The New Information Channel
Or
MMX Null Voided in Vacuum

The 'It from Bit' conjecture of John Archibald Wheeler (JAW) infers that binary information is fundamental to physics - that the immaterial essence of all things physical can be encoded and digitally processed. In this essay we extend this concept to the implementation of a full cycle for testing – from reality to cyber space and back - It To Bit and Bit To It(ITB:BTI). One projection of ITB:BTI is digital physics - the universe is naught but a vast, digital computation device which processes symbolic information content.

JAW uses 'immaterial' as a bit qualifier; it's a loaded term – how does physics deal with essences that are incorporeal and metaphysical, without substance or form, according to the dictionary? The reason the binary content cannot be material is clear.... if so, it would need its own encoding to symbolically represent reality.

In 1998 JAW imagined that information sits at the core of physics, just as it sits at the core of a computer. To flesh out this conjecture we further imagine that, in principle, a universal automaton or network of processors would execute a symbolic program to simulate the evolution of the universe via physical laws. The current state of reality would be coded and then processed in cyberspace to predict the future state of the universe. The program would implement the laws of physics in software and produce a coded output that would be decoded to represent the next universal state.

Realization of JAW's conjecture would enable running models of reality to potentially discover new laws and mechanisms in nature, fulfill a traditional goal of physics.

Immediately there are issues.... What about the completeness of the physical representation? A Theory Of Everything has been bandied about after every new advance in physics but no TOE now exists. Einstein's later years were devoted to a Grand Unified Theory of gravity and electromagnetism, but we are still GUT-less. String theory does address the ITB issue via the symbolism of reality by elementary vibrating strings ...but the theory has yet to satisfy the scientific method's demand for real-world testing. There are yet a lot of loose strings...

Information is never disembodied, it always resides in objects which implement information as intelligence, expressed symbolically (This concept of matter and [form|meaning|content] always being unified in physical objects – hylomorphism - was known as far back as Aristotle). The coded representation of physical laws that JAW envisioned would be processed by a program that implements the laws.

 Completeness would require that the computer on which the simulation runs itself be included in its own program, as part of the universe. But the program must reside on a material substrate that itself must be encoded ... in meta-code. Said meta-code must be encoded on more material, requiring meta-meta code, etc. Does the recursion terminate?

 Meta-coding for this computer could be run on a more powerful system and resolve cyberspace incompleteness.... if such a higher level system exists. The issue is similar to Turing's halting problem - and probably has the same solution.

This focus on completeness does not exclude the possibility that JAW's musing can be successfully realized in isolated pockets of space and time.... assuming that isolation of cosmic subsystems is possible. But how would such a limited version of JAW's hypothesis differ from current software simulators of physical law... like the ephemeris generators? And what if there is a ubiquitous primal substance that allows interaction and communication throughout the cosmos?   More of this anon.

We know the laws of physics are insufficient to include predicting the motion of life-forms, so biology reduces the scope of JAW's scheme to governing inanimate objects.

We cannot even account for the properties of life forms in material terms, the material difference between a living being and its dead corpus. If life has a material cause, then what matter leaves the body to cause death? Or is death a material addition to the life form?

JAW prudently sidesteps the faithful digital representation of life-forms, which cannot be modeled in physics, for no one can explain with physical laws the difference between the immaterial operations of the mind and the biochemical-neurological operations of the brain. Physics is a player on the material and energy exchange level, but is a mere spectator in the world of animate objects.

The current strategies model real-world phenomena with a set of mathematical formulas. How do these differ from JAW's grand scheme?

Software simulations allow a user to program an operation in software without actually performing that operation. Applications usually consist of games or real-time training systems that imitate real-world cause and effect relationships.
Advanced simulators have been used in areas that overlap with physical laws, like weather forecasting in meteorology, electronic circuit analysis and atomic and nuclear reactions and even biological processes. All simulations of natural phenomena have the same problem: identifying all the relevant causes and modeling them correctly. Using only the most important factors is acceptable for software simulations, but not for JAW's grandiose automaton of physical law.

