Wormhole-Stargates: Tunneling Through The Cosmic Neighborhood

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Abstract

This paper describes the physical features of traversable wormhole-stargates, which were derived from classical general relativity, and how they can be created. A summary of the engineering-physics parameters characterizing wormholes is provided to demonstrate the technical challenges facing laboratory efforts to create them. A real stargate can be derived from standard wormhole physics and its features are presented. The characteristics and performances of UFO phenomenon are delineated and a hypothesis is proposed that these can be understood as manifestations of traversable wormhole-stargate technology. A recent alternative theory of gravity is also presented, which supports faster-than-light motion that appears to parallel traversable wormhole and/or warp drive physics. This alternative model has also been shown to provide a natural explanation for much of the UFO phenomenon.

1.0 Introduction

It was many years ago when science fiction media (TV, film and novels) began to adopt traversable wormholes, and more recently "stargates", for interstellar travel schemes that allowed their heroes and heroines to travel the Cosmic Neighborhood. Little did anyone outside of relativity physics know but that in 1985 physicist Kip Thorne and his students at CalTech had in fact discovered the principle of traversable wormholes right out of Einstein's General Theory of Relativity (GTR, published in 1915). Thorne et al. (1,2) did this as an academic exercise, and in the form of problems for a physics final exam, at the request of Carl Sagan who had then completed the draft of his novel *Contact*. Sagan wanted to follow the genre of what I call science "faction", whereby the story's plot would rely on cutting-edge physics concepts to make it more realistic and technically plausible. This little exercise ended up becoming one of the greatest cottage industries in general relativity physics research - the study of traversable wormholes and time machines. However, it should be noted that it was Alan C. Holt (NICAP, VISIT and MUFON member, presently at the NASA-Johnson Space Center) who should receive credit for being the first to originate in 1979 the physical characteristics defining what he then called "field resonance spacetime tunneling" (3,4,5,6,7), which is what we now call a wormhole for all intents and purposes.

Real stargates exist in principle; they are merely a form of what are called traversable wormholes, and they are a form of "propellantless propulsion" or "field propulsion". These are unlike the well-known, non-traversable Einstein-Rosen Bridges or Schwarzschild wormholes that are formed from collapsed stellar matter (black holes) or spherically symmetric vacuum regions. Black holes are collapsed stars that have all their mass concentrated at an infinitesimal point where the induced gravitational field crushes all matter and spacetime. However, even Einstein-Rosen bridges can be made traversable by an infinitesimal tweaking of their spacetime metric.

Wormholes are hyperspace tunnels through spacetime connecting together either remote regions within our universe or two different universes; they even connect together different dimensions and

different times. Space travelers would enter in one side of the tunnel and exit out the other, passing through the throat along the way. In the case of black holes, there is the singularity of collapsed matter that totally blocks the way through the tunnel along with its crushing gravity field. A traversable wormhole does not have a singularity blocking the tunnel nor any crushing gravity field. Explorers would enter one side of the tunnel, travel through the throat, and exit out the other side. Traversable wormholes also do not possess an event horizon, which is a region of high gravitational field strength separating the inside space surrounding the black hole's singularity from the outside universe. Once you go through a black hole's event horizon, you can never come back out because you will have to attain greater than light speed to escape it. Not even light can escape from an event horizon.

Traversable wormholes are creatures of classical GTR allowing for very comfortable travel through the Cosmic Neighborhood. But from the viewpoint of modern physics, the Cosmic Neighborhood can encompass other universes, other space dimensions and other times beyond the 4-dimensional spacetime we live in. Mankind has certainly not discovered all of the universe's facets, and we will need to continue to construct new experiments and technology in order to verify or not these undiscovered facets. Wormholes can possess normal or backwards (in special cases) time flow, normal or nonexistent gravitational stresses on space travelers, and their entry/exit openings (or throats) are spherically shaped, cubic shaped, polyhedral shaped, or generic shaped, etc. A byproduct of wormhole studies has been the development of wormholes possessing flat entry/exit openings. These are essentially what a true stargate or flat doorway through spacetime and dimensions would be. UFO phenomenon presents a rich morphology of characteristics and performances, which provides evidence of spacetime metric modification during their manifestations. The craft seen during UFO encounters would likely be exploiting wormholes in order to intersect with our local space and interact with us, and the intelligence that controls wormhole technology could also use them as a window to peer into and probe our world without having to send craft through. I will not revisit here the age-old debacle over whether or not UFOs are real as that is beyond the scope of this paper. The question has been asked and answered: UFOs are real. Here I completely exclude the numerous varieties of UFO phenomenon that can be assigned prosaic explanations after rigorous forensic investigation and analysis. In this paper I will address how wormhole-stargates can provide a framework from which some UFO phenomenon can be explained. Wormhole-stargates could essentially facilitate the manifestation of phenomenon in our world by acting as a doorway through which UFOs would visit us from other universes, dimensions or spacetime. I will be approaching this topic strictly from the basis of Einstein's GTR, since this is the venue from which traversable wormholes and warp drive physics were derived. However, I will also discuss alternative theories of general relativity that have been recently proposed and how they apply to wormholes.

It is important to note that the application of wormhole-stargates to the UFO problem does not necessarily support the ETI Hypothesis as being the only viable one. Wormholes have the unique property of connecting together locations in different universes, different dimensions, and different times as well as different space locations (within the same universe). Einstein's GTR does not in any way constrain spacetime topology. Therefore, any sufficiently advanced intelligence capable of deploying wormholes can do so from near the surface of the Earth while existing in another dimension or another time without having to come from another exoplanetary system within our own spacetime. The current ETI Hypothesis

for UFOs is not strange enough to explain the facts of the phenomenon, whereas wormhole manifestations can. Wormholes are certainly strange and peculiar objects but, locally at least, they do not violate basic physical principles since the chief result of calculations (section 2.1) is that wormholes are described by plausible physics. *Warning*: There is no experiment that can distinguish between phenomena manifested by visiting interstellar (arbitrarily advanced) ETI and intelligent entities existing near/on Earth within a parallel universe or in different dimensions or who are (terrestrial) time travelers (see also section 3.0). In either case, the technology exploited by such intelligences would appear to the present human race as being indistinguishable from magic or perceived god-like powers.

