not fully understood. It has been suggested that the vacuum is dynamic and heterogenous at very small scales, resulting in unusual quantum behaviour[1]. Questions of how phenomena such as light and gravity arise out of an apparent vacuum have historically been explained by treating space as containing a universal fluid medium or “ether”. Fresnel[2] described light in terms of vibrations in this medium, while his contemporary Le Sage described gravity as a form of pressure resulting from a “gravific fluid”[3]. It has been proposed that such a medium could provide the superstructure through which energy might evolve into various forms of matter[4]. Einstein’s general relativity largely eclipsed the concept of a universal fluid medium with a flexible space-time that bends in response to mass-energy, successfully describing both gravity and time in terms of curvature in four-dimensional geometry. The limitations of current conceptions of general relativity have led some workers to return to aspects of the universal fluid medium model, seeking to integrate the two perspectives. For example, polarizable vacuum models describe general relativity in terms of refraction in flat space rather than geodesics in curved space [5][6].

More recently, other workers have approached the universal fluid medium explanation for inertia and gravity straightforwardly, describing these forces as far as possible in terms of classical hydrodynamics[7]. At first glance this may seem like an odd approach, considering that the Standard Model in all of its complexity has not yet been fully able to account for these forces. However, hydrodynamics is applicable when modelling certain states of both fermionic and bosonic matter, including the quark-gluon plasma theorized to make up the early universe[8][9]. Other theoretical models attempt to apply this to the universe in its present era of evolution. Ciufolini and Wheeler[10] modelled inertia and gravity in terms of a rotating universe containing a dynamic fluid with properties such as drag and shear forces, which is one interpretation of the Gödelian model[11]. Edwards[6] derived a reasonably accurate estimate of the gravitational constant for Le Sage gravity from the assumption of a universal medium with refractive properties affecting cosmic microwave background photons, complementing the electromagnetic theory of Wilson[12]. Such models can be useful in many respects, but cannot lead to a fully congruent model of the present universe unless the supposed universal fluid medium can be reconciled with presently observed forms of matter or energy, such as that represented by so-called dark energy[13] or already known forms of energy. The Higgs field and its quantum unit, the Higgs boson, are implicated in the mechanism through which energetic particles gain inertial mass, and it has only been possible to integrate these into the Standard Model as measured physics objects relatively recently [14][15]. Since mass touches on every known physical phenomenon in some way, it may be profitable to explore the implications of the Higgs field for alternative models.

*Email: bendlf@pm.me
Draft: July 26, 2026

This paper makes the following arguments:

1. Expressions for quantified inertia of objects or particles can be derived from simple equations for fluid viscosity that assume electromagnetic and hydrodynamic phenomena are to some extent interchangeable, implying that photons may have variable non-zero inertial mass.

2. Accurate formulae for the gravitational constant can be derived from either fluid-like shear forces or simple electromagnetic forces in a medium made up of Higgs bosons with geometrically precise properties related to spherical wave propagation. The Higgs field is the mediator of inertia and gravity, sets the limit on the speed of light, and can be considered synonymous with the universal medium or vacuum energy state.

3. The Einstein field equations and the vacuum energy density can be derived from a dynamic four-dimensional space-time represented by a Higgs field with spherical-like wave propagation. Fluid-like oscillatory damping and interference (ripple effect) due to the self-interaction of the Higgs field lead to the basic predictions of general relativity, and suggest a universe characterized by a finite period of space-time expansion. The cosmological constant and so-called dark energy are consequences of radiating damped oscillations in Higgs space-time.

1. Inertia-gravity from classical electrodynamics & hydrodynamics

1.1 First concepts

This section presents a brief summary of the paper by Butto[7] in which he derives Newton's second law of motion from quantum mechanics and classical hydrodynamics laws, and suggests that both electrodynamic and hydrodynamic perspectives are valid for inertia and gravity. Butto argues that the vacuum energy consists of so-called "building block" particles that make up all matter, with a minimum wavelength corresponding roughly to Planck units. The energy E_{V} imparted by the vacuum energy to an object moving through a vacuum would be measured in terms of the Planck constant h and the frequency of propagation f, such that

$$E_{\mathrm{V}} = hf \tag{1}$$

from which it follows that

$$F\lambda = hf \tag{2}$$

$$F = \frac{hf}{\lambda} = ma \tag{3}$$

where
F is the Newtonian force
λ is the wavelength
m is the mass
a is the acceleration

From this perspective, inertia is a product of forces caused by matter in motion within a fluid-like medium that is itself composed of matter of an extremely fine scale. In a simple sense, masses are permeated by this medium and constantly interact with it. If a fluid with density ρ is capable of penetrating objects such that it interacts with the entire volume V proportionally to its acceleration, then

$$F = \rho V a = ma \tag{4}$$

Changes in the velocity of the mass are not communicated to the whole medium instantaneously, resulting in opposing forces in time that are experienced by the mass as inertia. This is essentially the same principle by which gravitational waves are generated[16], although most interpretations of general relativity hold that gravitational and electromagnetic waves propagate through space-time itself and do not require any material medium.

The existence of a universal medium does not violate special relativity so long as the medium is not static, but dynamically moving along with the masses it contains. For the same reason, it is also not necessarily inconsistent with the observation that planets maintain angular momentum in orbit around their host stars. If the Earth were carried along by currents in a universal medium, such that these currents travel with the exact same velocity as the Earth, we would scarcely observe any loss of momentum due to friction.

However, this still implies that even in an apparent vacuum, it is possible for objects to lose momentum due to vacuum drag over astronomical distances if they were to move "against the current". Although this seems to be impossible to measure anywhere on Earth for now, there is is tentative support for such a phenomenon in the anomalous Sun-wards acceleration of the Pioneer 10 and 11 probes [17][1]. The concept of vacuum drag does not violate Newton's first law of motion if we accept that the vacuum is not actually empty, but contains forces that can oppose changes in motion.

It can also be shown that for the formula

$$\frac{F_{\mathrm{D}}}{A} = P = \frac{1}{2}\rho v^2 C_{\mathrm{D}} \tag{5}$$

where
F_{D} is the fluid drag force
A is the cross-sectional area
P is the pressure
v is the velocity
C_{D} is the drag coefficient

substituting measured values of the vacuum density $\rho_{\Lambda} = 5.96 \times 10^{-27}\ kg\ m^{-3}$ for ρ and the matter density (space-time curvature) parameter $\Omega_{\mathrm{m}} = 0.308$ for C_{D}[18] and $v = c = 299792458\ m\ s^{-1}$ gives $P = 8.249... \times 10^{-11}\ kg\ m^{-1}\ s^{-2}$, which is a quantity of similar form and scale to the Newtonian gravitational constant G, which here is a measure of the degree to which vacuum drag opposes gravitational attraction[7][2]. Later on we will derive a better means of estimating G by considering both hydrodynamic-like forces and electrodynamic properties of the Higgs field.

1.2 Inertia

1.2.1 Derivation of Newtonian inertia from dynamic viscosity In order to quantify inertia in an electro-hydrodynamic model, it is necessary to define inertial forces both in terms of electromagnetic wave properties and shear forces in viscous media.

$$E = F\lambda = mc^2 \tag{6}$$

Therefore

$$F = \frac{m\lambda^2 f^2}{\lambda} = m\lambda f^2 \tag{7}$$

If we take λ to represent distance and f^2 as $\frac{1}{t^2}$ this translates as

$$m\lambda f^2 = ma \tag{8}$$

Now note the formula

$$F = m\delta\lambda\delta f^2 = m\frac{\delta\lambda}{\delta t^2} = m\frac{\delta v}{\delta t^t} \tag{9}$$

where δ indicates the derivative

This formula resembles Newton's law of viscosity, which describes shear forces in fluids, and is expressed as

[1] A related alternative explanation for the Pioneer anomaly is mentioned briefly near the end of the paper.
[2] Butto used different values of ρ_{Λ} and Ω_{m} to arrive at the precise value of G, but it is not clear on what basis these values were chosen.

$$\tau = \mu \frac{\delta u}{\delta y} \tag{10}$$

where
τ is the dynamic viscosity of system
μ is the coeffient of viscosity of system
u is the flow velocity of fluid
y is the distance the from boundary layer
$\frac{\delta u}{\delta y}$ is the shear rate

More simply,

$$\tau = \mu \sigma \tag{11}$$

where $\sigma = \frac{\delta u}{\delta y}$

If we assume that

$$\tau = F = \frac{E}{\lambda} \tag{12}$$

then

$$\frac{E}{\lambda} = \mu \sigma \tag{13}$$

$$\mu = \frac{E}{\lambda \sigma} = \frac{E}{\lambda^2 f^2} = \frac{E}{v^2} \tag{14}$$

If $v = c$ then $\mu = m$ in these equations.

Therefore, assuming a purely relativistic situation (ie. $\beta = \frac{v}{c} = 1$) where $\tau = F$ and $\mu = m$,

$$\sigma = \frac{\tau}{\mu} = \frac{F}{m} = \frac{E\lambda^2 f^2}{E\lambda} = \lambda f^2 = a \tag{15}$$

and therefore

$$\tau = ma \tag{16}$$

So for any matter moving at or near the speed of light, the dynamic viscosity τ may be used as an expression for the force of inertia. In terms of fluids, the motion of an energetic mass induces shear forces in the local medium, the rate of change of which is equal to of the acceleration of the reference object. The shear itself is due to differences in the flow of the fluid that makes up the medium caused by some disturbance[3].

