TITLE: The Nature of Elementary Particles and the Structure of Space

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Abstract:

Space is a four dimension spherical shell comprised of energy density, where the distribution of energy density in space is determined by distribution of mass (energy) in space. An object's energy density decreases at approximately one over the square root of the distance from the object. Accordingly, space (the Universe) is like a four dimensional balloon wherein the thickness of the balloon varies according to the magnitude of the energy density (mass divided by radius squared for each object in the Universe). The energy density (the thickness of the 4D balloon) at any given point is given by the value of the G00 element of the metric tensor at that point, where the G00 element of the metric tensor can be determined by solving the Equations of General Relativity or by using an approximate solution if appropriate. Elementary particles are travelling wave and standing wave solutions to a second order hyperbolic partial differential

equation, which is exactly the same differential equation that applies to seismic waves in the Earth, except that the elementary particle differential equations have a fourth dimension. Photons are shear waves that oscillate in two of the normal space dimensions and travel in the third space direction. The differential equations and the wave function solutions and the wave properties for a photon can be same to exactly the same as those of a shear wave in the Earth. An electron is shown to be a standing wave comprising two photons, where the standing wave of the electron affects the space surrounding the electron and causes some of that space to become anisotropic (having different velocities in different directions). The location of an electron is at its central wave packet, which is where a photon would most likely interact with the standing wave. All gauge bosons are traveling waves, like photons. All massive particles are standing waves or linear combinations of standing waves, like electrons. A group of seismic waves will split off a travelling wave, if the seismic wave encounters anisotropic space (this wave splitting can be observed on the internet). Similarly, when a charged massive particle (standing wave) encounters anisotropic space, the anisotropic space of the charged particle interacts with the anisotropic space and splits off a photon. This occurs when two electrons interact and exchange photons (traveling waves). Savickas and Hilo have separately demonstrated that the speed of light in a vacuum is proportional to the G00 element of the metric tensor. Accordingly, light will refract towards the normal when it travels into an area having a smaller magnitude of value for the G00 element of the metric tensor, where the magnitude of the G00 element decreases for greater mass density, which occurs as you go deeper into a gravity well. However, gravity does not have discontinuous edges. Gravity provides a continuously reducing index of refraction. Maxwell proved that a continuing reducing index of refraction provides circular orbits. Accordingly, this refraction provides gravity consistent with traditional GR, since the refraction

is determined by the G00 element of the metric tensor and since the velocity of massive objects is also determined by the G00 element of the metric tensor and since the direction of the normal is determined by the G11 element, the G22 element, and the G33 element of the metric tensor.. Accordingly, the proposed model provides an intuitive framework for understanding forces and gravity and it provides that framework in a manner that is completely consistent with General Relativity and Quantum Mechanics.

MAIN TEXT:

Elementary particles are shown to be standing gravitational waves. Gravitational waves are further shown to be representations of more fundamental energy density waves. The energy density waves are presumed to have compression and shear type waves, similar to seismic waves because the 4D shell of energy density has elastic properties. The compression waves and shear waves being waves that travel through the 4D elastic shell. The thickness of the 4D elastic energy density shell at any point in space is determined by the sum of the energy densities for each object at that point in space, where each particle has an energy density for each point in space based upon its wave function and where that energy density is approximately the inverse of the radius squared.

Elementary particles are travelling wave or standing wave solutions to a set of second order hyperbolic partial differential equations for a four dimensional elastic medium. These partial differential equations are the same as the partial differential equations that apply to seismic waves in the Earth, except that they include an additional dimension, where the normal space dimensions form a surface and energy density forms the thickness of the shell. The energy density waves include compression waves and shear waves that are analogous to P (primary or compression waves) and S (secondary or shear waves) type seismic waves in the Earth. The energy density waves (elementary particles) are the solutions to a set of hyperbolic second order partial differential equations for the four dimensional elastic shell.