Is it possible for the scope to be prediction of the evolution of the universe? What questions have to be asked by the programmer for the model of a particular physical law? Whatever they are, they must require a binary response..... but what if the number is infinite, or unknown? In brief, what is the guarantee of completeness?   Or the source of the encoder's and decoder's intelligence?
A collection of bits is not information ... unless the code has meaning to encoder and decoder. Are the bits like the shadows on the walls of Plato's cave, an incomplete representations of the reality outside?

Before examining information systems a common ground for communication must be established. We establish two self-evident metaphysical principles founded on the philosophical school of realism:
First, the principle of causality, that every effect has at least one cause.
It's difficult to see how any scientist can deny this axiom,   if prediction of future natural events is the goal of science. Yet such is sometimes the case.

Those who claim no self-evident first principles are needed, that no metaphysics is needed for physics, should consider that
- This statement itself is a presupposition – a metaphysics
- Gödel's theorem[w]

Second is the principle of consistency or non-contradiction.   If contradictions are accepted, then any statement can be proven true or false, making the acquisition of knowledge impossible.
In any logical system there is no contradiction that can be ignored or eliminated by an abundance of true statements, or a multitude of supporting experiments. A contradiction is truly worse than just being wrong....
For example, if the axiom '1=2' is added to the self-consistent system of arithmetic, the use of the other axioms leads to a proof that x =y, for any x,y. The contradiction spreads, like a bad apple in a barrel of good apples. Then the scientific method brings physics to the metaphysics rules, with criteria of testability and consistency – in both internal logic and external testing.

Hopefully all readers accept these basic principles of realism, that an objective reality exists outside the mind. Subjective idealism will lead to no common ground. Any rejection of causality denies repeatability and predictability; there would be no 'laws' of science. And rejection of consistency can only lead to chaos. Karl Popper believed that anything can be proven true or false in an inconsistent system.... it was worse than just being wrong.

Examination of JAW's thesis requires putting the question in context.... the processing of intelligence in a digital information system. Drawing from my experience the following definition will be advanced:
An agent (encoder) provides useful knowledge/intelligence in symbolic language or patterns (code) to a receiver (decoder) via an Information Exchange Medium (IEM). In this way a code of meaningful content is transferred to an intelligence that finds it useful, via a sequence of physical and symbolic transformations (like the OSI model).

What follows now are common examples of the information system envisioned above.

First scenario: the current information exchange. This, and other examples, are summarized in Table 1.
1. I, the author/encoder, created code for this essay in text form which was converted to binary code and placed on a WWW server. At the request of the reader/decoder (you) the code was transported to your computer and translated from binary to ASCII/HTML and displayed on your screen. This last link includes the electromagnetic radiation – light - that passes from screen to eye, to be further processed by the wonders of the biological neuro-optical system. All the links that connect together the components of the system will be called the Information Exchange Medium (IEM) . Note the conversion of information from one symbolic form to another and that information systems require intelligent agents to send and receive/encode and decode information.

Encoder-Code–Decoder... all are worthy subjects of investigation as components of information systems, but 9 books are not enough to cover them, much less 9 pages. For example, in the few years since the JAW proposal, technology has advanced the ITB conversion from software symbols to objects in the real world with a modest first step, 3D printing. A three-

dimensional solid object of virtually any shape is produced from a digital model by adding a sequence of material layers having different shapes, a first step in a full-blown BTI.

The spotlight of this essay will be turned onto what appears to be insignificant to the over-all system – the IEM – Information Exchange Medium, with surprising conclusions. The immaterial electromagnetic waves propagate in either metal wires or are broadcast into space as microwave radiation.

Info process	Encoder	Code	Decoder	IEM
1.WWWeb	Author	ASCII/HTML	Reader	EM waves - in space or material
2.Language written – oral –	Hand Mouth	Words in text Words in speech	Eye Ear	Light Air
3.Cell growth	Nature	DNA genetic	Ribosome	RNA, Cytoplasm
4.Laws of physics	Object IDs, State of motion	Laws of Maxwell and Newton	Predicted motions	Fields of EM /gravity/inertia

Table 1 – Examples of Information Systems

2. Human language enables transfer of information between persons. In written communication the writer encodes information into basic units and assembles these words to express single thoughts in a visible form(on paper or display screen). The reader receives the coded information by scanning the light pattern on paper or screen and mentally converts this into information.
Oral communication differs by using speech to encode the speaker's information into sound units (phonemes and words) that are transmitted through air waves to the ear of the listener, where the words are decoded. Using intermediate conversion of the sound to electromagnetic waves by an audio system's microphone and return to sound waves via a speaker system allows long-distance transmission of sound. Light and air are the information exchange media, respectively.