The properties of a medium and a reference object or wave traveling through said medium are not necessarily equivalent, however. The expanded expression for σ (let us call this σ') can be annotated as follows:

$$\sigma'_{\mathrm{R}} = \frac{E\lambda^2 f^2}{E\lambda} = \frac{E_{\mathrm{M}} {\lambda_{\mathrm{R}}}^2 {f_{\mathrm{R}}}^2}{E_{\mathrm{R}} \lambda_{\mathrm{M}}} = \frac{E_{\mathrm{M}} {v_{\mathrm{R}}}^2}{E_{\mathrm{R}} \lambda_{\mathrm{M}}} \tag{17}$$

where the subscript R refers to properties of the reference object, and the subscript M refers to properties of the medium through which the reference object travels, which exerts a force upon it.

It is equally true that as the object travels through the medium, the medium travels through that object and experiences a reciprocal force. If the medium itself is taken as the reference (ie. the *object* is the medium) then

$$\sigma'_{\mathrm{M}} = \frac{E_{\mathrm{R}} {v_{\mathrm{M}}}^2}{E_{\mathrm{M}} \lambda_{\mathrm{R}}} \tag{18}$$

[3] Although the terms “object” and “medium” are used here, these are considered interchangeable with the terms “wave” and “field”.

1.2.2 Derivation of inertial coefficient from kinematic viscosity The resistance of a fluid medium to flow can also be expressed by

$$\nu = \frac{\mu}{\rho} \tag{19}$$

where
ν is the kinematic viscosity of system
μ is the coefficient of viscosity of reference
ρ is the density of medium

If $\mu = m$ and $\rho = \frac{m}{V}$,

$$\nu = \frac{\mu}{\rho} = \frac{m}{\frac{m}{V}} = V \tag{20}$$

If, however, the wave properties of the medium and an object traveling through said medium are not equivalent, then

$$\nu = \frac{m_{\mathrm{R}}}{m_{\mathrm{M}}} V = \frac{E_{\mathrm{R}} {v_{\mathrm{M}}}^2}{E_{\mathrm{M}} {v_{\mathrm{R}}}^2} V \tag{21}$$

In plain words, the viscosity of a volume wherein an object travels through a medium is proportional to the energetic mass of the object times the velocity of the medium, divided by the energetic mass of the medium times the velocity of the object. This translates as a quantifiable resistance to motion per unit three-dimensional space (volume).

The previous equation can also be expressed as the ratio

$$\frac{\nu}{V} = \frac{E_{\mathrm{R}} {v_{\mathrm{M}}}^2}{E_{\mathrm{M}} {v_{\mathrm{R}}}^2} \tag{22}$$

Let this be called the inertial coefficient j of the reference. We will see later how this formula might be applied to real situations.

1.2.3 Consideration of equivalence principle According the equivalence principle, inertia is linked to gravity, and the two apparently separate forces are really manifestations of the same force in different forms or reference frames, akin to the relationship between electricity and magnetism, or between energy and mass[19]. The equivalence principle can be expressed as

$$F_{\mathrm{G}} = \frac{G m_{\mathrm{A}} m_{\mathrm{B}}}{r^2} = ma \tag{23}$$

where
F_{G} is the force of gravity
G is the Newtonian gravitational constant
m_{A} is the mass of object A
m_{B} is the mass of object B
r is the distance between the centers of mass of objects A and B

The identity of these two forces is revealed by their relationship with mass, which can be defined in at least two different ways. There is mass in terms of energetic content, which applies to any volume containing non-zero energy, and there is inertial mass, which can be described as the product of the interaction of forms of energy with the Higgs field[20]. The two definitions are not identical. Photons have energetic mass and therefore interact with the gravitational field, but are defined as being without inertial mass, and so not really interacting with the Higgs field, notwithstanding their seeming conversion to plasmons inside superconductors[21].

According to the equivalence principle, the mass m in the expression for F_{G} is equivalent to the mass m in the expression $F = ma$. In other words, gravitational and inertial masses are the same – a given value m in either expression is the inertial mass, as well as the energetic mass[22]. How do we reconcile these two perspectives?

1.2.4 Derivation of inertial mass expressions We have previously shown that when $\beta = 1$,

$$\tau = \mu\sigma = ma \tag{24}$$

But what about values of $\beta < 1$? To understand inertia in these situations we must define the inertial mass μ in a way that applies to all inertial frames.

As described previously, the shear force expression σ' defines a reference object and a medium through which the object moves:

$$\sigma'_{\mathrm{R}} = \frac{E_{\mathrm{M}}{\lambda_{\mathrm{R}}}^2{f_{\mathrm{R}}}^2}{E_{\mathrm{R}}\lambda_{\mathrm{M}}} \tag{25}$$

The complementary expression is

$$\sigma'_{\mathrm{M}} = \frac{E_{\mathrm{R}}{\lambda_{\mathrm{M}}}^2{f_{\mathrm{M}}}^2}{E_{\mathrm{M}}\lambda_{\mathrm{R}}} \tag{26}$$

Since formulae for τ or F also pertain to a specific reference object in a specific medium, then

$$\mu_{\mathrm{R}} = \frac{\tau_{\mathrm{R}}}{\sigma'_{\mathrm{R}}} = \frac{\frac{E_{\mathrm{R}}}{\lambda_{\mathrm{M}}}}{\frac{E_{\mathrm{M}}{\lambda_{\mathrm{R}}}^2{f_{\mathrm{R}}}^2}{E_{\mathrm{R}}\lambda_{\mathrm{M}}}} = \frac{\frac{E_{\mathrm{R}}}{\lambda_{\mathrm{M}}}}{\frac{E_{\mathrm{R}}\lambda_{\mathrm{M}}}{E_{\mathrm{M}}{\lambda_{\mathrm{R}}}^2{f_{\mathrm{R}}}^2}} = \frac{\frac{E_{\mathrm{R}}}{E_{\mathrm{M}}}}{\frac{E_{\mathrm{R}}}{{v_{\mathrm{R}}}^2}} \tag{27}$$

If $v_{\mathrm{R}} = c$, then

$$\mu_{\mathrm{R}} = m_{\mathrm{R}}\frac{E_{\mathrm{R}}}{E_{\mathrm{M}}} \tag{28}$$

This describes the inertial mass as proportional to the energetic mass times an interaction term, which is simply the ratio of the reference energy over that of the medium[4]. Now recall that

$$\sigma = \lambda f^2 \tag{29}$$

If we take this to refer to the shear rate in the medium, ie.

$$\sigma_{\mathrm{M}} = \lambda_{\mathrm{M}}{f_{\mathrm{M}}}^2 \tag{30}$$

then

$$\tau = \mu_{\mathrm{R}}\sigma_{\mathrm{M}} = \frac{\frac{Er}{{\lambda_{\mathrm{R}}}^2{f_{\mathrm{R}}}^2}}{(\frac{E_{\mathrm{R}}}{E_{\mathrm{M}}})(\lambda_{\mathrm{M}}{f_{\mathrm{M}}}^2)} = \frac{E_{\mathrm{R}}}{\lambda_{\mathrm{M}}}\frac{E_{\mathrm{R}}{v_{\mathrm{M}}}^2}{E_{\mathrm{M}}{v_{\mathrm{R}}}^2} = \tau_{\mathrm{R}}j_{\mathrm{R}} \tag{31}$$

That is, the shear force (inertia) in a simple fluid system is equal to the reference object's inertial mass times the shear rate in the medium. The shear rate in turn is equal to the viscosity the object experiences times the inertial coefficient. In terms of fluids, it is intuitive that local differences in the magnitude, velocity, length or, indeed, any basic characteristic of interacting waves generate opposing forces. It is these forces that differentiate inertial mass from energetic mass. If opposing forces did not exist (e.g. $\frac{E_{\mathrm{R}}}{E_{\mathrm{M}}} = 1$, or $\frac{v_{\mathrm{M}}}{v_{\mathrm{R}}} = 1$) then the inertial and energetic masses would be equivalent. This would only be true for a field or medium that is fundamentally static and homogenous at all scales.

1.2.5 Energy & acquisition of inertial mass The above equations describe inertia and inertial mass as arising from the propagation of energy in a universal medium that has non-zero energy at all points and that may be locally heterogenous. This essentially describes the Higgs field, through which effectively massless excitation states may become particles with detectable inertial mass, including excitations in the Higgs field itself which manifest as Higgs bosons[14]. Although the Higgs energy is usually defined as having a stable non-zero value at all points in space, the Higgs mechanism arises from a field with variable potential and possibly more than one stable state[21].

Matter with energy higher than the energy of the universal field or medium, which should apply to most matter comprised of fermionic fields, is generally expected to have an inertial coefficient > 1. Bosonic matter

[4] For two stationary masses where $v = c$ this term is equivalent to j.

such as the photon may have a much lower energy, and is expected to have an inertial coefficient $<< 1$ except at tremendously high energies. That is to say, at sufficiently low energies certain types of matter may have an inertial mass so small it is not detectable, but at high energies the inertial mass will become apparent.