Standing waves made of compression traveling waves or shear traveling waves can reproduce all of the observable characteristics of massive elementary particles, such as spin and charge and

quantum behaviour. Gluons and photons are traveling shear waves, while quarks and electrons are standing waves made of two traveling shear waves. A photon involves oscillation between two space dimensions that correspond to the B and E fields, while each of the three quarks/gluons involves oscillation in a space dimension and the energy density dimension. Gravity is a type of refraction, where the velocity of a traveling wave, such as a photon, is proportional to the G00 element of the metric tensor, where the angle of an object with respect to the normal of a gravity well will be given by

$\emptyset_2 = \emptyset_1(\arcsin(\text{sqroot}(g00(r_1)/\text{sqroot}(g00(r_2)))$.

Charged particles cause anisotropic space, which causes the charged particles to exchange photons when the anisotropic space caused by two distinct charged particles (charged standing waves) intersects. Forces are a consequence of wave splitting or wave combining in anisotropic space, which is a phenomenon observed in 3D seismic waves. Neutrinos can have velocities greater than C, since neutrinos are standing P type waves and P type waves always travel faster than S waves in elastic media. Gravity is an application of Snell's law to gradually reducing index of refraction following Maxwell's proof that a $1/r^2$ GRIN lens would provide circular orbits of the light rays (photons), where high intensity gravitational fields provide a gradually reducing index of refraction that further includes $1/r^4$, $1/r^6$, etc. terms in accordance with the g00 element of the metric tensor. Additionally, the velocity of objects changes in accordance with the change in the G00 element of the metric tensor such that energy is conserved. Accordingly, refraction provides object paths identical to the geodesic paths predicted General Relativity.

The equations of General Relativity comprise a set of partial differential equations.[1] The solutions to those differential equations have been shown to include Wave function solutions. [1] The wave function solutions of General Relativity are known as gravitational waves. Gravitational waves are waves of curvature propagating through curvature.[2] All gravitational waves must be linear combinations of the wave functions that satisfy the differential equations, since these waves comprise the eigenstates of the system.

However, all massive particles have an energy density in all space and thereby curve space according to that energy density. Accordingly, the curvature caused by all particles must be a linear combination of the wave functions that satisfy the set of General Relativity partial differential equations, since those wave functions are the only allowed states of curvature. Since all particles that have rest energy can be considered to be at rest in some reference frame, all massive particles must be standing wave solutions to the partial differential equations. Photons and Gluons are types of traveling wave solutions. However, standing waves are just combinations of two traveling waves. Further, those same particles/standing waves will have velocity when observed from other reference frames, so that a massive particle (standing wave) will also have a group velocity.

Although Gravitational waves are waves of curvature traveling through a medium of curvature, they can be thought of as representations of more fundamental energy density waves. Oscillations of energy density would necessarily cause oscillations in curvature, since the curvature in the neighborhood of a point in space is dependent upon the distribution of mass density near that point in space. Also, energy density extends through the entire Universe in the

same way that matter extends through the entire earth. However, energy density provides us with a 4D shell, much like it is the rubber of a 4D balloon. Accordingly, the 4D elastic shell will have elastic waves that satisfy the second order partial differential equations for deformation in an elastic media.[6] The form of the differential equations as shown in Stone applies to the 4D shell because it is provided in compact notation.

Accordingly, we should expect to have compression and shear (P and S) type energy density waves in the 4D elastic shell that comprises the Universe, since they are the predominate types of waves in elastic media.[5] Photons and Gluons are shear traveling energy density waves. Electrons and Quarks comprise shear standing waves. Accordingly, electrons and nucleons have a gamma factor based on C. W bosons are standing waves with rest energy, since they create anisotropic space. The Z boson is the gauge boson (traveling wave) that transfers energy between the W bosons and applies forces to them. Z and W bosons are likely surface waves. It may be possible to have linear combinations of shear, compression and surface waves, where energy can couple between the waves. However, not all such linear combinations of standing waves will be stable, where the decay times can be determined by using numerical methods for solving the partial differential equations.

Neutrinos are standing compression waves and thus travel faster than C, since compression waves always travel faster than shear waves.[5] In the 3D elastic medium of the of the Earth, the travelling P waves travel about 1.7 times faster than the travelling S waves, where the 1.7 ratio applies for all media.[5] Accordingly, neutrinos should be able to exceed C without very

significant relativistic effects because the gamma factor of Neutrino will be based upon the speed of the travelling P waves.