3. In biology the primary information system is the cell, where instructions for growth and reproduction are coded in DNA. In brief....the code is copied onto messenger RNA, then transported to the decoding ribosome via the surrounding cytoplasm. The decoded information is used to build proteins... But what is the model for the cell – or the brain - after death?

4. Laws of physics – implementing the JAW conjecture:
The laws of physics will be taken as the mechanics of Newton and the electromagnetic theory of Maxwell. The first step is encoding the starting conditions of the objects with extrinsic parameters of location (x,y,z) and motion (Vx,Vy,Vz) and intrinsic constants (mass, charge, spin...). Then apply the laws of motion for electromagnetism and mechanics to the binary representation of the encoded physical objects, to produce as output the predicted extrinsic and intrinsic changes (mass can be created or annihilated). With feedback from the output, predictions of trajectories can be projected into the future.

Encoding the laws of motion is itself a difficult problem: How can Action At A Distance (AAAD) be reconciled with causality? AAAD or non-locality is the direct interaction of two objects that are separated in space with no intermediate agency or mechanism. When applied to

quantum theory Einstein referred to this as "spooky action at a distance". More fundamentally than 'spooky', this concept of unexplained remote interactions is a violation of our principle of causality. Tests have shown that entangled particles must either violate the principle of locality/causality or communicate via an information medium over cosmic distances at superluminal speeds. Again and again they verify that entanglement occurs even when the measurements are faster than light could travel between the test sites. No information at less than c can communicate that can pass between entangled objects; this transfer is at least 10,000 times faster than c. Aether represents a possible classical (i.e., a non-quantum) primitive mechanism explaining why this type of correlation occurs faster that light can travel.

Take gravity, for example. Newton's theory of gravity did not identify any mediator of interaction in his theory of gravity. His theory assumes that gravitation acts instantaneously, independent of distance. But he clearly saw the logical problem if a medium for gravity was ignored.

> "It is inconceivable that inanimate Matter should, without Mediation of something else, which is not material, operate upon, and affect other matter without mutual Contact.. "
> —Isaac Newton, *Letters to Bentley, 1692*

Rather than violate causality Newton held to a gravitational aether that was immaterial, as did JAW.

Another stumbling block is modeling the laws of motion in an arbitrary reference frame, as relativity permits, when the laws are found to be invalid in certain reference frames. An example is the following classic anomaly.

Newton's Bucket[w] was published about 325 years ago, but still consists of two unresolved conflicts with standard physics beliefs,

1- Ernst Mach maintained the vortex formed due to rotation relative to the rest of the universe, by action-at-a-distance from near and distant matter, informing the water about the state of the universe. (Note: Mach's principle[w] is usually cited as being rotation relative to the far stars, but his statement includes everything that was not the bucket... including the Earth.)

   What Mach left unspecified is the mechanism for implementing relative rotation. For the bucket's water to sense the configuration of the universe requires – by causality- immediate communication between all objects via an information-bearing substrate... an information ether. Yet then rotational information would travel at speeds far beyond c in this medium – which causality demands.

2- The laws of physics are not the same in the bucket proper frame as in the Earth's lab frame. When the water and bucket are co-rotating in the lab frame, then centrifugal force explains the vortex formation. But the water is at rest in the bucket's proper frame, yet a vortex forms, without any rotation and so without a centrifugal force. This law of physics,

$$Fc = mv^2/r, \qquad (1)$$

   is valid in the lab frame, but invalid in the bucket frame.

   This violates the law of general covariance[w], that the laws of motion should be the same in all reference frames (form invariance). For the JAW's 'it to bit' to operate in cyberspace, the rotational laws of physics can only be applied in the lab frame.... and in any other reference frame in which the laws of physics (like centrifugal force) are valid.