Why consider wormholes for travel through space, time and other dimensions? All standard space propulsion engineering is based on Newton's law of mechanics, which is dependent upon the expenditure of propellant kinetic energy to induce thrust generating momentum transfer on a spacecraft. Many investigators have proposed interstellar propulsion schemes based on a variety of nuclear (fission, fusion and pulsed) rockets, electric (ion or plasma) rockets, matter-antimatter annihilation rockets, solar or laser sails, fusion or laser ramjets, interstellar ion scoops, beamed energy propulsion (sails, rockets and ramjets), etc. Many of these modes have either been experimentally tested at one time or another in our recent history or remain as theoretical proposals, but all are based on Newtonian mechanics. The limiting speed of space flight, based on any of these modes, is the speed of light. It is important to point out that for the interstellar travel application, Newtonian rocket propulsion modes suffer from enormous mass ratios > 10^5 - 10^{100} (depending on the specific impulse) for spacecraft cruise velocities > 0.05*c* (*c* = speed of light), if we are to constrain the travel time to within 100 years for a one-way voyage. If we increase the cruise velocity to sub-relativistic, near-relativistic or even ultra-relativistic speeds, and thus reduce the one-way travel time, then the mass ratio increases (exponentially!). The mass ratio is the initial spacecraft mass (payload + structure + propellant) at launch divided by the final spacecraft mass (payload + structure) at "burnout". The large ratios given above show that Newtonian rockets will consist mostly of propellant in order to propel a given tiny payload through interstellar space. The specific impulse is a measure of rocket propulsion system efficiency: how much impulse (thrust multiplied by time) is produced per unit of mass of propellant expenditure. It is desired that rocket propulsion systems possess a very high specific impulse in order to reduce the mass ratio, and hence propellant mass requirement, to reasonable levels.

The non-traditional propulsion modes (sails, ramjets, beamed power, etc.) have different efficiencies and constraints, but they are all still dependent upon Newtonian mechanics even though their mass ratio and specific impulse characteristics are slightly improved over that of the traditional modes. But all traditional and non-traditional propulsion modes come with a great cost in interstellar voyage travel time. At non-relativistic and sub-relativistic cruise speeds, it will take explorers several human lifetimes to reach stellar destinations. At low relativistic to ultra-relativistic cruise speeds, the travel time will be reduced to hours, days, weeks, months or years. However, at these cruise speeds relativistic time dilation will kick in and the returning interstellar voyagers will find that decades to thousands of years have elapsed on Earth since their launch date, their families and their culture no longer exist or are unrecognizable. This is an undesirable outcome for any interstellar voyage. Furthermore, traditional Newtonian propulsion cannot transcend time or spacetime dimensions or universes.

The cure to this problem is to dispense entirely with long interstellar voyage times or the undesirable outcome of relativistic time dilation. Explorers could deploy a wormhole-stargate near the Earth's surface or in Earth orbit or anywhere in the solar system they like, and just pass through the "stargate" and come out the other side in remote spacetime within a matter of seconds, moving through the throat at tiny cruise speeds (30 mph!), and with no time dilation effects. Explorers could travel through the wormhole-stargates in small scout ships or send probes unencumbered neither by enormous propellant mass ratios nor by extensive life support provisions. Effective travel time through the Cosmic Neighborhood via stargates would become irrelevant, but could be estimated to be many times or thousands of times light speed. Explorers could spend all day investigating the remote spacetime location, and then go back through the stargate to return home in time for dinner with their families. If they were to really push the envelope, then they would design their stargate so that they could return from their voyage in time to wave goodbye to themselves as they see themselves depart on their journey. Travelers can even go further back in time than that in principle. This is no longer recognized in classical GTR physics as a time paradox issue. It is very easy to build a time machine given a traversable wormhole. But time travel via wormhole is beyond the scope of this paper. Suffice it to say that classical GTR is seriously infested with time machines, the theory both allows for and demands time travel in order to preserve self-consistency of dynamic spacetime solutions.

2.0 The Engineering-Physics Parameters of Wormhole-Stargates

In this section I will summarize the key physical parameters for engineering stable, traversable wormholes. Those seeking more exhaustive technical treatment of wormholes should see references 1, 2 and 8. Wormholes represent a class of exact metric solutions of Einstein's GTR equation. The solutions are "exact" in the sense that no niggling approximations requiring a plethora of physical assumptions had to be made to derive the final result. The solutions are "metric" in the sense that a spacetime metric, a measure of the infinitesimal distance between two spacetime points, is the geometrical fabric we mathematically endow our universe with in order to model the dynamics of matter-energy in curved spacetime. Einstein's GTR equation is the relation between a geometrical term that tells matter-energy how to move through curved spacetime and a mass-energy term that tells spacetime geometry how to curve. To define a stable, traversable wormhole one needs to outline the desirable physical characteristics it is to have in order to achieve the desired interstellar travel benefit. These characteristics then define the appropriate spacetime metric geometry that would describe the wormhole. The resulting metric components are then "plugged into" and "cranked through" the Einstein GTR equation in order to calculate the resulting spacetime curvature effect the wormhole geometry is to generate. Last, this result is then equated with the mass-energy part of the GTR equation; this new result will provide the prescription for the type of mass-energy field that we will need to generate in order to create the wormhole spacetime geometry.