There is tentative evidence that even light rays may gain inertial mass at high energies. Albert et al.[23] noted a time delay between peak γ-ray emissions emitted during flares from the quasar Markarian 501 (Mrk 501), with higher-energy rays ($> 1.2\ TeV$) appearing to arrive at the detector 4–5 minutes (240–300 seconds) later than lower-energy rays ($< 0.25\ TeV$). That is to say, light rays from the same source traveling through the same medium appeared to travel 5–6 times slower depending on their energy content.

Let us assume that the luminosity of the higher-energy peaks was greatest in the range of 1.2–1.5 TeV, and that of the lowest-energy peaks in the range of 0.22–0.25 TeV, approximating the actual measurements. It is possible to calculate the inertial coefficients of these light rays in the Higgs field, assuming Higgs bosons with uniform energy of 125 GeV:

$$j_1 = \frac{(1.2 \times 10^{12}\ eV)((3 \times 10^8\ m\ s^{-1})^2)}{(1.25 \times 10^{11}\ eV)((3 \times 10^8\ m\ s^{-1})^2))} = 9.6$$

$$j_2 = \frac{(1.5 \times 10^{12}\ eV)((3 \times 10^8\ m\ s^{-1})^2)}{(1.25 \times 10^{11}\ eV)((3 \times 10^8\ m\ s^{-1})^2))} = 12$$

$$j_3 = \frac{(2.2 \times 10^{11}\ eV)((3 \times 10^8\ m\ s^{-1})^2)}{(1.25 \times 10^{11}\ eV)((3 \times 10^8\ m\ s^{-1})^2))} = 1.76$$

$$j_4 = \frac{(2.5 \times 10^{11}\ eV)((3 \times 10^8\ m\ s^{-1})^2)}{(1.25 \times 10^{11}\ eV)((3 \times 10^8\ m\ s^{-1})^2))} = 2$$

$$\frac{j_1}{j_2} : \frac{j_3}{j_4} = 5.46 : 6.0$$

The inertial coefficients of light rays at the higher energies, according to this formula, would therefore be between 5 and 6 times higher than light rays at the lower energies. This would correspond to a proportional slowing of light rays through an interaction with the Higgs field at relevant wavelengths, in agreement with the actual measurements.

It has already been suggested that the Mrk 501 anomaly may indicate distortions of a dynamic fluid-like structure of space-time (a quantum "foam" *sensu* Hawking[1]) at high energies[24]. In this sense, the "building-block" particles of Butto[7] may be better described as Planck-scale oscillations in fluid-like space-time, or as vibrations in the Higgs field. On the other hand, the apparent time delay between spectral peaks from Mrk 501 has been attributed by other workers to a number of factors that do not contradict conventional Lorentz invariance [25][23].

Although the above equations assume that all classes of particles interact with the Higgs field and so have at least a very small inertial mass, complex interactions and quantization may mean there is still some minimum energy required for these to manifest as actual effects. A key question is whether or not neutrinos, which occupy an uncertain position in the Standard Model, really straddle the line between massive and massless. Theoretical studies have predicted that neutrinos have massive (as much as $4.8 \times 10^8\ Gev/c^2$) as well as massless flavours[26], whereas the most recent measurements suggest that neutrinos are all massive with much lower upper limits ($< 0.45\ eV\ c^2$)[27].

These apparent contradictions begin to make more sense if the structure of the universal medium is not uniform and unchanging, but resembles a dynamic wave function with alternating peaks and troughs. High energy particles with relatively short wavelengths would experience interference with the vacuum energy, producing inertial mass. Low energy particles with very long wavelengths would move out of phase with the vacuum energy and experience little or no interference, making them effectively massless. One analogy is that of marbles and basketballs rolling over a rough road. Marbles are on the same order of size as the small bumps and dips in the surface of the road, and so traverse a much greater effective surface area (and therefore experience much more resistance to their motion) relative to basketballs, which simply roll over the bumps and are too big to interact with the dips.

1.3 Gravity

1.3.1 Derivation of the gravitational constant A complete theory of inertia should naturally lead to a complete theory of gravity. The Higgs boson is likely to be implicated in the generation of both forces, with or without a supersymmetric partner particle[28]. If true, then the link between the Higgs field and the gravitational field must lie in the link between inertial mass and energetic or gravitational mass.

We can expand the expression for the energy-dependent inertial mass of a reference object μ_{R} in a given medium as follows:

$$\mu_{\mathrm{R}} = m_{\mathrm{R}} \frac{E_{\mathrm{R}}}{E_{\mathrm{M}}} = \frac{E_{\mathrm{R}}}{{v_{\mathrm{R}}}^2} \frac{E_{\mathrm{R}}}{E_{\mathrm{M}}} \tag{32}$$

This expression contains three energies: the energies of two objects and the energy of the shared medium. This is a strong hint. The only element missing is the shear force that introduces inertia into the system.

$$\mu_{\mathrm{R}} \sigma_{\mathrm{M}} = \frac{E_{\mathrm{R}}}{E_{\mathrm{M}}} \frac{E_{\mathrm{R}}}{{v_{\mathrm{R}}}^2} \sigma_{\mathrm{M}} = \frac{E_{\mathrm{R}}}{v_{\mathrm{R}}} \frac{E_{\mathrm{R}}}{v_{\mathrm{R}}} \frac{\sigma_{\mathrm{M}}}{E_{\mathrm{M}}} = \tau_{\mathrm{R}} j_{\mathrm{R}} \tag{33}$$

And so we can deduce that

$$F_{\mathrm{G}} = \frac{G m_{\mathrm{A}} m_{\mathrm{B}}}{r^2} = \frac{\sigma_{\mathrm{M}}}{E_{\mathrm{M}}} \frac{\mu_{\mathrm{RA}} \mu_{\mathrm{RB}}}{r^2} = \frac{(\tau_{\mathrm{RA}} j_{\mathrm{RA}})(\tau_{\mathrm{RB}} j_{\mathrm{RB}})}{r^2} \tag{34}$$

Therefore

$$G = \frac{\sigma_{\mathrm{M}}}{E_{\mathrm{M}}} = \frac{\lambda_{\mathrm{M}} {f_{\mathrm{M}}}^2}{E_{\mathrm{M}}} \tag{35}$$

This is similar to the equation obtained if we solve for G using the relationship between the Newtonian equations for gravity and inertia:

$$G = \frac{m_{\mathrm{A}} r^2}{m_{\mathrm{A}} m_{\mathrm{B}}} = \frac{a r^2}{m} = \frac{\lambda f^2 r^2 c^2}{E} \tag{36}$$

Ignoring the distance factor r^2 and the energy-mass conversion factor c^2 (ie. assuming both are equal to 1), the equations are equivalent. Alternatively, we can generalize this equation to

$$G = \frac{\lambda f^2 c^2 \pi \times 10^{-70}}{E} \tag{37}$$

The factor π is necessary to account for the fact that gravitational waves propagate radially, and are not simply a linear interaction between two masses. The factor of magnitude 1×10^{-70} (we will find out the nature of this factor later) indicates that this is actually an extension of the simpler equation

$$G = \frac{\lambda}{E} \tag{38}$$

Note that the relationship

$$G = \frac{\lambda f^2 c^2 \pi \times 10^{-70}}{E} = \frac{\lambda}{E} \tag{39}$$

can only be true for values such that

$$c^2 = \frac{1}{f^2 \pi \times 10^{-70}} \tag{40}$$

This can be interpreted as stating that it is the inverse of the angular frequency of radial oscillations in the underlying field, multiplied by a squared inverse acceleration $1 \times 10^{-70}\ m^{-2}\ s^4$, that sets the limit on the speed of light. Similarly, mass can be interpreted as energy times the frequency of radial oscillations:

$$m = \frac{E}{c^2} = E f^2 \pi \times 10^{-70} \tag{41}$$

The inertial mass is then proportional to

$$\mu_{\mathrm{R}} = \frac{E_{\mathrm{R}}}{c^2}\frac{E_{\mathrm{R}}}{E_{\mathrm{M}}} = \frac{Er_{\mathrm{R}}2}{E_{\mathrm{M}}}{f_{\mathrm{M}}}^2\pi \times 10^{-70} \tag{42}$$

which is a function of change in radial energy density in time, expressed as energy per rad second squared.

In other words, the inertial-gravitational field and the electromagnetic field can really be seen as manifestations of the same field. It is not hard to imagine that if the frequency of oscillations in this field could be made to vary locally, so could the speed of light, along with the inertial and gravitational mass of particles and other objects.