The main topic here is the IEM – the communication link for information processing.

A candidate for the IEM of both gravity and electromagnetism is the aether[w] (or perhaps two separate aethers) which is the carrier of electromagnetism and gravity fields and waves. Its reality was almost universally believed prior to the 20th century, but aether is no longer an area of active research in physics; in fact, it has the status of being anathema in modern circles where its non-existence is considered well-established.

A brief review of aether history is justified.

In the 1800s the world of physics accepted the reality of aether, supported by Fresnel's aether drag[w] hypothesis, that refractive matter in motion would partially entrain some of the aether along with it. Previously Arago had tried to detect light refraction by a glass prism in the path of a telescope[i]. Different stellar velocities and terrestrial motion during the year were expected to cause angular variations but Arago found none – a true null result.

Fresnel proposed that the speed of light V was composed of a static term determined by the aether density $1/n$, and a kinematic term proportional to v, the speed of the medium through the aether, modified by the drag factor $1-1/n^2$.

$$V = \frac{c}{n} + v\left(1 - \frac{1}{n^2}\right)$$

(2)

Fresnel's formula accounted for Arago's null result, as being partial drag of aether by the prism as it participated in the Earth's motion. The partial drag theory was later supported again by Fizeau[w], using a light beam in a water flume. This success led to aether acceptance by most physicists of that time, including Faraday and Maxwell. In fact Maxwell suggested that the Earth's orbital motion of 30 km/s through aether could be detected by interferometers sensitive to second order effects of $O(v^2/c^2)$. This led to the famous Michelson-Morley experiment[w] (MMX) which challenged the aether theory by its negative 'null' result.

By analogy with a boat crossing a river or going up or down-stream , the orthogonal half beams in the MMX were expected to return at different times, causing a phase shift of the superposed signals and interference fringes corresponding to an orbital speed of 30 km/s.

The actual MMX testing over 6 weeks resulted in speeds about 15% of predictions and the result was termed 'null', not meaning zero, but much less than expected. The actual results shown in Fig 1 were considered error variations for a true zero result.

Einstein's SR attempted to resolve the impasse of not detecting Earth's orbital motion through aether by postulating that light speed was always a constant, c[w]. This made the aether concept irrelevant to determining light speed, and also made c the upper limit for the speed of information transfer.

Further tests of the MMX were performed intending to improve accuracy by removing the air from the optical path. This would, it was thought, remove sound and thermal waves as error sources. Later interferometer testing in vacuum showed light speed was c to 7 significant digits, the precision increasing as the vacuum pressure dropped. All vacuum MMX results and straight-forward tests of light speed indicated that light speed isotropy increased with improvements in the vacuum level, leading to rejection of a mobile electromagnetic aether and acceptance of the

relativity paradigm. Mainly on the basis of the MMX 'null' result aether was ignored as a research topic during the 20th century and beyond. For the rest of the 20th century, aether research was virtually non-existent. The MMX was obviously a crucial test in rejecting aether and accepting relativity.
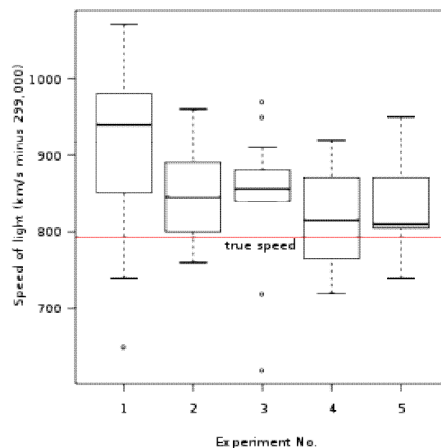

Fig 1   MMX speeds for 5 datasets. The red line is c.[ii]

But troubling issues remained...

1. The MMX test runs were all greater than c, suggesting the presence of a systematic error.

2. The MMX testing was too short ... 25 years of testing by Dayton Miller indicated both daily and annual periodic changes in light speed.

3. The M&M theory used a static rigid aether as the absolute frame of reference in which the Earth moved.... despite knowledge from the Fizeau and Airy[w] tests that aether was flexible.