Anti-matter is a massive particle having a traveling wave component 180 degree out of phase with a traveling wave component of the corresponding matter particle, such that the combination of the two standing waves out of phase component travelling waves would free the remaining traveling wave from each particle after the two out of phase traveling waves cancelled each other out.

The energy density waves will have a set of second order partial differential equations that describe them, since all physically existing waves are solutions to differential equations.[6] accordingly, the true nature of elementary particles is as wave function solutions to a set of hyperbolic second order partial differential equations for a 4D elastic shell, where standing wave solutions represent massive particles and travelling waves represent gauge bosons. More complex objects are made of wave packets comprising linear combinations of the Eigen-waves. Qualities such as charge or spin are provided by the wave characteristics (phase, polarization, etc.) of the S and P type waves and of surface waves. [3, 5, 6]

The standing waves provide the particles with a rest energy that corresponds to all of the energy of the particle (standing wave) when it is at rest. Kinetic energy (momentum energy) is additional energy that the particle has in addition to its rest energy and it causes the standing wave as measured from the observer's wave and kinetic (momentum) will cause the particle to move with respect to the observer's standing wave and will correspond to the group velocity of

the particle. When a massive particle goes deeper into a gravity well, its rest energy decreases in proportion with the decrease in the magnitude of the G00 element of the metric tensor and its velocity increases by an equivalent to the decrease in rest energy.[4] However, photons will get slower when they go deeper into a gravity well, since the G00 element of the metric tensor gets closer to zero.[7,9] Accordingly, the gamma factor will eventually cause the speed of massive particles to decrease as they get deeper in a gravity well, since the standing wave velocity can never exceed the travelling wave velocity

The standing waves, as well as the traveling waves that comprise them, extend through the universe and provide the particle with an energy density value at all points of the Universe, where the energy density of a particle reduces according to its wave function (approximately by the inverse of the radius squared) the farther from the particle you get. The thickness of the 4D elastic energy density shell at a point in space is determined by the sum of the energy densities for all objects at that point.[3] As observed from a particular observation frame, the sum of the energy densities of each particle in the universe at a point in space combine together to give the total energy density value at that point in space. A gravity well is a volume of space where the total energy density increases as you approach the center of the volume. When a particle goes deeper into a gravity well (an area of high energy density), the particle's rest energy decreases, which means that the particle needs less energy to exist as a standing wave when it is deeper in the gravity well then when it is higher up in the gravity well.[4] Accordingly, rest energy will transform into kinetic (momentum) energy as the particle goes deeper into the gravity well to conserve energy as observed from any specific reference frame.

A massive particle will change direction towards or away from the normal in accordance with the traveling waves that comprise the standing wave, so that Snell's law will apply to standing waves, such as electrons and gluons, to the same exact extent as it applies to photons. However, the velocity of the standing waves (massive particles) will be based upon the change in rest energy caused to the particle as the G00 value of the metric tensor changes when the particle moves in the gravity well. A particle's change in direction with respect to the normal, its decrease in standing energy density, and its increase in group velocity when the particle slows as it enters a volume of greater energy density deeper in the gravity well is the same thing that happens to a seismic wave when it goes from a faster medium to a slower medium higher in the Earth, where the wave velocity increases, the wave amplitude decreases, and the wave direction turns towards the normal when the wave transmits into and through the slower medium.[3] Accordingly, gravity is a type of refraction of the standing waves or traveling waves, since refraction changes the direction of both the traveling waves and the standing waves in the same way, even though the velocity of traveling waves and standing waves varies differently in a gravity well.

Accordingly, all massive objects in the Universe can be represented as standing gravitational waves or as standing energy density waves. The behavior of particles as standing energy density waves is given by the differential equations for energy density in an elastic 4D shell, which is analogous to the behavior of seismic waves travelling through the volume of the earth. The 4D elastic shell is the sum of the energy densities of all particles at that point and at that time and it is similar to the rubber of a balloon.[6,7] However, the four dimensional elastic shell of

energy density does not have a reference frame, since it comprises energy density from everything.