2.1 The Spacetime Characteristics and Mass-Energy Prescription

The physical characteristics we desire of our proposed wormhole-stargate are the following:

(a) Travel time through the wormhole tunnel or throat should be ≤ 1 year as seen by both the travelers and outside static observers
(b) Proper time as measured by travelers should not be dilated by relativistic effects
(c) The gravitational acceleration and tidal-gravity accelerations between different parts of the travelers' body should be ≤ 1 $g_{\oplus}$ ($g_{\oplus}$ = Earth gravity) when going through the wormhole
(d) Travel speed through the tunnel/throat should be < c
(e) Travelers (made of ordinary matter) must not couple strongly to the material that generates the wormhole curvature; the wormhole must be threaded by a vacuum tube through which the travelers can move
(f) There is no event horizon at the wormhole throat
(g) There is no singularity of infinitely collapsed matter-energy residing at the wormhole tunnel/throat

These properties plus additional boundary conditions define the time and space components comprising the spacetime metric of a spherically symmetric (coordinate space of a 3-dimensional sphere plus time) traversable wormhole as described in (1), see figure 1. These components contain two freely specifiable functions, which are used to shape the wormhole and define the mass-energy properties of the material forming the wormhole – they are called the redshift function and the shape function. These metric components, along with properties (a) - (g), are then cranked through the Einstein GTR equation to define the properties of the material required to generate the wormhole metric and its corresponding spacetime curvature effect. Figure 2 hypothetically shows how the wormhole entry/exit mouths would look in 4-dimensional spacetime. The result is that the energy density of material required to create and thread a traversable wormhole must be "negative". Negative in the sense that the material we must deploy to generate and thread the traversable wormhole must have an energy density (ρc^2, ρ = mass density) that is less than the stress-energy (τ), or we can write this condition as: *mass-energy* $\rho c^2 \leq$ *stress-energy* τ. We call this material property "exotic". So the term "negative" is just a misnomer in this context.

The condition for ordinary, non-exotic forms of matter that we are all familiar with is *mass-energy* $\rho c^2 >$ *stress-energy* τ. This represents what is variously called the weak (WEC), null (NEC) or dominant (DEC) or standard energy conditions (hypotheses!), which allegedly forbid negative mass-energy and gravitational repulsion (antigravity) between material objects to occur in nature. However, there are general theorems of differential geometry that guarantee that there must be NEC violations (meaning exotic matter-energy is present) at a wormhole throat. In view of this, however, it is known that static radial electric or magnetic fields are borderline exotic when threading a wormhole if their tension were infinitesimally larger, for a given energy density (9,10). Other exotic (energy condition violating) matter-energy fields are known to be squeezed states of the electromagnetic field (and other squeezed quantum fields), Casimir (electromagnetic zero-point) energy and other quantum fields/states/effects. With respect to creating wormholes, these have the unfortunate reputation of alarming physicists. This is unfounded since all the energy condition hypotheses have been experimentally tested in the laboratory and experimentally shown to be false - 25 years before their formulation (11). Further investigation of this technical issue showed that violations of the standard energy conditions are widespread for all forms of classical and quantum matter-energy such as planets, stars, black holes, neutron stars, people, space dust

clouds, etc. (12). Violating the energy conditions commits no offense against nature. Traversable wormholes can be created and stabilized.

2.2 Embedding the Wormhole Geometry in the Surrounding Spacetime Geometry

A criterion for creating a wormhole is that it must be embedded in the surrounding (asymptotically) flat spacetime away from localized concentrations of non-exotic, normal mass-energy. Visser (13) and Hochberg and Visser (14) demonstrate that it is only the behavior near the wormhole throat that is critical to understanding what is going on, and that a generic throat can be defined without having to make all the symmetry assumptions and without assuming the existence of an asymptotically flat spacetime to embed the wormhole in. One only needs to know the generic features of the geometry near the throat in order to guarantee violations of the null energy condition (10) for certain open regions near the throat (13). So we are free to place our wormhole anywhere in spacetime we want to because it is only the geometry and physics near the throat that matters for our analysis.

2.3 Wormhole Design Parameter #1

We know that we need "exotic" or "negative" matter-energy to create and thread a wormhole. So in this regard, we ask what kind of wormholes can one make with less effort? It has been shown (15) that we can relate the local wormhole geometry to the global topological invariant of the spacetime via the Gauss-Bonnet Theorem. In the Gauss-Bonnet Theorem the local wormhole geometry is quantified by the energy density (U, in geometrodynamic units) threading the wormhole plus a wormhole curvature constant, while the global topological invariant of the spacetime is quantified by what is called the Euler Number (χ_e). The Euler Number is also defined by the genus (g), which is the number of handles or throats (or tunnels) a wormhole can be assigned, and the definition is: $\chi_e = 2(1 - g)$. Finally, the wormhole Gauss-Bonnet relation is: $U \leq \chi_e /4$ or $U \leq (1 - g)/2$. This relation will help us to decide if we want to build a wormhole with one handle/throat (or tunnel) or two or more, and at what energy cost this will incur. The following is the result of our analysis:

(a) 1-handle/throat (flat torus or spherical wormhole topology) defines $g = 1 \rightarrow \chi_e = 0$, therefore $U \leq 0$

(b) 2-handles/throats defines $g = 2 \rightarrow \chi_e = -2$, therefore $U \leq -1/2$

(c) 3-handles/throats defines $g = 3 \rightarrow \chi_e = -4$, therefore $U \leq -1$, and so on

It is apparent that as the number of wormhole handles/throats increases then the energy required to create the multi-handled/throat wormhole will grow negative-large in value. This is an undesirable demand on whatever technology we would have to devise to mine negative energy. It is clear that condition (a) defines the most desirable engineering outcome we can hope for: design a 1-handle/throat wormhole (like in Figure 1) that will require zero or (relatively) small negative energy to create.