1.3.2 Inertia-gravity identity in the Higgs field Let us now assume that the field in question is nothing other than the Higgs field, such that

$$G = \frac{\lambda_{\mathrm{H}}{f_{\mathrm{H}}}^2c^2\pi \times 10^{-70}}{E_{\mathrm{H}}} = \frac{\lambda_{\mathrm{H}}}{E_{\mathrm{H}}} \tag{43}$$

where
λ_{H} is the wavelength of Higgs boson
f_{H} is the angular frequency of Higgs boson
E_{H} is the mass-energy of Higgs boson

The first version of the formula lets us define the inertia-gravity relationship for point masses in terms of shear forces:

$$F_{\mathrm{G}} = \frac{\sigma_{\mathrm{H}}\pi \times 10^{-70}}{m_{\mathrm{H}}}\frac{m_{\mathrm{A}}m_{\mathrm{B}}}{r^2} = m\Delta a \tag{44}$$

where
$\sigma_{\mathrm{H}} = \lambda_{\mathrm{H}}{f_{\mathrm{H}}}^2$ is the natural Higgs shear rate
m_{H} is the mass of Higgs boson
Δa is the initial acceleration of the reference object relative to the medium

Here the Newtonian inertia is really a special framing of shear gravity, where one of the two masses participating in the interaction is taken to be the mass of the Higgs boson itself. The difference in acceleration between the reference mass and the Higgs field (composed of Higgs bosons) generates a shear force, which the reference mass experiences as inertia. The factor $\frac{\pi\times10^{-70}}{r^2}$ can simply be ignored in framings involving a single reference mass, because there is no distance at all between the mass and the Higgs field; indeed, the former can be treated as a function of the latter.

If we treat energy as equivalent to mass (ie. we assume $c^2 = 1$) and distance as equivalent to wavelength, we can also derive the general equation:

$$F_{\mathrm{G}} = \frac{\lambda_{\mathrm{H}}}{E_{\mathrm{H}}}\frac{E_{\mathrm{A}}E_{\mathrm{B}}}{\lambda^2} = \frac{E}{\lambda} \tag{45}$$

1.3.3 Speculation on Higgs boson properties Current measurements and estimates put the energetic mass of the Higgs boson at around 1.25 GeV, with some specifying this value to 1.251 GeV or as high as 1.256 GeV [15][29][30][31]. The wavelength of the Higgs boson has not been measured directly, but has been estimated as being on the order of a specific fraction of the Bohr radius, $\frac{5.29\times10^{-11}\ m}{225} = 1.58\times10^{-18}m$[32] .

The value of G is known with some confidence to be around $6.674\times10^{-11}\ m^3\ kg^{-1}s^{-2}$, although measurements range slightly above or below this value and do not clearly converge. Schlamminger et al.[33] recently provided a summary of historical measurements and used rigorous methods to produce a measurement of $6.67387 \pm 0.00038\times10^{-11}\ m^3\ kg^{-1}\ s^{-2}$.

From $G = \frac{\lambda f^2}{E}$ it follows that

$$f_{\mathrm{H}} = \sqrt{GE_{\mathrm{H}}/\lambda_{\mathrm{H}}} \tag{46}$$

To solve for this equation G must be converted to compatible units. First we eliminate the contribution of the distance factor r^2 to obtain

$$G = 6.674 \times 10^{-13}\ m^{-1}\ kg^{-1}\ s^{-2}$$

Since $E = mc^2$ and if $c^2 = (3 \times 10^8\ m\ s^{-1})^2$:

$$G = 60066\ m\ J^{-1}\ s$$

Since 1 $eV = 1.60217... \times 10^{-19}\ J$ (the elementary charge, C):

$$G = 3.749... \times 10^{23}\ m\ eV^{-1}\ s^{-2}$$

Therefore we can estimate the the frequency of the Higgs boson as

$$f_{\mathrm{H}} = \sqrt{GE_{\mathrm{H}}/\lambda_{\mathrm{H}}} = \sqrt{\frac{(3.749 \times 10^{23}\ m^{-1}\ eV^{-1}\ s^{-2})(1.25 \times 10^{11}\ eV)}{1.58 \times 10^{-18}\ m}} = 1.724 \times 10^{26} s^{-1}$$

which is in fact the angular frequency ω. We can of course also solve for the angular frequency using the Planck-Einstein equation, which shows that the above formula, although a reasonable approximation of the angular frequency, is still an underestimate:

$$\omega_{\mathrm{H}} = \frac{E_{\mathrm{H}}}{\hbar} = \frac{1.25 \times 10^1 1\ eV}{6.582119... \times 10^{-16}\ eV\ s} = 1.899... \times 10^{26}\ rad\ s^-1$$

where $\hbar$ is the reduced Planck constant.

The previously cited estimates for properties of the Higgs boson are clearly not quite accurate. Firstly, I propose that the actual wavelength is equal to, or at least very close to, $\frac{4}{3} \times 10^{-18}\ m$. This specific value is not chosen without good reason. We should recognize the ratio $\frac{4}{3}$ from the equation for the volume of a sphere:

$$V_{\mathrm{O}} = \frac{4}{3}\pi r^3 \tag{47}$$

Under the influence of gravity in more or less neutral inertial frames, collections of freely moving particles tend to arrange themselves into spheres. This familiar tendency is demonstrated by the shapes of stars and planets, or by a free-floating volume of water on a spacecraft in orbit. Although this tendency begins to break down at smaller scales, where other forces dominate, even atomic nuclei with balanced shells take on a spherical shape[34]. There is no particular reason why this should be the case at such a range of scales, unless particles attract according to a wave function that is fundamentally spherical.

The predicted value for ω_{H} is of course very close to $6\pi \times 10^{25}\ rad\ s^{-1}$, such that the proper velocity is described by

$$v_{\mathrm{H}} = \lambda_{\mathrm{H}}\omega_{\mathrm{H}} = 8\pi \times 10^7\ m\ rad\ s^{-1}$$

Interestingly, this is of similar form to the square of the angular velocity of the universal fluid medium predicted by interpretations of the Gödelian model[10], represented by

$$\omega^2 = 8\pi\varepsilon \tag{48}$$

where ε is a density parameter corresponding to the vacuum pressure. The factor 8π is also recognizable from the equation for the energy density of light[35]:

$$E_{\mathrm{L}} = \frac{{F_{\mathrm{E}}}^2}{8\pi} \tag{49}$$

where E_{L} is energy of light per unit volume and F_{E} is the electromagnetic force, and so reappears in the Einstein gravitational constant:

$$k = \frac{8\pi G}{c^4} \tag{50}$$

1.3.4 Calculation of the value of the gravitational constant It is interesting to note that if we assume the following values:

$E_{\mathrm{H}} = 1.251 \times 10^{11}\ eV$
$c = 299792458\ m\ s^{-1}$
$\lambda_{\mathrm{H}} = \frac{4}{3} \times 10^{-18}\ m$
$\omega_{\mathrm{H}} = 6\pi \times 10^{25}\ rad\ s^{-1}$ (*ie.* $\hbar = \frac{E_{\mathrm{H}}}{\omega_{\mathrm{H}}} = 6.63676... \times 10^{-16}\ eV\ s$)

then

$$G = \frac{\lambda_{\mathrm{H}} {\omega_{\mathrm{H}}}^2 c^2 \pi \times 10^{-70}}{E_{\mathrm{H}}} = 6.67367 \times 10^{-11}\ m\ kg^{-1}\ rad\ s^{-2}$$

This is well within the range of $6.67387 \pm 0.00038 \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$ indicated by recent measurements[33]. But if we do not adjust the value of $\hbar$ and therefore allow $E_{\mathrm{H}} = 1.2407 \times 10^{11}\ eV$, then $G = 6.72907 \times 10^{-11}\ m\ kg^{-1}\ rad\ s^{-2}$. This is an inaccuracy of about 0.8% for both E_{H} and G (unless we are willing to entertain the possibility of significant inaccuracies in the measurements). This also gives us

$$G = \frac{\lambda_{\mathrm{H}}}{E_{\mathrm{H}}} = 6.70751 \times 10^{-11}\ m\ J^{-1}$$

which is an inaccuracy of only about 0.5%, although still outside of the range of 6.671–6.676 $\times 10^{-11}$ suggested by the past few decades of measurements. This leaves a discrepancy of about 0.3% between the two equations if using unadjusted constants. As mentioned previously, the two equations for G are only equivalent if $c^2 = 1/f^2\pi \times 10^{-70}$, or rather

$$c^2 = \frac{1}{{\omega_{\mathrm{H}}}^2 \pi \times 10^{-70}} \tag{51}$$

Our current choices for resolving this problem are to assume a slightly lower value for either c ($= 299311870.2\ m\ s^{-1}$) or ω_{H} ($= 1.88193 \times 10^{26}\ rad\ s^{-1}$ or $\frac{6\pi}{1.0016056}\ rad\ s^{-1}$). If we choose to be conservative and assume the latter, we should note that this requires $E_{\mathrm{H}} = \hbar\omega = 1.237\ GeV$, which is even lower than what current measurements suggest. To obtain an identical and accurate value of G from both equations given this value of E_{H} also requires $\lambda_{\mathrm{H}} = 1.3245 \times 10^{-18}\ m$ or $\frac{\frac{4}{3}}{1.00666}\ m$.

Given the considerable uncertainty regarding properties of the Higgs field, this would seem to be the most likely source of the discrepancy between the predictions of the equations and the actual measurements. That being said, it is not impossible that there are non-trivial inaccuracies in the measurement of G and other physical constants such as h, C or even c that singly or cumulatively would have the same effect. Alternatively, the discrepancy disappears if we allow for some small factor, which for argument's sake we will call φ [5], that modifies the Higgs energy in electromagnetic interactions (ie. $E_{\mathrm{H}} = \hbar\omega_{\mathrm{H}}\varphi = \frac{m_{\mathrm{H}}c^2}{\varphi}$).