The observed characteristics of elementary particles can all be represented by the characteristics of travelling waves or of standing waves. Indeed, we know that photon waves can have spin and angular momentum and the additional degrees of freedom provided by shear and compression waves can represent all known elementary particle characteristics, where some of the more exotic particles could correspond to surface waves and their linear combination with shear and compression waves.[6,7] Energy between S and P waves and Surface waves can couple amongst them as determined by the differential equations, but the combinations are not always stable. Further, we can expect energy density waves to have quantum behavior because they exist as eigenvectors (Eigen wave functions) of the system and thus only have specific quantums of value and because and because the uncertainty relation will naturally hold.[3,5,6] Further, the probabilities of interactions of a photon with a massive particle will obey the statistical probabilities of QM because of the distributed nature of the respective particles.

In elastic media, a wave will split into two waves when it encounters anisotropic media, where anisotropic media is media where the wave velocity varies according to direction. [3,5,6] Anisotropic media can also provide wave combining. [3,5,6] Charged particles (charged standing waves) create anisotropic space, unless they are balanced out by an equal but opposite charge. Accordingly, neutral particles do not have anisotropic space except in the close vicinity of the charged particle. When the anisotropic space of two standing waves intersect, both standing

waves emit traveling waves (i.e. photons or gluons) that are absorbed by the other standing wave. However, such photons likely couple directly form one particle (standing wave) to the other so that no free standing photon ever exists when a force is applied by a charge. When a photon interacts with the anisotropic space near a particle, the velocity difference between the particle's component travelling wave and the incident travelling wave cause the waves to combine.

Frame dragging will be caused if a large mass, such as a black hole, is rotating, since the mass of the large mass will dominate the energy density in its local area. This frame dragging imposes a rotation into the local elastic shell near the large rotating mass. The rotation of the frame will likely cause a close orbiting star to acquire large additional velocity and kinetic energy as it goes through the frame dragging area. The relative amount of rotation of space (the energy density shell) will increase as you approach the boundary of the black hole and the rotation of the energy density shell will provide velocity and energy to the star (standing wave packet) in a manner similar to what would happen to a sound wave travelling through an ocean current.

The rest energy and volume (the wave packet size) of the standing waves varies in exactly the way that is predicted for general relativity.[3] Accordingly, Lev Okun's statement "the phenomenon known as the red shift of a photon is the blue shift of an atom" applies to the standing wave solutions (atoms) and travelling wave solutions (photons) moving up in a gravity well.[4]

The speed of light decreases proportionally to the G00 element of the metric tensor[7,9], which decreases according to mass density as you go deeper in the gravity well. Through algebraic manipulation, the G00 element can be applied to C. Accordingly, you can use the G00 element to determine the index of refraction of the energy density waves. However, photons will be additionally affected by condensed matter to create phonons (lattice oscillations that have virtual particle properties) and further slow the photons (travelling waves).

Gravity will affect travelling waves and standing waves in the same way that gradual index of refraction lenses bend light.[8] Equation 3 of Moore, shows how the index of refraction changes for a change in radius of the GRIN lens, where the index of refraction decreases as a function of the radius squared.[8] This can be seen to be is the same equation as the equation for determining g00 in a gravity field, since transforms can be applied to change the metric tensor into a tensor having only non-zero elements along the diagonal of the tensor if the square root of G00(r) is given by an infinite sum of linear basis function and if the other three diagonal elements are also represented by infinite sums of linear basis functions relating to momentum in the three space directions. The r^2 term is equivalent to the inverse of the weak field gravitational potential and the remaining terms provide better approximations with the infinite sum equaling the non-linear function.