2.4 Wormhole Design Parameters #2 and 3

Now we need to calculate the amount of exotic or negative matter-energy our stargate engineers will have to acquire to create and thread a traversable wormhole. Visser (8) derived the quantity we need

and it is a very simple relation. Table 1 presents a tabulation of the required exotic/negative mass as a function of the size of the wormhole throat. Inspection of Table 1 shows us that to build a wormhole big enough for spacecraft to pass through will require negative masses a hundred or more times the mass of Jupiter. Wormholes of a meter or less in size will require negative masses of a fraction of Jupiter's mass to several times Earth's mass. Caveat: Insofar as it is meaningful to define gravitational field energy in GTR, the energy of the gravitational field may be positive, negative, or zero. In Newtonian theory, positive mass objects typically possess negative gravitational energy. And by extension, negative mass objects possess positive gravitational energy. The net result is that the total net mass, as measured by outside observers far away from the wormhole, may be positive, negative, or zero depending on the details of the arrangement of the negative energy constituting the wormhole system.

After a traversable wormhole is created, it will be important to stabilize it against collapse by threading it with matter-energy fields of stupendous negative (outward) tension. Morris and Thorne derived this simple relation (1). Table 2 shows the tension required to induce and stabilize a range of wormhole throat sizes. By inspecting Table 2, it becomes apparent that the calculated tensions are indeed stupendous. One can see that for wormhole throats smaller than 0.11 *ly* (*ly* = light-year), the required tension will be greater than 5.0×10^{12} N/m^2, which exceeds the tensile strength of steel or tungsten (~ several $\times 10^{11}$ N/m^2). Indeed, for a 1000 meter wormhole throat, the required tension of 5.0×10^{36} N/m^2 has the same magnitude as the pressure at the center of the most massive neutron star.

The mass and tension numbers for creating a wormhole-stargate are ugly. Are they impossible for human technology to reach? No. Is present human technology capable of engineering such enormous negative energies? No, but human ingenuity will find an answer in the future, it always does, history is our guide. An arbitrarily advanced civilization would likely have conquered this technical challenge using a clever approach.

2.5 Designing a Stargate

It is a straightforward exercise to design a real stargate from wormhole physics. A stargate is essentially a wormhole with a flat-face shape for the throat as opposed to the spherical-shaped throat of the Morris and Thorne wormhole. A traveler encountering and going through such a wormhole will feel no tidal gravitational forces and see no matter-energy, exotic or otherwise, that threads the throat. The traveler will simply be shunted into the other remote spacetime region or other universe. We construct such a stargate by generating a thin-shell or surface layer (like a thin film of soap stretched across a loop of wire) of exotic matter-energy possessing a radius of curvature on each side of the surface, and work this through the Einstein equations (8,16). The result is that the surface energy density and surface tensions of the exotic matter-energy are negative as required (Section 2.1), but they are inversely proportional to the surface radii of curvature. But a flat surface layer or thin-shell has infinite radii of curvature by definition. In this case, therefore, the negative surface energy density and tensions become zero and the exotic matter-energy threading the throat cannot be felt or seen by travelers. The wormhole throat or stargate is flat like a doorway.

2.6 Generating Negative Energy

In Section 2.1 it was pointed out that static radial electric or magnetic fields are borderline exotic when threading a wormhole if their tension were infinitesimally larger, for a given energy density. In addition to this, other exotic matter-energy fields are known to be squeezed states of the electromagnetic field (and other squeezed quantum fields), Casimir (electromagnetic zero-point) energy and other quantum fields/states/effects. I originally proposed an experiment to generate a wormhole-inducing magnetic field by nuclear explosion (17,18). However, the nuclear test ban treaty prevents this proposal from being realized. Morris et al. (2) proposed constructing a wormhole by using the Casimir effect. However, their design required two closely spaced (nanometers to angstroms spacing), concentric thin electrically charged hollow spheres the size of the Earth's orbit to be constructed to generate the requisite Casimir energy. The design parameters are incredibly demanding and technically unreachable in the foreseeable future.

During further research into this problem I discovered that utilizing the gravitationally squeezed quantum vacuum states of the electromagnetic field is a more fruitful approach to this problem (19). Breakthrough research by Hochberg and Kephart (20) proved that one can utilize the negative vacuum energy densities, which arise from *distortion of the electromagnetic zero point fluctuations* due to the interaction with a prescribed gravitational background, for providing a violation of the energy conditions. No exotic matter-energy is required here. The authors showed that the squeezed quantum states of quantum optics provide a natural form of matter having negative energy density. "Squeezing" is the control of quantum fluctuations and corresponding uncertainties, whereby one can squeeze the variance of one (physically important) observable provided the uncertainty in the (physically unimportant) conjugate variable is stretched. And since the vacuum is defined to have vanishing energy density, any region having less energy density than the vacuum must have a negative energy density. The analysis, via quantum optics, shows that gravitation itself provides the mechanism for generating the matter (squeezed vacuum states) needed to support stable traversable wormholes. The production of negative energy densities via a squeezed vacuum is a necessary and unavoidable consequence of the interaction or coupling between ordinary matter and gravity, and this defines what is meant by gravitationally squeezed vacuum states.