We should not then abandon the idea that the natural wavelength and angular frequency of the Higgs boson may be equal or very close to $\lambda_{\mathrm{H}} = \frac{4}{3} \times 10^{-18}\ m$ and $\omega_{\mathrm{H}} = 6\pi \times 10^{25}\ rad\ s^{-1}$ respectively, or that Higgs field properties basically describe the behaviour of light. Not only does this result in estimates that are not far off the mark but, it will be shown, this has implications for the nature of space-time.

2. Implications for general relativity

2.1 Einstein field equations

Let us return to geometrically precise assumptions for λ_{H} and ω_{H} as previous and include a factor φ such that

$8\pi = \lambda_{\mathrm{H}}\omega_{\mathrm{H}} \times 10^{-7}\ m\ rad\ s^{-1}$
$c^2 = \frac{\varphi}{{\omega_{\mathrm{H}}}^2 \pi \times 10^{-70}}$
$G = \frac{\lambda_{\mathrm{H}} {\omega_{\mathrm{H}}}^2 c^2 \pi \times 10^{-70}}{E_{\mathrm{H}}\varphi^2} = \frac{\lambda_{\mathrm{H}}}{E_{\mathrm{H}}\varphi}$

[5] The previously cited values of G require $\varphi \approx 1.005$.

From these relationships we obtain[6]

$$k = \frac{8\pi G}{c^4} = \frac{{\lambda_{\mathrm{H}}}^2{\omega_{\mathrm{H}}}^3\pi \times 10^{-77}}{E_{\mathrm{H}}\varphi c^2} = \frac{{\lambda_{\mathrm{H}}}^2{\omega_{\mathrm{H}}}^5\pi^2 \times 10^{-147}}{E_{\mathrm{H}}\varphi}$$

We can now express the Einstein field equations in the form

$$k = \frac{{\lambda_{\mathrm{H}}}^2{\omega_{\mathrm{H}}}^5\pi^2 \times 10^{-147}}{E_{\mathrm{H}}\varphi^2} = (\frac{\Gamma_{\mathrm{uv}} + \Lambda g_{\mathrm{uv}})}{T_{\mathrm{uv}}} \tag{52}$$

where
Γ_{uv} is the Einstein tensor
Λ is the cosmological constant
g_{uv} is the metric tensor
T_{uv} is the stress-energy tensor

We can see that the space-time curvature as described by $\Gamma_{\mathrm{uv}} + \Lambda g_{\mathrm{uv}}$ is proportional to the wavelength and angular frequency of the Higgs boson, while the stress-energy tensor is proportional to the Higgs energy.

In a gravity-neutral vacuum we may assume that the Einstein tensor Γ_{uv} does not apply, leaving us with

$$\frac{T_\Lambda}{g_\Lambda} = \rho_\Lambda = \frac{\Lambda}{k} \tag{53}$$

where ρ_Λ is the (positive) vacuum energy density. Given that

$$\Lambda = \rho_\Lambda 8\pi G \tag{54}$$

For $\rho_\Lambda = 60.3 \times 10^{-27}\ kg\ m^{-3}$[36] we obtain (in standard units of seconds squared) the value

$$\Lambda = 1.016526 \times 10^{-35}\ s^{-2}$$

And for $\rho_\Lambda = 59.6 \times 10^{-27}\ kg\ m^{-3}$[18] we obtain

$$\Lambda = 9.9461 \times 10^{-36}\ s^{-2}$$

It is worth pointing out that recently updated limits on the standard error of ρ_Λ place the lower bound of the range of expectations at about $59 \times 10^{-27}\ kg\ m^{-3}$[36]. There is no harm in suggesting a value such as $\rho_\Lambda = 59.619 \times 10^{-27}\ kg\ m^{-3}$. Note that for this value we obtain

$$\Lambda = 1 \times 10^{-35}\ s^{-2} = \sqrt{1 \times 10^{-70} s^{-1}} \tag{55}$$

This allows us to pinpoint the factor $1 \times 10^{-70}\ m^{-2}\ s^4$ in the new equations for G and c as simply being Λ^2 [7]. The cosmological constant may have been staring us in the face as it were, or rather, it leads us to a formulation for which a cosmological constant is not really necessary[8]. With a single modification to the vacuum density formula above we can say

$$\rho_\Lambda = \frac{\Lambda^2}{8\pi G} = \frac{E_{\mathrm{H}}\varphi^2}{{\lambda_{\mathrm{H}}}^2{\omega_{\mathrm{H}}}^3 c^2\pi} = \frac{m_{\mathrm{H}}\varphi^2}{{\lambda_{\mathrm{H}}}^2{\omega_{\mathrm{H}}}^3\pi} \tag{56}$$

which can also be written in the form

$$\rho_\Lambda = \frac{m_{\mathrm{H}}\varphi^2}{(\frac{4}{3} \times 10^{-18})\pi(\sqrt[3]{\lambda_{\mathrm{H}}}\omega_{\mathrm{H}})^3} = \frac{m_{\mathrm{H}}\varphi}{V_{\mathrm{HO}}} \tag{57}$$

In other words, the vacuum density equation approximates the equation for the mass-energy density of a type of spherical volume or field whose radius is in units of 4-dimensional space-time ($\sqrt[3]{\lambda_{\mathrm{H}}}\omega_{\mathrm{H}}$), corresponding to the wavelength and angular frequency of the Higgs boson (under the assumptions stated in the beginning of

[6] Note that when k is expressed in units of mass rather than energy a factor $\frac{1}{c^2}$ falls away so that $\frac{{\lambda_{\mathrm{H}}}^2{\omega_{\mathrm{H}}}^3\pi\times10^{-77}}{E_{\mathrm{H}}\varphi^2}$ is also a valid solution.

[7] Deriving Λ^2 from $8\pi = \lambda_{\mathrm{H}}\omega_{\mathrm{H}} \times 10^{-7}\ m\ rad\ s^{-1}$ results in units of $m\ s^{-3}$, the relevance of which we will soon see.

[8] This is not to say that Λ actually has the *exact* value 1×10^{-35}; in fact $\Lambda = \sqrt{\frac{\varphi}{c^2\omega^2\pi}} \approx 1.001 \times 10^{-35}\ m^{-2}\ s^4$ or $m\ s^{-3}$ or s^{-2}

this section). The Higgs field could then be seen as synonymous with space-time. This would imply that by describing vibrations in the Higgs field, one is describing the same thing as dynamic curvature of space-time or gravitational waves.

The metric tensor can therefore be written as

$$g_{\mathrm{uv}} = \begin{bmatrix} t & 0 & 0 & 0 \\ 0 & s & 0 & 0 \\ 0 & 0 & s & 0 \\ 0 & 0 & 0 & s \end{bmatrix} \quad or \quad \begin{bmatrix} \omega_{\mathrm{H}} & 0 & 0 & 0 \\ 0 & \sqrt[3]{\lambda_{\mathrm{H}}} & 0 & 0 \\ 0 & 0 & \sqrt[3]{\lambda_{\mathrm{H}}} & 0 \\ 0 & 0 & 0 & \sqrt[3]{\lambda_{\mathrm{H}}} \end{bmatrix} \tag{58}$$

where t indicates the time dimension and s indicates a spatial dimension.

This implies g_{uv} proportional to $\frac{s}{t^3}$. That is to say that, although time has only one degree of freedom compared to the three dimensions of space, time also describes a hyperbolic curve ς_{t} with respect to a unit of curvature ς_{s} in space. This makes sense when plotted in a Cartesian system (Figure 1) where

$$\varsigma_{\mathrm{t}} = \frac{1}{{\varsigma_{\mathrm{s}}}^3} \tag{59}$$

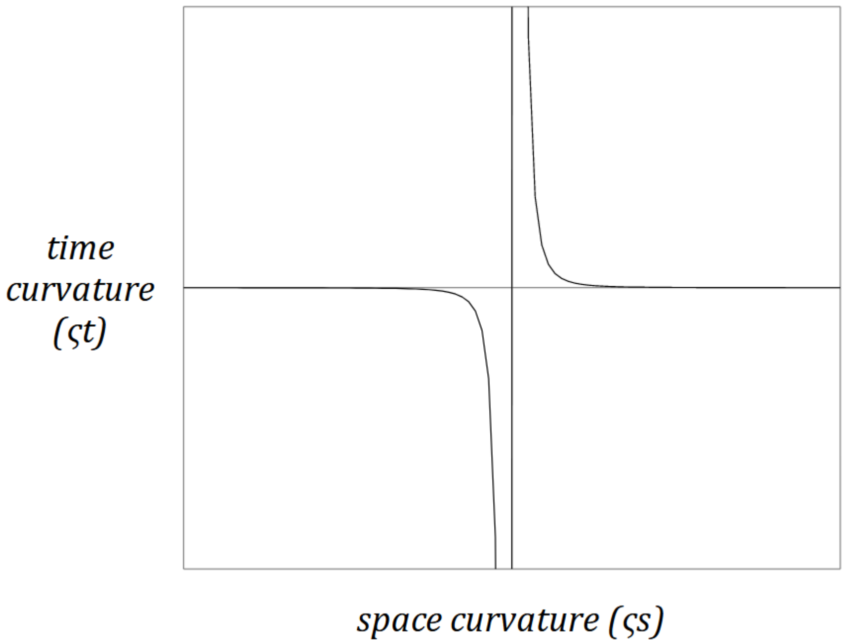

Figure 1: *Hyperbolic relationship of time curvature ς_t to space curvature ς_s.*

Across any real (positive) space with varying curvature, it is possible for time to flow at a different rate relative to other points in space with greater or lesser curvature. Time in theory may flow infinitely quickly or infinitely slowly, but there is no such thing as zero time within non-zero space curvature, nor is negative time possible in any real (positive) space. This is the same basic relationship that is described by general relativity.