Indeed, Maxwell proved that the $1/r^2$ GRIN lens provides circular orbits for light rays.[8] Accordingly the $1/ r^2$ case will provide circular orbits for all massive and non-massive objects orbiting a very heavy object, where the $1/ r^2$ case is the weak field approximation applicable in a

weak gravity field and that gives Newtonian gravity. If the orbiting objects are of similar mass, then the objects will have elliptical orbits because they will form $1/r^2$ grin lenses about the Barry center. The additional $1/r^4$, $1/r^6$, etc. terms provide progressively better approximations in gravity just like they do in a GRIN lens because it is the infinite sum that applies to the change in velocity in a gradually reducing index of refraction and because it provides the required infinite sum of linear basis functions. Energy density determines the G00 element of the metric tensor and the G00 element is proportional to the gauge boson velocity. [7,9] Since the angle with respect to the normal of an objects velocity is determined by the G00 element of the metric tensor, and since the velocity of massive objects is determined by the G00 element, and since the direction of the normal is determined by the G11, the G22, and the G33 elements, the path provided by refraction of particles is identical to the geodesic path provided by traditional General Relativity.

Accordingly, the angle of an object with respect to the normal of the gravity well will be given by $Ø_2 = Ø_1(\arcsin(\text{sqroot}(g00(r_1)/\text{sqroot}(g00(r_2)))$. Further, the change in rest energy will be proportional to the change in sqroot(g00) and the change in momentum energy will be the opposite of the change in rest energy. The speed of travelling waves decreases when the waves enter an area of the 4D elastic shell having higher energy density. Accordingly, the gamma factor will increase as you go lower in a gravity well, which will counter the effect of increasing massive particle velocities at very high G00 levels.

Space is shown to exist as a four dimension elastic shell of energy density comprised of the energy densities of each object in the Universe. Elementary particles are travelling wave and

standing wave solutions to a set of second order hyperbolic partial differential equations for a four dimensional elastic medium. These partial differential equations are the same as the partial differential equations for seismic waves in the Earth, except that it includes an additional dimension. Forces are created by anisotropic space, which causes a standing wave to emit travelling waves and to absorb travelling waves. General Relativity and Quantum mechanics emerge from this model. Gluons and photons are traveling shear waves, while quarks and electrons are standing waves made of two traveling shear waves and which also include a standing compression wave (neutrino). W bosons are traveling surface waves and Z bosons are standing waves comprised of W bosons. Gravity is a type of refraction, where the velocity of a traveling wave is proportional to the G00 element of the metric tensor, where the angle of an object with respect to the normal of a gravity well will be given by the equation:

$\emptyset_2 = \emptyset_1(\arcsin(\text{sqroot}(g00(r_1)/\text{sqroot}(g00(r_2))))$.

[1] H. Bondi, F. A. E. Pirani, I. Robinson, Gravitational Waves in General Relativity. III. Exact Plane Waves. Proceedings of the Royal Society of London. Series A, Mathematical and PhysicalSciences, Vol. 251, No. 1267 (Jun. 23, 1959), pp. 519-533.

[2] L. Jun, THE ACTION OF HARMONIC CONDITION ON THE STUDY OF GRAVITATIONAL WAVES. Science in China (Series A), Vol. 35 No. 2, (February 1992).

[3] J. Virieux, P-SV wave propagation in heterogeneous media: Velocity-stress finite-difference method. GEOPHYSICS, April 1986, Vol. 51, No. 4 : pp. 889-901

[4] L. B. Okun, K. G. Selivanov, V L. Telegdi, Gravitation, photons, clocks. Physics- Uspekhi 42 (10) 1045 -1050 (1999).

[5] V. Cerveny, I. Psencık, Seismic Ray Theory

[6] M. Stone, P. Goldbart, Mathematics for Physics, *PIMANDER-CASAUBON,* Section 6, 2008

[7] M. H. M. Hilo, et al., Deriving of the Generalized Special Relativity (GSR) by Using Mirror Clock and Lorentz Transformations, **Natural Science, 2014, 6, 1275-1281** Published Online December 2014 in SciRes. http://www.scirp.org/journal/ns http://dx.doi.org/10.4236/ns.2014.617117

[8] D. Moore, Gradient-index optics: a review Applied Optics. 04/1980; 19(7):1035-8. DOI: 10.1364/AO.19.001035. Chapter 9

[9] D. Savickas, Relations Between Newtonian mechanics, General Relativity and Quantum mechanics, Am. J. Phy. 70(8), (August 2002)