It was shown (19) that the magnitude of the gravitational squeezing of the vacuum can be estimated from the squeezing condition, which simply says that substantial gravitational squeezing of the vacuum occurs for those quantum electromagnetic field modes with *wavelength* (l *in meters*) > *Schwarzschild radius* (r_S *in meters*) of the mass in question (whose gravitational field is squeezing the vacuum). The Schwarzschild radius is the critical radius, according to GTR, at which a spherically symmetric massive body becomes a black hole, i.e., at which light is unable to escape. We can actually choose any radial distance from the mass in question to perform this analysis, but using the Schwarzschild radius makes equations simpler in form. Table 3 shows when gravitational squeezing becomes important for example masses. We know how to get small amounts of negative energy; we do not know if it is possible to get large amounts of negative energy. This is the subject of an experimental proposal I developed whereby ultrahigh intensity peta- (or eta or zetta) Watt (peta = 10^{15}, exa = 10^{18}, zetta = 10^{21})

lasers can be used to explore gravitational squeezing of the vacuum and modifying the vacuum polarization (discussed in Section 4.0) as a first step towards engineering the vacuum (21,22).

We don't know how to construct a traversable wormhole in the laboratory yet. There are mathematical ideas addressing this, but there are no practical engineering solutions being offered besides my own proposals (16,18,21). We must first solve the technical problem of generating a large amount of negative energy, and then we can build a wormhole. It should be pointed out that spherically symmetric vacuum regions, which are non-traversable Einstein-Rosen bridges, are everywhere in space. As mentioned in Section 1.0, we can tweak the Einstein-Rosen metric and make it completely traversable in principle by injecting a small amount of negative energy into an arbitrary vacuum region. This wormhole metric is experimentally indistinguishable from the ordinary Schwarzschild black hole metric until one gets very close to where one would have expected to find the event horizon, and instead finds a traversable throat.

2.7 What a Wormhole-Stargate Looks Like

The negative energy density threading a wormhole throat generates repulsive gravity, which will then deflect light rays going through and around it. The entrance to the (spherically symmetric) wormhole would look like a sphere that contained the mirror image of a whole other universe or remote region within our universe, incredibly shrunken and distorted. This is an example of the topological inversion manifested in wormhole geometry. See figure 2, for example. The spherical wormhole entrance/exit (a.k.a. the throat) is called a hypersphere because it is the hyperspace surface of our four dimensional spacetime. If you were to travel through the wormhole and look back at it form the other side, then you would see a sphere (the entry way back home) that seemed to contain your whole original universe or your home region of space near Earth (within your universe). This would look just like a glass Christmas tree ornament, which is just a spherical mirror that reflects, in principle, the entire universe around it. A flat-faced stargate (section 2.5), which is also a hypersurface, would not distort the mirror image of the remote space region or other universe seen through it because the negative energy density at the throat is zero as seen and felt by light and matter passing through it. Starlight from distant sources surrounding the wormhole or stargate is deflected into a rainbow-like caustic of enhanced light intensity that surrounds the immediate vicinity of the throat (23). If a small wormhole-stargate (3-D or higher-dimensional) were to begin to appear or bump into our local space we would perceive this process as the occurrence of an unusually bright spot in the sky. Blue and red Doppler shifting of this bright spot would manifest when the intersection of the multidimensional wormhole with our local space grows or recedes, respectively.

Wormholes can also trifurcate or merge together under certain conditions with resulting optical manifestations encompassing the properties mentioned above but with additional complex features. Higher dimensional wormholes or hyperspace tunnels will not be considered here, however, an excellent treatment is provided in references 24 and 25. The salient features of these objects are similar to the 3-dimensional wormholes considered here.

3.0 UFO Phenomenology

Paul Hill has already delineated and characterized UFO performances and dynamics in his excellent book (26). From a rigorous aeronautical and physics analysis of many cases (the unexplainable, non-prosaic ones), Hill concluded that UFOs are craft that would have to utilize an engineered "acceleration-field" technology in order to manifest their various performance characteristics. "Acceleration-field" is the old fashioned term for spacetime metric. Wormhole-stargates and the Alcubierre warp drive metric (27) are examples of modern spacetime metric engineering concepts, both of which require engineering of the vacuum to mine the negative energies needed to generate such metric modifications.

Jacques Vallee has also analyzed UFO cases over four decades and summarized his findings in several excellent, groundbreaking books and articles (28,29,30,31 - the key references). Vallee concluded that UFO phenomenon is consistent with a technology centered on a craft using a very revolutionary propulsion system, which possesses an anti-physical dimension in addition to others. The phenomenon is the product of a technology in the sense that it is a real, physical, material object. The physical characteristics of UFOs is as follows (adapted from 28,29,32 and the NIDS database):

- witnesses describe an object that occupies a position in space*
- moves as time passes*
- interacts with the environment through thermal effects as well as light absorption and emission*
- produces turbulence*
- when landed, leaves indentations and burns from which approximate mass/energy figures can be derived*
- gives rise to photographic images*
- gives rise to electric, magnetic and gravitational disturbances*

But UFOs also manifest anti-physical effects by using advanced physical principles. These anti-physical effects are as follows (adapted from 28,29 and the NIDS database):

- sinking into the ground*
- shrink in size, grow larger, or change shape*
- becoming fuzzy and transparent on the spot*
- divide into two or more craft, several of them merge into one object at slow speed*
- disappearing at one point and appearing elsewhere instantaneously*
- remaining observable visually while not detected by radar*
- missing time/time dilation*
- topological inversion/space dilation (UFO was estimated to be of small exterior size/volume, but witness(s) saw a huge interior many times the exterior size)*
- balls of colored, intensely bright light under intelligent control*
- Doppler blueshifting and redshifting effects of moving and motionless UFOs*

The physiological reactions caused by UFOs are (adapted from 28,29,32 and the NIDS database):

- burns**
- sounds (beeping, buzzing, humming, sharp/piercing whistling, swooshing/air rushing, loud/deafening roaring, sound of a storm, etc.)**

