## INTRODUCTION

For the field of physics, the great theoretical triumph of James Clerk Maxwell in the 1860's had seemed to wrap up electricity and magnetism so neatly that there was talk that perhaps all of nature's secrets had been laid bare and there may soon be nothing left to discover.

An elegant set of four differential equations known as Maxwell's Laws described all known electrical and magnetic effects in terms of Electric and Magnetic Fields. These "fields" were visualized as disturbances in an all-pervasive medium that was named "aether," in the same way that ripples are disturbances in a water surface and that sound is a disturbance in air.

Maxwell's equations had their dramatic triumph when, in 1887, Heinrich Hertz, using a spark generator, produced a signal consisting of electromagnetic waves while a collaborator captured the energy of these waves some distance away in what could be described as the first radio receiver. This experiment confirmed Maxwell's prediction of twenty years earlier that, like water ripples and sound waves, these electromagnetic disturbances, once created, propagated through space independently of the charged objects that gave rise to them.

It turned out, quite surprisingly, that one can derive from Maxwell's equations not only the prediction of electromagnetic waves, but the speed with which these waves propagate through space. This speed is known as "the speed of light," because light is the best-known and most noticeable of electromagnetic waves. The letter " c " is used to denote the speed of light. Its origin is a Latin word (CELERITAS); translated as "swiftness" or "speed."

This remarkable result from Maxwell's equations was something of a mixed blessing because it appeared to be incompatible with what is known now as the classical principle of relativity, or the principle of "Galilean Relativity."

The principle of Galilean Relativity states that the laws of motion work the same way within any frame of reference, regardless of any (constant) velocity that this frame of reference may possess. It is this principle that allows us, the inhabitants of a planet that is constantly zooming through space at a speed of 67,000 miles per hour (in its orbit around the Sun), to drop things, pour things, throw and catch things, and otherwise live by reasonable and simple laws of motion as if the floor we are standing on were solidly at rest. This classical principle is a cornerstone of Newtonian mechanics, one of the most successful of scientific systems.

If the laws of motion are the same inside an airplane flying at a velocity of $400 \mathrm{mi} / \mathrm{hr}$ and one parked on the ground, then it is impossible to say which airplane is moving and which is standing still (except by reference to some marker that defines the background, such as the airport terminal). Galilean relativity implies that no law of motion can tell how fast something moves; any such speed is always relative to some marker (called a "frame of reference") that can be chosen arbitrarily.

No one seriously questioned Galilean Relativity. Several hundred years of experimental evidence was in its favor. The chief suspicion was that there may be a technicality by which Galilean Relativity provides a loophole for Maxwell's Laws if light were to be declared not an "object" in the sense in which the Laws of Motion apply to "objects."

The possible loophole aside, Maxwell's Laws appear to do just what Galilean Relativity prohibits; they tell us how fast light travels without reference to a marker.

Einstein was well versed in both the mathematical and the physical details that were involved in the Maxwell conundrum. He saw Galilean relativity as intrinsically compelling, and had little patience with thoughts of carving out a loophole for Maxwell's law based on a technicality. In addition, Maxwell's equations seemed to Einstein one of those rear giant strides in scientific conciseness and symmetric elegance, describing, as it did, all known electrical and magnetic phenomena.

Einstein saw the conundrum as no longer a question of whether Maxwell's Laws or Galilean Relativity was flawed, but that the problem may lie in the "velocity addition theorem." The classical velocity addition theorem, a principle whose venerable record went back thousands of years, was based not on a large body of evidence but on ancient common wisdom. All of Newtonian Mechanics rested on this common wisdom.

Einstein's Special Theory of Relativity is nothing more than a declaration of his choice to retain Maxwell's laws, and also to hold on to Galilean relativity. Einstein's choice of abandoning the classical velocity addition theorem implied rethinking the nature of time and space.

## Einstein's Relativity

In an effort to reconcile the null results of the Michelson-Morley experiment Hendrik Lorentz concocted some bizarre formulas and concepts that attempted to explain the null results. Albert Einstein took a different approach. His solution was simply to change our perception of TIME.