2.2 Dynamic model of Higgs space-time

The traditional conception of general relativity essentially describes space-time in terms of static geodesics with uniform curvature. In contrast, a universal fluid medium (or UFM) model implies more complex, dynamic curvature. In a truly empty and frictionless vacuum, disturbances in space-time caused by mass-energy would not attenuate with distance from the source, nor could matter interact with it as a medium. This would preclude all relativistic effects, unless one were to invoke geodesic curves that exist as pure geometry not composed of matter, but that somehow interact with matter regardless (as is the standard assumption in general relativity). A universal fluid medium model of the universe can remain consistent with general relativity if we allow for a field with positive mass or energy density everywhere, but that is non-uniform at very small scales, such that there is positive vacuum friction. This would allow the field to interact dynamically with itself, not only with other forms of mass-energy that somehow exist independently of it, but this would also set limits on how far these self-interactions could be extended. Space-time in the Higgs field thus satisfies the requirements of general relativity, and takes on some of the basic properties ascribed to classical fluids. Vibrations in the field can be expected to lead to a damped oscillation effect, or ripple-like wave patterns in space-time (Figure 2), where the deviation from a basically flat topology originates from a local energy $\mathrm{E_R}$ in excess of the Higgs energy $\mathrm{E_H}$. This wave behaviour for a dynamic space-time ς_{st} can be represented in a single-plane approximation by

$$f(\varsigma_{\mathrm{st}}) = \cos\left(\pi\left(\frac{E_{\mathrm{R}}+E_{\mathrm{H}}}{E_{\mathrm{H}}}\right)(\sqrt[3]{\lambda}\omega)^2\right)^{-(\sqrt[3]{\lambda}\omega)(\frac{E_{\mathrm{R}}+E_{\mathrm{H}}}{E_{\mathrm{H}}})} \tag{60}$$

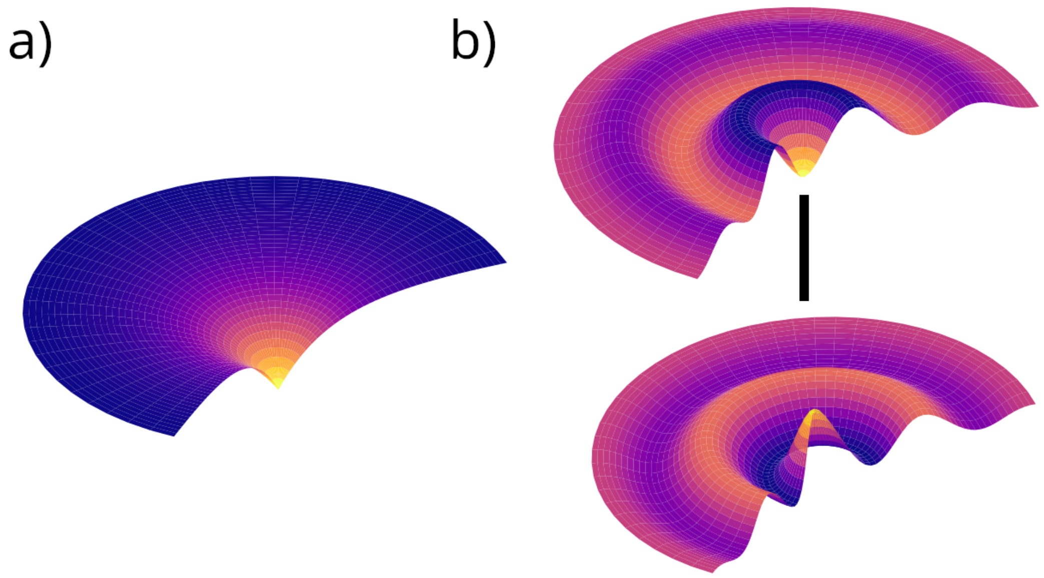

Figure 2: *Single-plane representations of curved space-time with a) uniform curvature described by ordinary geodesics and b) dynamic curvature displaying radial oscillatory damping. (Created in NumPy 2.5)*

An even simpler approximation of the above would be to see space-time as dynamically bunching up or stretching out (ie. curving) in proportion to a wave flux Φ, represented by the number of wavelengths encountered per unit time by an observer at a certain point on the wave function. This flux would in turn be proportional to the distance r from a stationary mass m that is the source of the radiating waves of disturbance, as shown by

$$\Phi = \frac{\Sigma\lambda}{\Delta t} \propto \frac{1}{r^2} \tag{61}$$

The bunching of space-time ripple waves as one approaches a large mass would lead to longer path lengths in space-time from the perspective of a distant observer (Figure 2), while the reverse would occur as one travels away from the mass. For two nearby masses, positive wave interference translates as the contraction of intervening space-time, manifesting as gravitation (Figure 3). Remember that we can describe the attractive force between any pair of masses in the Higgs field separated by a known distance as

$$F_{\mathrm{G}} = \frac{\lambda_{\mathrm{H}}}{E_{\mathrm{H}}\varphi} \frac{m_{\mathrm{a}} m_{\mathrm{b}}}{r^2} \tag{62}$$

Acceleration of a single mass would have a similar result due to the Doppler effect, leading to the experience of inertia (Figure 4). An accelerating observer encounters increasing resistance to motion caused by chasing space-time waves generated by its own movement, up to the limit of radial wave propagation in the medium. This limit is imposed by the properties of the Higgs field and is defined by

$$c^2 = \frac{\varphi}{{\omega_{\mathrm{H}}}^2 \pi \Lambda^2} \approx 3 \times 10^8 \ m^2 \ s^{-2} \tag{63}$$

Remember that inertia for a reference mass in a Higgs field can be expressed as

$$\tau = \mu_{\mathrm{R}} \sigma_{\mathrm{H}} = \mu_{\mathrm{R}} \lambda_{\mathrm{H}} {\omega_{\mathrm{H}}}^2 \tag{64}$$

2.3 Visualization

Here is an alternative way of visualizing the predictions of general relativity based on the ideas presented above. Imagine ripples on the surface of a pond caused by dropping a stone. Let us assume the pond is a special fluid of very high density but low viscosity, such that the stone does not sink but continues to bob up and down on the surface, producing ripples continuously. Imagine also that the height of the wave-crests of the ripples decreases with increasing distance from the stone while the distance between wave-crests increases.

Imagine a pair of ants, each floating on a little leaf-boat at different distances from the stone. The ant who is further away from the stone watches the ant who is nearer to it, and who is buffeted by taller and more frequent waves. From the perspective of the distant ant, the nearer ant seems to be moving much slower, as it takes much longer for her to get anywhere by floating. But the nearer ant is actually floating at the same speed; it is merely the length of the path she travels over the turbulent water that makes the journey seem slower from the distant ant's perspective. In fact, even if both ants were stationary relative to the stone, the nearer ant would be covering more distance each second than the distant ant, as she bobs up and down on the waves. Since ants do not use clocks, the time taken to crest a wave is the measure of a second. If the two ants were able to compare, they would find that one second for the nearer ant is longer than one second for the distant ant.

As they float on the surface of the pond, our ants on their leaf-boats generate their own ripples in the water that overlap with the ripples produced by the bobbing stone, making the wave action more intense. (Let us assume these are special ripples that do not exert force in the direction of propagation, and so have no pushing action.) A strange thing happens – where the ripples overlap, the pond surface effectively shrinks on the horizontal plane. As a result, distances are diminished, and the ants find themselves drawn towards this point as if pulled by an unseen force (Figure 3). The ant nearest the point where the stone was dropped feels a stronger attractive force in proportion to the intensity of the wave action.

Now imagine one of our ants decides to build a tiny sail to catch the wind. As long as she collects kinetic energy from the wind, she accelerates, and also generates ripples at an increasing rate. (This in turn should cause a slightly stronger attraction towards the ripple source of the stone, so slight she would barely notice it unless she were to reach a tremendous speed[9]). If she sails fast enough in any direction, she will begin to catch up with the wave-crests caused by her own movement, producing the same effect as if she were traveling against waves produced by the bobbing stone.

Now if our intrepid ant continues to move with increasing speed towards her own wave-crests, she will be forced to sail into and over them. Even if the interaction between the water and her leaf somehow produced

[9] This is proposed as a possible explanation for the Pioneer anomaly; traveling away from the Sun at around 12 $km\ s^{-1}$, the Pioneer 10 and 11 probes have perhaps the highest sustained linear velocities of any human-made objects of similar mass [17].