4. Allais[iii] and Cahill[iv] revisited the MMX and the Miller data, concluding there was a non-null variation in speed and direction, roughly corresponding to the modern Cosmic Microwave Background dipole data.

5. There has been no attempt to test MMX with various dielectric media, to determine any dependence of light speed V on the index of refraction n.

Then, in a barely-noticed set of tests about 40 years ago, the Russian physicist Demjanov performed a series of MXX tests[v] using various transparent dielectrics as media, tests that were surprising in 2 ways:

1- That it took over 80 years to study and determine the effect of medium choice on the MMX result

2-   That the fringe detection had decreasing sensitivity to aether motion as the vacuum increased (n ➜ 1)

Demjanov repeated the MM derivation, by replacing the constant c with Fresnel's formula for light speed in aether and successfully predicted the two zeros found in the experiment (see tech notes). Both the amplitude of the interference pattern and the phase difference in the two half-beams approached zero as the medium approached a true vacuum (n = 1). This was not really surprising, even predictable before its empirical confirmation, because the Fresnel formula

(Eq.1) predicted that $V = c$ when $n=1$, independent of the aether speed v. Contrary to the post MMX error analysis,

Use of a vacuum MMX did not enhance...but eliminated ... the detection of relative aether motion!

In effect, the experimental protocol that called for eliminating matter from the optical path in the interferometer was equivalent to the adage, "throwing the baby out with the bath water". By eliminating any interaction between the light beam and physical media, detection of the aether wind was also eliminated, as Fresnel's equation demonstrated.

A measured light speed of zero implies that
- Aether speed is zero, or
- The drag factor is zero, when the medium is a vacuum ($n =1.000...$), or
- Both

In modern physics the aether as a real substance with the possibility of motion plays no role anymore. Issues concerning aether entrainment are not considered meaningful anymore by the scientific community.

The Demjanov experiment now supports revival for the belief of the great physicists of the 19th century in a mobile aether and a call to all physicists to re-examine prior tests and theories with an aethereal point of view, especially those with superluminal implications.

There were other tests of light speed anisotropy that have supported the existence and motion of entrained aether. Both Sagnac(1913)[vi] and Wang(2005)[vii] have found that the speed of light **V** near rotating or translating objects becomes

$$\mathbf{V} = \mathbf{c} +\text{-} \mathbf{v} \qquad\qquad (3)$$

Sagnac interpreted **v** as the aether being dragged by the object's motion.

All of the AAAD mysteries that challenged information transfer can be visited again with this key breakthrough, puzzles like the connection of rotating objects with the distant stars in Mach's Principle, frame-dragging, galactic rotation in conflict with gravity...

Quantum enigmas like the communication of state information by quantum -mechanically entangled particles over arbitrary distances as supported by Bell's inequalities, the validity of Bohm's pilot wave theory[w] considered as aether waves, and the Einstein-Podolsky-Rosen paradox[w] which does not violate causality if the Heisenberg Uncertainty principle[w] is violated.

How does a QED particle pretest all possible paths before selecting the one that has the least action?

Are the following in truth just euphemisms for aether: zero-point energy, quantum foam, dark matter, dark energy, physical vacuum, ground state energy, virtual particle energy? .... space-time curvature!?

Summary:

Wheeler's extended idea was ideal simulation of physical processes: real objects can be encoded as its-to-bits and then programmed to run experiments via software and produce a digital result that is decoded into a physical object as bits-to-its..)

If information is fundamental, then aether must surely be involved, as the prime matter of reality.

The 'it to bit' answer to superluminal information transfer may be the 'itsy bitsy' aether, *de facto.*

What information separates life forms from inanimate objects is out of scope for physics.
As the fundamental ubiquitous substance in the cosmos, aether is also the basic carrier of information in the universe.

A universal generator of all future events based on current reality and coded in software is not possible.

Information can never be exchanged when abstract; only when it's instantiated in matter, when matter is encoded with symbols that have meaning to the decoder.

The laws of physics are only valid in certain reference frames. Why?

The correlation of two modern anisotropies - the light speed results of non-vacuum MMX with the CMB dipole (Cahill) - bespeak of a common aethereal cause.