- vibrations*
- partial paralysis**
- extreme heat or cold sensation*
- odors (powerful, sweet or strange fragrance, rotten eggs, sulphurous, pungent, stinking, musky-like, etc.)**
- metallic taste**
- pricklings**
- temporary blindness when exposed to the objects' light*
- nausea**
- bloody nose and/or ears; severe headache**
- difficulty in breathing**
- loss of volition**
- drowsiness in the days following a close encounter**

There are psychic effects triggered by UFOs either purposely or as a side effect of the presence of the UFO. These are (adapted from 28,29 and the NIDS database):

- impressions of communication w/o direct sensory channel†
- levitation of the witness or of objects and animals in the vicinity*
- poltergeist phenomena: motions and sounds w/o a specific cause, outside of the observed presence of a UFO†
- maneuvers of a UFO appearing to anticipate the witness' thoughts†
- premonitory dreams or visions†
- personality changes promoting unusual abilities in the witness†
- healing†

Wormhole-stargate characteristics can fulfill Hill's and Vallee's criteria for UFO phenomenon in both the physical and anti-physical sense. The items marked with single asterisks are explainable as manifestations of a wormhole opening up and intersecting our local space, the negative energy used to generate the wormhole, and/or of effects from the scout craft/probes that came through the wormhole. Items marked with double asterisks are explainable as reactions triggered by the scout craft/probes that come through the wormhole. Items marked with a dagger can only be explained as consciousness-related effects that are triggered on purpose or as a side effect of the presence of the intelligence controlling the wormhole and scout craft/probes. This goes to the heart of the incommensurability or cognitive mismatch problem that exists between the human race and the intelligence responsible for UFO phenomenon (34).

Wormhole and other UFO-related manifestations can be instrumented in the field with a sensor array system to measure and record their physical effects. Stride (35) developed a proposal for a passive autonomous data acquisition platform using COTS hardware to collect sensor data on phenomenon. NIDS deploys a subset of such portable sensor devices in the field. Germane to the wormhole issue are sensors that measure acceleration/gravimetric effects, electric and magnetic effects (AC/DC), spectroradiometry, temperature/pressure changes, optical and acoustic radiometry, radio/microwave, visible/IR/UV imaging, and so on. Miniaturization of electronic sensor instruments has allowed such devices to become very

small, lightweight, portable and easily integrated into reasonably sized packages for field deployment. These items are detailed in (35) and elsewhere in the technical literature.

A wormhole-stargate has never been constructed in the laboratory, so a full accounting of its physical effects is not yet known beyond what is obvious from recent theory. This also applies to the generation of large amounts of negative energy, which will likely, if it is possible, to have a technology with byproduct effects that are not determinable at this time. Laboratory experiments on the vacuum using ultrahigh intensity lasers will be necessary to ascertain these issues.

3.1 Example Cases from the NIDS Database

UFO witness descriptions are the database presently available for examining the wormhole hypothesis along with the meager physical data acquired by surveillance equipment (see for example, references 36-39). And we recognize that witness reports are not rigorous from the standpoint of collecting physics data. Of the more than 650 cases investigated by NIDS, several dozen clearly portend wormhole manifestations. Particular examples include field research NIDS conducted in northeastern Utah whereby the following example data was acquired:

- intensely bright, colored balls of light under intelligent control; either monochromatic or changing color; possessing either smooth or variable liquid turbulence-like surface/internal texture; maneuvering/hovering near people and around property; brightening or fading and blue/red Doppler shifting when appearing or disappearing
- very large, very bright orange-colored opening in the daytime sky; a completely different or foreign looking sky was seen through the opening; an object was seen (through rifle spotting scope) moving through the opening at rapid speed
- faint light appears in the air a few feet above a dirt road; light grows in intensity becoming very bright; bright light then becomes a hole that opens up (growing from 1 to 3 feet diameter) and from within which another light is emanating; a large, black creature (~ 400 lbs., 8 to 9 feet tall) is seen crawling out of the hole (as seen through 3rd generation military night vision, hole appeared 3-dimensional with tunnel-like interior), it stood up and ran away into the surrounding dark of night; the brightly lit hole closed and faded away

4.0 Alternative Theories of Gravity

Before closing it is necessary to discuss an important issue concerning recent alternative theories of gravity that could have ramifications on the physics of wormholes and their application to the UFO problem. It is important to consider alternative theories of gravity since it is well known within the relativity community (but not without great controversy) that GTR is mathematically over-determined, is in physical and mathematical error by neglecting gravitational self-energy in the Einstein equation while conservation laws and energy are not well defined, and suffers from experimental verification problems for a key PPN (parameterized post-Newtonian) parameter, not to mention that GTR/Newtonian gravity has not been experimentally verified below fractional centimeter distance scales while the universal gravitational constant continues to elude high precision experimental measurement (40,41 and references cited therein, for example). Einstein's GTR is not flat-out wrong, but it just needs some repair. An

important recent development by Puthoff (42-45) indicates that a parallel treatment of wormholes is possible within the context of his alternative gravity model, which is now being explored by us (46).

Puthoff's approach, known as the polarizable-vacuum (PV) representation of general relativity, treats the vacuum as a polarizable medium (42). The PV approach treats spacetime metric changes in terms of equivalent changes in the permittivity and permeability constants of the vacuum, ε_o and μ_o, essentially along the lines of the "TH$\varepsilon\mu$" methodology used in comparative studies of gravitational theories (see references cited in 42). Such an approach, relying as it does on parameters familiar to engineers, can be considered a "metric engineering" approach. Maxwell's equations in curved space are treated in the isomorphism of a polarizable medium of variable refractive index in flat space (see references cited in 42); the bending of a light ray near a massive body is modeled as due to an induced spatial variation in the refractive index of the vacuum near the body; the reduction in the velocity of light in a gravitational potential is represented by an effective increase in the refractive index of the vacuum, and so forth. As elaborated in reference 42 and the references therein, PV modeling can be carried out in a self-consistent way so as to reproduce to appropriate order both the equations of GTR, and the match to the classical experimental (PPN parameters and other) tests of those equations. There is agreement between Puthoff's PV model and Yilmaz's approach in theoretical and experimental predictions for cases of interest in GTR and propulsion.