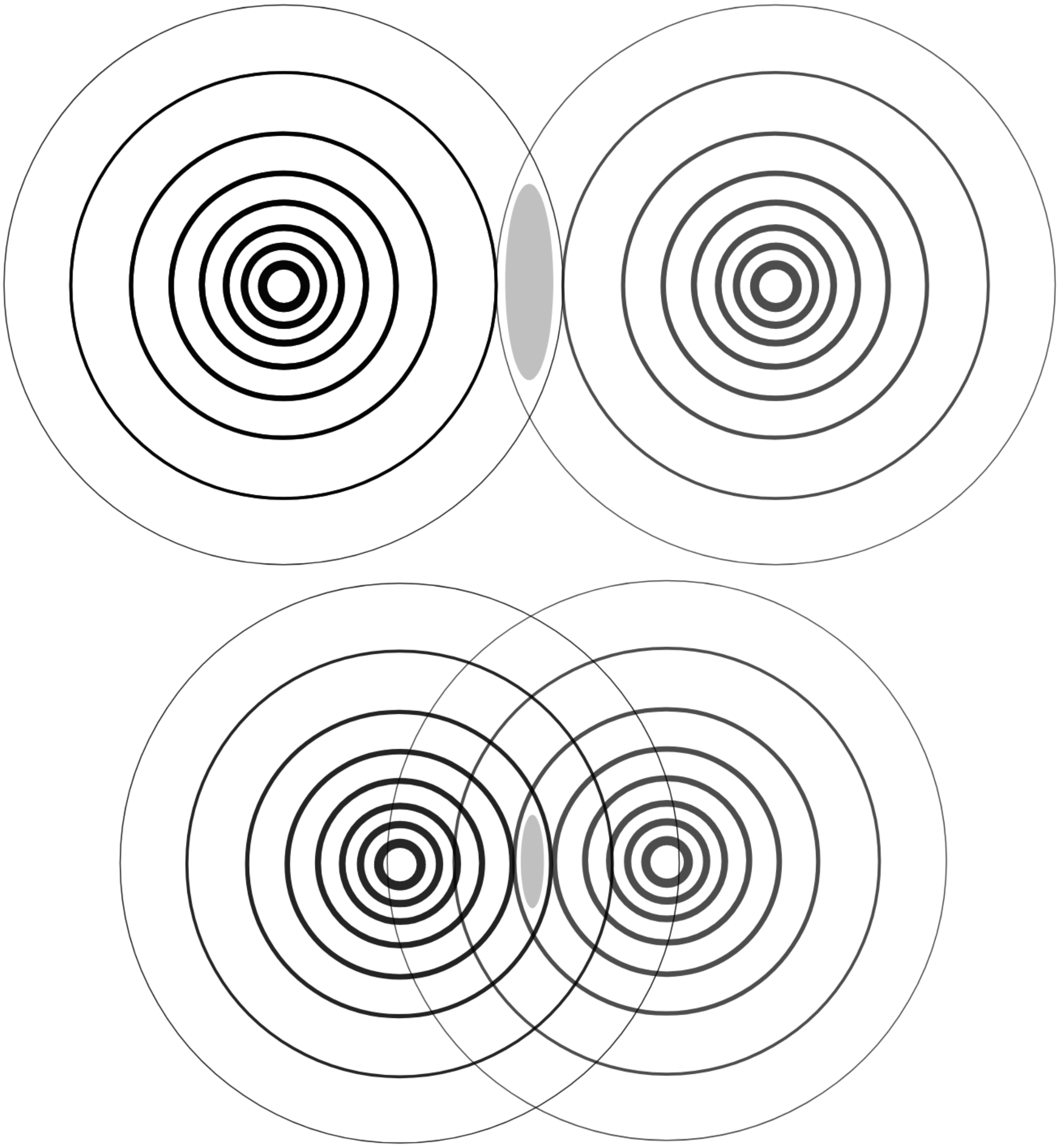

Figure 3: *Positive interference of space-time waves leads to an apparent attractive force caused by the contraction of space-time between two masses, represented by the grey ellipse getting smaller.*

waves without friction, the increasing path length would effectively provide increasing resistance to her motion (Figure 4). At some point it becomes impossible for our ant to go any faster, because she would have to travel as fast or faster than her own wave-crests generated in the past, equivalent to crossing the threshold from positive time to zero or negative time (while somehow remaining in positive space). Her speed is now limited by the minimum length of time required for waves to propagate in the pond (or the maximum possible frequency).

2.4 Universal inflation as expansion of space-time

Considered on a grand scale, the model presented above leads neatly to a kind of super-relativistic universal inflation. Assume that some primordial disturbance (ie. the Big Bang) were to occur within an infinite and formerly static and homogenous universe. Hypothetical observers within the field of disturbance, who would previously have lived in an absolutely non-relativistic universe, would suddenly become aware of finite, virtual

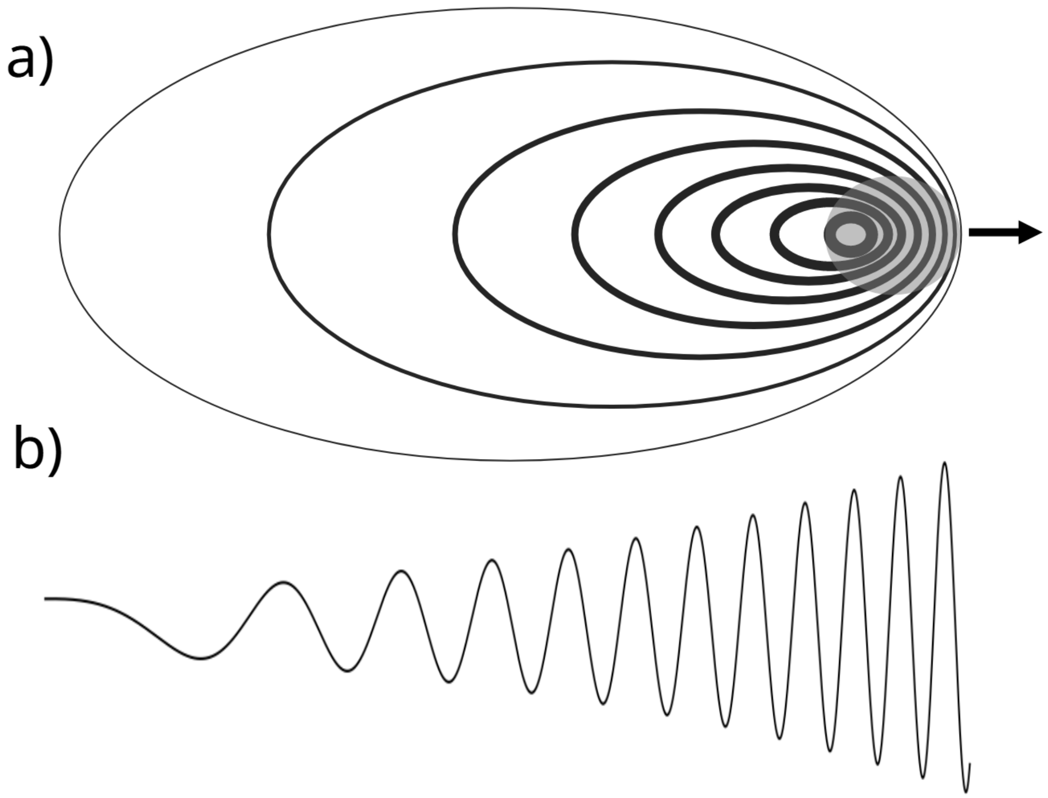

Figure 4: *a) Increased space-time wave flux (in grey area) experienced by accelerating observers (due to the Doppler effect) results in b) increased path length in space-time, translating as inertia. The upper limit of the path length is a function of the maximum frequency of oscillations in the medium and determines the maximum possible speed.*

distinctions in space and time that did not exist previously. These distinctions could eventually evolve into a system of dynamic, self-interacting fluctuations, eg. Higgs-space-time and all that arises from it. This system could have different properties in different eras of its evolution, but at some point might settle into a stable form somewhat resembling a fluid in certain dimensions.

At this point, similar laws apply as those that govern the "ripples in the pond" described in the visualization. Due to self-interactive attenuation or damping, space-time will continue to expand exponentially following the initial disturbance, ie. the more (space-)time elapses since the Big Bang, the greater the distinctions in space and time in the virtual (relativistic) universe seem to get from the perspective of observers within it.

This does not preclude the possibility of observers of some kind that remain outside the relativistic universe, if the field of disturbance is finite (which logically it must be, if it occurs within an infinite state). Since this disturbed universe will expand infinitely it will, somewhat counterintuitively but by definition, come to an end as it inevitably returns to its former infinite, non-relativistic state – a kind of death by dilution.

This perspective implies that the self-interaction of the Higgs field (or a precursor field that evolves into the Higgs field and other phenomena of our universe) is the intrinsic source of space-time, the main factor driving accelerated universal space-time expansion, and may be partly or wholly identifiable with dark energy[13].

Competing interests

The author has no competing interests to declare that are relevant to the content of this article.

Funding statement

No funding was received to assist with the preparation of this manuscript.