Aether has been around since the Big Bang burst. Its reincarnation as a hyperspeed information channel in modern physics may solve old physical anomalies and inconsistencies, while opening up a path to new horizons of discovery. Now that the MMX chains are unleashed, let the research begin!

Tech notes

 "In 1968-1975 years I proved experimentally that about 100 years sought for shift of interference fringe when turning interferometer really exists, confidently detecting the absolute motion of the Earth relative to aether at a speed of several hundred km/sec." *Demjanov*

Around 1970 Demjanov experimented with various media in the optical path of the MMX for eight years. His empirical results are summarized in Fig.2, which displays MM testing with transparent dielectric gases, liquids and solids. The spread in the interference pattern, *Xm*, vs. a function of the refractive index n, $\Delta\varepsilon = n^2 - 1$, are both plotted logarithmically.
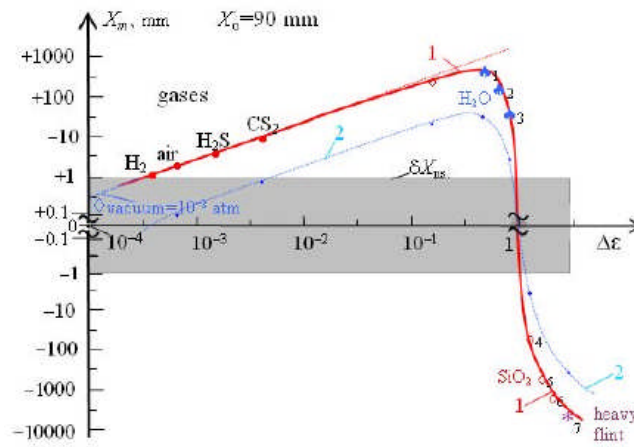

Fig 2. Log-log plot of Xm, the interference pattern bandwidth, vs. $(n^2 - 1)$

The zeros of *Xm* represent where the interference pattern disappears; this threshold occurs at

$$\Delta\varepsilon = 0,1 \quad \text{or} \quad n = 1 \text{ or } \sqrt{2}. \tag{4}$$

The general curve form is an inverted parabola, which is clearer if $\Delta\varepsilon$ is plotted in decimal, as in Fig.3.
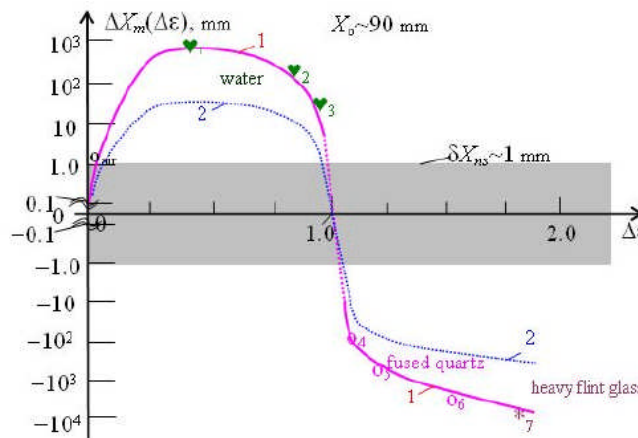

Fig 3. Semi-log plot of Xm, the interference pattern bandwidth, vs. $(n^2 - 1)$

The shift Xm of the interference fringe in the Michelson interferometer is absent when the medium is vacuum (n = 1) but present in measurements where the refractive index n > 1.

Demjanov used the same conventional derivation as given at http://en.wikipedia.org/wiki/Michelson%E2%80%93Morley_experiment#Beam_travel_times.

The time difference in the two orthogonal half beams is

$$\Delta t = t_\perp - t_\parallel$$

(5)

But c was replaced by Fresnel's aether drag equation (1) for the speed of light in a moving optical medium and Lorentz contraction then applied to the arm parallel to the motion, http://en.wikipedia.org/wiki/Michelson%E2%80%93Morley_experiment#Length_contraction_and_Lorentz_transformation.