Specifically, the PV approach treats such measures as the speed of light, the length of rulers (atomic bond lengths), the frequency of clocks, particle masses, and so forth, in terms of a variable vacuum dielectric constant K in which vacuum permittivity ε_o transforms to $\varepsilon_o \rightarrow K\varepsilon_o$, vacuum permeability to $\mu_o \rightarrow K\mu_o$. In a planetary or solar gravitational potential $K > 1$ while $K = 1$ in "empty" remote space. In the former case, the speed of light is reduced, light emitted from an atom is redshifted as compared with a remote static atom ($K = 1$), clocks run slower, objects/rulers shrink, etc.

The interesting feature of both the PV model and Yilmaz's approach is they both predict that the endpoint of (large-mass) stellar collapse is not a black hole, but is instead a "gray hole" possessing neither an event horizon nor a singularity. Such a body would simply be an extremely collapsed state of matter. Recent astronomical observations have reported that neutron stars more massive than the lower limit collapse mass for black holes have been discovered, which severely contradicts the strict mass constraints placed on neutron star formation by Einstein's GTR (46). And it still has not been experimentally possible to positively confirm black hole candidates on the basis of predicted strong gravitational field effects occurring outside their alleged event horizons. No astronomy experiment has positively observed and measured a black hole's event horizon. And it is impossible to experimentally confirm the existence of black hole singularities given the inaccessibility of the black hole's interior to observation and measurement as predicted by Einstein's GTR. Einstein's GTR is not a flat-out failure, it is just in need of some repair.

Under certain conditions the spacetime metric can in principle be modified to reduce the value of K to below unity thus allowing for faster-than-light (FTL) motion to be physically realized. In this case, the local speed of light (as measured by remote static observers) is increased, light emitted from an atom is blueshifted as compared with a remote static atom, objects/rulers expand, clocks run faster, etc. In fact, Puthoff has analyzed certain special black hole metrics and found $K < 1$ from his model. We are both

examining whether the traversable wormhole metric will also lead to $K < 1$ within the PV model (46). In fact, we have reason to believe that there will be such a solution on the basis that traversable wormhole metrics are an exact metric solution to Einstein's GTR such that they do not possess physically/mathematically pathological features such as an event horizon or singularity. This has been supported by exact high-order nonlinear quantum electrodynamic analysis of the vacuum cavity within a Casimir-effect capacitor experiment showing that the speed of light will in fact increase, as the Casimir-effect energy grows more negative within the cavity (47). This is what we would expect when a traversable wormhole effect manifests itself within a region of squeezed vacuum (recall section 2.6). We are also exploring the application of the PV model to the Alcubierre warp metric, and expect $K < 1$ in this case since it is physically similar to traversable wormhole physics. However, we cannot predict at this time what potential alteration to wormhole and/or warp drive physics either the Yilmaz approach or the PV model will require.

Finally, Puthoff's PV model is the only alternative theory of gravity that has been successfully applied to explain the physical, anti-physical and physiological characteristics and performances of UFOs as described in section 3.2 (48). Puthoff showed that when the data from section 3.2 and reference 26 are taken together, these characteristics and performances can be reproduced by craft exploiting a technology that modifies the local spacetime metric by varying K ($K < 1$ or $K \geq 1$) as needed to generate the desired (propulsion and dynamic maneuvers and related) effects. It is possible that the PV model can provide either or both traversable wormhole and warp drive like manifestations within the context of UFO phenomenon.

5.0 Conclusion

In this paper I summarized the salient physical characteristics of traversable wormhole-stargates, and discussed the engineering parameters required to create them. I also described how one can construct a flat-faced or doorway like wormhole that represents a true stargate, and I delineated the physical and visual characteristics such wormholes would manifest when they are remotely observed or experienced by travelers going through them. The key performances and characteristics of UFOs, as delineated by decades of field research and measurements, was described and compared to the manifestations of traversable wormholes. It was then shown how traversable wormhole-stargates provide a natural explanation for UFO phenomenon. Additional field research and instrumented data acquisition during UFO close encounters will need to continue in order to further test this hypothesis. Experiments are being arranged in order to explore and develop negative energy generation and subsequently creating a traversable wormhole in the lab in order to bring experimental wormhole physics to fruition. This will be necessary to answer the many questions about wormholes that I have not addressed here as well as addressing issues relevant to UFO manifestations.

An alternative theory of gravity, the polarizable-vacuum model of general relativity, was described showing that it provides a theoretical framework supporting FTL motion. Recent studies have shown that this framework provides a potential description of traversable wormhole and/or Alcubierre warp drive FTL physics. Last, the PV model has been shown to parallel the traversable wormhole hypothesis by being able to provide a natural explanation for UFO manifestations.

In conclusion, the UFO phenomenon is rich with complexity possessing a variety of spectacular characteristics and performances. It is recognized, however, that most of these features go beyond what is accepted by both the mainstream science and UFO communities as fitting within a rational framework. Synthesis will only occur when both communities apply the scientific method to the UFO problem utilizing forensic investigative methods while engaging cutting-edge engineering-physics developments. This best describes the practice of NIDS in the conduct of its institutional mission. It has been left up to the very few of us to rise up to the challenges presented by the UFO problem and understand its phenomenology.