References

[1] S W Hawking. "The Propagation of Particles in Space-Time Foam". In: *Physics Letters B* 86 (1979), pp. 175–178.

[2] A F Fresnel. "Letter to François Arago". In: *Annales de chimie et de physique* 9.57 (1818).

[3] J S Rowlinson. "Le Sage's *Essai de Chymie Méchanique*". In: *Notes and Records of the Royal Society of London* 57.1 (Jan. 2003), pp. 35–45. ISSN: 0035-9149. DOI: 10.1098/rsnr.2003.0195. (Visited on 07/20/2026).

[4] B Moore. *The Origin and Nature of Life*. London: Williams and Norgate, 1913.

[5] H E Puthoff, E W Davis, and C Maccone. "Levi-Civita Effect in the Polarizable Vacuum (PV) Representation of General Relativity". In: *General Relativity and Gravitation* 37.3 (Mar. 2005), pp. 483–489. ISSN: 0001-7701, 1572-9532. DOI: 10.1007/s10714-005-0037-8. (Visited on 06/17/2026).

[6] M R Edwards. "Gravity from Refraction of CMB Photons Using the Optical-Mechanical Analogy in General Relativity". In: *Astrophysics and Space Science* 351.2 (June 2014), pp. 401–406. ISSN: 0004-640X, 1572-946X. DOI: 10.1007/s10509-014-1864-4. (Visited on 06/17/2026).

[7] N Butto. "The Nature and Origin of Inertia". In: *Journal of High Energy Physics, Gravitation and Cosmology* 07.02 (2021), pp. 761–772. ISSN: 2380-4327, 2380-4335. DOI: 10.4236/jhepgc.2021.72044. (Visited on 04/19/2026).

[8] L D Landau. "The Theory of a Fermi Liquid". In: *Journal of Exploration of Theoretical Physics* 30 (1956), pp. 1058–1064.

[9] STAR Collaboration et al. "Temperature Measurement of Quark-Gluon Plasma at Different Stages". In: *Nature Communications* 16.1 (Oct. 2025), p. 9098. ISSN: 2041-1723. DOI: 10.1038/s41467-025-63216-5. (Visited on 07/20/2026).

[10] I Ciufolini and J A Wheeler. *Gravitation and Inertia*. 1995.

[11] K Gödel. "An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation". In: *Reviews of Modern Physics* 21.3 (July 1949), pp. 447–450. ISSN: 0034-6861. DOI: 10.1103/RevModPhys.21.447. (Visited on 07/20/2026).

[12] H A Wilson. "An Electromagnetic Theory of Gravitation". In: *Physical Review* 17.54 ().

[13] D H Lee et al. *Evolving Dark Energy Is Vacuum Energy after All*. June 2026. DOI: 10.48550/arXiv.2606.20036. arXiv: 2606.20036 [astro-ph.CO]. (Visited on 06/22/2026).

[14] P W Higgs. "Broken Symmetries and the Masses of Gauge Bosons". In: *Physical Review Letters* 13.16 (Oct. 1964), pp. 508–509. ISSN: 0031-9007. DOI: 10.1103/PhysRevLett.13.508. (Visited on 04/19/2026).

[15] ATLAS Collaboration. "Observation of a New Particle in the Search for the Standard Model Higgs Boson with the ATLAS Detector at the LHC". In: *Physics Letters B* 716.1 (Sept. 2012), pp. 1–29. ISSN: 03702693. DOI: 10.1016/j.physletb.2012.08.020. arXiv: 1207.7214 [hep-ex]. (Visited on 04/19/2026).

[16] B F Schutz. "Gravitational Waves on the Back of an Envelope". In: 52.5 (1984), pp. 413–419.

[17] J D Anderson et al. "Study of the Anomalous Acceleration of Pioneer 10 and 11". In: *Physical Review D* 65.8 (Apr. 2002), p. 082004. ISSN: 0556-2821, 1089-4918. DOI: 10.1103/PhysRevD.65.082004. arXiv: gr-qc/0104064. (Visited on 06/22/2026).

[18] Planck Collaboration et al. "*Planck* 2015 Results: XIII. Cosmological Parameters". In: *Astronomy & Astrophysics* 594 (Oct. 2016), A13. ISSN: 0004-6361, 1432-0746. DOI: 10.1051/0004-6361/201525830. (Visited on 06/22/2026).

[19] S Carlip. "Kinetic Energy and the Equivalence Principle". In: *American Journal of Physics* 66.5 (May 1998), pp. 409–413. ISSN: 0002-9505, 1943-2909. DOI: 10.1119/1.18885. arXiv: gr-qc/9909014. (Visited on 06/22/2026).

[20] S Carroll. *The Particle at the End of the Universe: How the Hunt for the Higgs Boson Leads Us to the Edge of a New World*. New York: Penguin, 2012.

[21] S D Bass, A D Roeck, and M Kado. "The Higgs Boson - Its Implications and Prospects for Future Discoveries". In: *Nature Reviews Physics* 3.9 (July 2021), pp. 608–624. ISSN: 2522-5820. DOI: 10.1038/s42254-021-00341-2. arXiv: 2104.06821 [hep-ph]. (Visited on 04/19/2026).

[22] P Worden and J Overduin. "Einstein's Happiest Moment: The Equivalence Principle". In: *arXiv.org* (2022). DOI: 10.48550/arXiv.2209.13781.

[23] J Albert et al. "Variable Very High Energy γ-Ray Emission from Markarian 501". In: *The Astrophysical Journal* 669 (2007), pp. 862–883.

[24] E S Perlman et al. "New Constraints on Quantum Gravity from X-ray and Gamma Ray Observations". In: *The Astrophysical Journal* 805.1 (May 2015), p. 10. ISSN: 1538-4357. DOI: 10.1088/0004-637X/805/1/10. (Visited on 04/19/2026).

[25] F W Stecker and S L Glashow. "New Tests of Lorentz Invariance Following from Observations of the Highest Energy Cosmic Gamma Rays". In: *Astroparticle Physics* 16.1 (Oct. 2001), pp. 97–99. ISSN: 09276505. DOI: 10.1016/S0927-6505(01)00137-2. arXiv: astro-ph/0102226. (Visited on 04/19/2026).

[26] L Boyle, K Finn, and N Turok. "The Big Bang, CPT, and Neutrino Dark Matter". In: *Annals of Physics* 438 (Mar. 2022), p. 168767. ISSN: 00034916. DOI: 10.1016/j.aop.2022.168767. arXiv: 1803.08930 [hep-ph]. (Visited on 04/19/2026).

[27] KATRIN Collaboration. "Direct Neutrino-Mass Measurement Based on 259 Days of KATRIN Data". In: *Science* 388.6743 (2025).

[28] C Branchina et al. *Gravity and the Higgs Boson Mass*. July 2025. DOI: 10.48550/arXiv.2507.13832. arXiv: 2507.13832 [hep-th]. (Visited on 06/22/2026).

[29] M Tanabashi et al. "Review of Particle Physics". In: *Physical Review D* 98.3 (Aug. 2018), p. 030001. ISSN: 2470-0010, 2470-0029. DOI: 10.1103/PhysRevD.98.030001. (Visited on 07/21/2026).

[30] P Slavich et al. "Higgs-Mass Predictions in the MSSM and Beyond". In: *The European Physical Journal C* 81.5 (May 2021), p. 450. ISSN: 1434-6044, 1434-6052. DOI: 10.1140/epjc/s10052-021-09198-2. arXiv: 2012.15629 [hep-ph]. (Visited on 06/17/2026).

[31] CMS Collaboration et al. "A Portrait of the Higgs Boson by the CMS Experiment Ten Years after the Discovery". In: *Nature* 607.7917 (July 2022), pp. 60–68. ISSN: 0028-0836, 1476-4687. DOI: 10.1038/s41586-022-04892-x. (Visited on 04/19/2026).

[32] B F Riley. "The Mass of the Higgs Boson". In: *ai.viXra.org* (2019).

[33] S Schlamminger et al. "Redetermination of the Gravitational Constant with the BIPM Torsion Balance at NIST". In: *Metrologia* 63.2 (Apr. 2026), p. 025012. ISSN: 0026-1394, 1681-7575. DOI: 10.1088/1681-7575/ae570f. (Visited on 06/22/2026).

[34] P A Butler. "Pear-Shaped Atomic Nuclei". In: *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences* 476.2239 (July 2020), p. 20200202. ISSN: 1364-5021, 1471-2946. DOI: 10.1098/rspa.2020.0202. (Visited on 07/21/2026).

[35] A Einstein. "Zur elektrodynamik bewegter körper". In: *Annalen der Physik* 322.10 (Jan. 1905), pp. 891–921. ISSN: 0003-3804, 1521-3889. DOI: 10.1002/andp.19053221004. (Visited on 06/22/2026).

[36] E Perlman et al. "Vacuum Energy Density Measured from Cosmological Data". In: *Journal of Cosmology and Astroparticle Physics* 2022.06 (June 2022), p. 015. ISSN: 1475-7516. DOI: 10.1088/1475-7516/2022/06/015. arXiv: 2111.08151 [astro-ph.CO]. (Visited on 07/20/2026).