With definitions

$$n = \sqrt{\varepsilon} \, . \qquad\qquad \Delta\varepsilon = \Delta n^2 \qquad\qquad \Delta n^2 = n^2 - 1$$

(6)

The time delta in phase and the bandwidth of the interference pattern are

$$\Delta t \approx \frac{v^2}{c^2}\frac{l}{c\sqrt{\varepsilon}}\Delta\varepsilon(1 - \Delta\varepsilon)$$

$$\Delta X_m \approx X_0\frac{v^2}{c^2}\frac{l_1 + l_2}{c\sqrt{\varepsilon}}\Delta\varepsilon(1 - \Delta\varepsilon)$$

Both agree with the experimental results in Figs 2 and 3.

The agreement between testing and the theory predicting the parabolic curve and the two zero crossings gives credibility to the document set.

Still hanging in the air is the significance of no interference at n = √2.   (4)

References:

[w] - phrase exposition can be found at http://en.wikipedia.org/wiki/

[i] Rethinking the Foundations of the Theory of Special Relativity: Stellar Aberration and the Fizeau Experiment, A.F. Maers and R. Wayne, May 2011, Fig.2, Page 4, verified 5/30/13, http://arxiv.org/ftp/arxiv/papers/1105/1105.2305.pdf

[ii] Michelson-Morley box plot, verified 5/30/13, http://commons.wikimedia.org/wiki/File:Michelsonmorley-boxplot.svg,

[iii] Maurice Allais-His interest in physics, verified 5/30/13, http://en.wikipedia.org/wiki/Maurice_Allais#His_interest_in_physics, The Experiments of Dayton C. Miller (1925-1926) and the Theory of Relativity, Maurice Allais, 21st century Science & Technology, *Spring 1998*, *p.32,* verified 5/30/13, http://allais.maurice.free.fr/English/media12-7.htm

[iv] Experimental Investigation of the Fresnel Drag Effect in RF Coaxial Cables, Reginald T Cahill, David Brotherton (Flinders University, Australia),*Sept 2010,* verified 5/30/13, http://arxiv.org/abs/1009.5772, Quantum Foam, Gravity and Gravitational Waves, Reginald T. Cahill, September 2003, verified 5/30/13, http://www.mountainman.com.au/process_physics/HPS16.pdf

[v] Physical interpretation of the fringe shift measured on Michelson interferometer in optical media, V.V. Demjanov, Aug 2011, verified 5/30/13, http://arxiv.org/pdf/0910.5658v4.pdf The compatibility of non-negative outcome of Michelson & Morley experiments with Lorentz-invariant transformations of the light speed in moving optical media, V. V. Demjanov, Jan, 2012, verified 5/30/13, http://ether-noo.narod.ru/compatibility.pdf What and how the Michelson interferometer measures, V.V. Demjanov, March 2011, verified 5/30/13, http://arxiv.org/pdf/1003.2899v6.pdf

[vi] Sagnac Effect, verified 5/30/13, http://en.wikipedia.org/wiki/Sagnac_effect On the Proof of the Reality of the Luminous Ether by the Rotating Interferograph Experiment, Georges Sagnac, *Comptes rendus*, 1913, tome 157, pp 1410–1413. Translated from the French by William Lonc, verified 5/30/13, http://zelmanov.fr/papers/zj-2008-08.pdf The Luminous Ether Demonstrated by the Effect of the Relative Ether, Georges Sagnac, *Comptes Rendus . . . de l'Academie des Sciences* (Paris) 157, Oct 1913: pp. 708-710, verified 5/30/13, ,http://gsjournal.net/Science-Journals/Historical%20Papers-Astrophysics/Download/2638

[vii] First-Order Fiber-Interferometric Experiments for Crucial Test of Light-Speed Constancy, Ruyong Wang, *Galilean Electrodynamics,* March/April 2005 (Vol. 16, No. 2), verified 5/30/13, http://web.stcloudstate.edu/ruwang/GED_2005_MarApr_Wang.pdf Generalized Sagnac Effect , Ruyong Wang, Yi Zheng, and Aiping Yao, *Physical Review Letters*, Vol 93, No. 14, Oct 2004, verified 5/30/13, http://web.stcloudstate.edu/ruwang/PRL93.pdf