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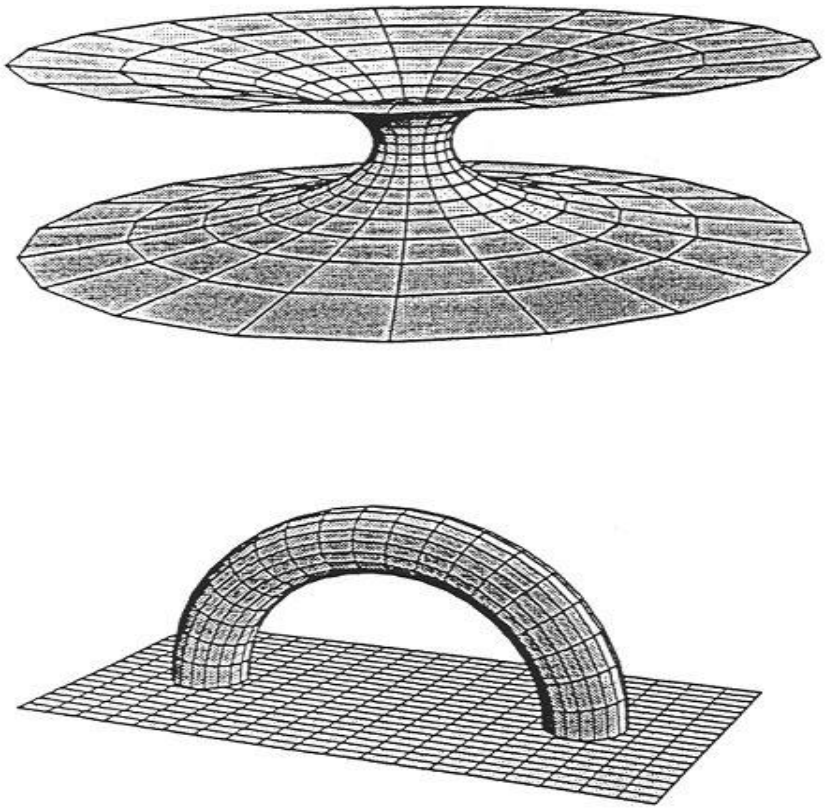

Figure 1 The top figure is an embedded space representation ($\theta=\pi/2$, time=constant) of a Morris & Thorne traversable Inter-Universe wormhole. The top flared-out "mouth" is in our universe while the bottom "mouth" is in another universe. The wormhole throat-tunnel connects the two universes. The bottom figure is an Intra-Universe wormhole with the throat-tunnel connecting two remote regions within the same universe. This diagram from reference 33 serves to aide in visualizing wormhole geometry, and is merely a geometrical exaggeration.

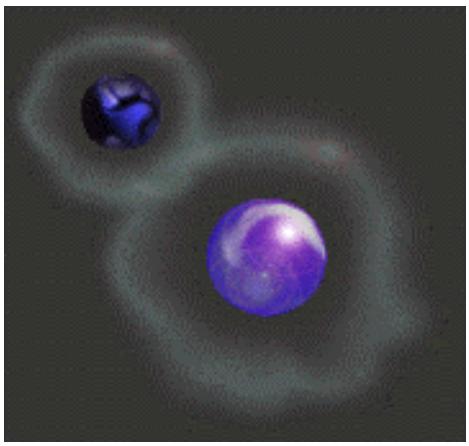

Figure 2. A view of two (spherically symmetric) Inter-Universe or Intra-Universe wormhole-stargate "mouths". The white rings are exaggerated starlight caustics around the mouths.

Table 1. Negative Mass Required to Create Wormhole of Given Size

Wormhole throat radius, r_{throat} (meters)	Required mass, M_{wh}
1000	-709.9 M_J
100	-71 M_J
10	-7.1 M_J
1	-0.71 M_J
0.1	-22.6 M_E
.01	-2.3 M_E

$M_J = 1.90 \times 10^{27}$ kg, mass of planet Jupiter
$M_E = 5.976 \times 10^{24}$ kg, mass of planet Earth

Table 2. Wormhole Throat Size Induced by Applied Outward Tension

Wormhole throat radius, r_{throat}	Tension, τ (x 5.0 N/m^2)
10^{18} (105.7 *ly*)	10^{6}
10^{16} (1.06 *ly*)	10^{10}
10^{15} (0.11 *ly*)	10^{12}
10^{13} (66.7 *AU*)	10^{16}
10^{11} (0.67 *AU*)	10^{20}
10^{9} (1.44 *Solar Radii*)	10^{24}
10^{6} (0.16 *Earth Radii*)	10^{30}
10^{3} meters	10^{36}
1 meter	10^{42}

ly = light-year = 9.460×10^{15} meters
AU = Astronomical Unit = 1.496×10^{11} meters
1-Solar Radius = 6.960×10^{8} meters
1-Earth Radius = 6.380×10^{6} meters

Table 3. Substantial gravitational squeezing occurs when $\lambda \geq 8\pi r_S$ (for electromagnetic ZPF)

Mass of body	Schwarzschild radius of body, r_S	ZPF mode wavelength, λ
Sun = 2.0×10^{30} kg	2.95 km	$\geq$ 78 km
Jupiter = 1.9×10^{27} kg	2.82 m	$\geq$ 75 m
Earth = 5.976×10^{24} kg	8.87×10^{-3} m	$\geq$ 0.23 m
Starship ~ 10^{8} kg	1.48×10^{-19} m	$\geq 3.9 \times 10^{-18}$ m
Human ~ 68 kg (average)	1.01×10^{-25} m	$\geq 2.7 \times 10^{-24}$ m
Proton = 1.673×10^{-27} kg	2.48×10^{-54} m	$\geq 6.5 \times 10^{-53}$ m