FIGURE 1
This diagram illustrates the consequences of Einstein's "Special Theory of Relativity."


From which follows: $\quad \mathrm{t}^{\prime}=\frac{\mathrm{t}}{\sqrt{1-v^{2} / c^{2}}}$


Time dilation, space contraction, failure of simultaneity at a distance, invariance of " $c$ ", etc..
FIGURE 2

Isaac: Very impressive, my esteemed colleague, but Galileo and I do not agree. We will outline our views forthwith, but first, a brief review of "Galilean Relativity."

## GALILEAN RELATIVITY


$v=0$

$v=100 \mathrm{MPH}$


FIGURE 3
The vehicle in FIGURE 3 has a pistol attached to the ceiling. At $t_{0}$ the vehicle is at rest. Both the observer riding in the vehicle and the observer watching trackside measure the time it takes the bullet fired from the pistol to reach the target on the floor of the vehicle as $\left[\mathrm{t}=\mathrm{L} / \mathrm{v}_{\text {(BULLET) }}\right]$.

At $t_{1}$ the vehicle is moving at a constant velocity. The pistol is fired again at $t_{3}$. The observer riding in the vehicle will see the bullet go from the ceiling straight down to the target on the floor. The observer watching trackside will see the bullet travel diagonally as illustrated in FIGURE 4.


The vehicle, the observer inside the vehicle, the pistol and the bullet are all moving at a constant velocity (v) when the pistol is fired at $t_{3}$; Newton's laws of mechanics are applied (FIGURE 5), Galilean Relativity is validated.

Galileo: Now let us outline our concerns with your presentation (FIGURE 1 and FIGURE 2).

## EINSTEINIAN RELATIVITY



## FIGURE 6

According to your representation (FIGURE 6) the vehicle has a LASER attached to the ceiling. At $t_{0}$ the vehicle is at rest. Both the observer riding in the vehicle and the observer watching trackside measure the time it takes the light pulse emitted by the LASER to reach the target on the floor of the vehicle as $[t=L / c]$.

At $t_{1}$ the vehicle is moving at a constant velocity. The LASER is activated again at $t_{3}$. The observer riding in the vehicle will see the light pulse go from the ceiling straight down to the target on the floor. The observer watching trackside will see the light pulse travel diagonally as illustrated in FIGURE 7.


How is that possible? The vehicle, the observer inside the vehicle and the LASER are all moving at a constant velocity (.5c) at $\mathrm{t}_{1}$ and $\mathrm{t}_{2}$, but the light pulse does not yet exist. The light pulse does not exist until $\mathrm{t}_{3}$ when the LASER is activated. As soon as the light pulse is produced, it will move away from the source (LASER) independent of the source, at velocity (c). Since the light pulse does not exist until it is produced, it possesses no horizontal velocity (FIGURE 8). The light pulse will not strike the target. Galilean Relativity does not apply.

Isaac: In Maxwell's electromagnetic theory ("Maxwell's equations") a wave equation for electromagnetic waves can be derived. The speed of the waves is given by [1/ Sqrt(epsilon) (mu)] where epsilon is the electric permittivity of "free space" and mu is the magnetic permeability of "free space." The values of these constants is determined in the lab by measuring the force of attraction between electrically charged objects (pith balls, etc.) and the attraction between current carrying wires.

Their physical dimensions are such that the reciprocal of the square root of their product is a "velocity." This is the velocity that Maxwell's theory says electromagnetic waves will have. The only question is "velocity relative to what?" The equations did not explicitly answer this question.

Maxwell (as did his contemporaries) believed in the "Aether." Thus Maxwell's waves traveled at " $c$ " with respect to the Aether. This is similar to sound waves that travel at "the speed of sound" with respect to the air. This is what is responsible for a "sonic boom" that is created by supersonic aircraft. Incidentally, cosmic rays which travel near the speed of light often enter the Earth's atmosphere at a speed which is greater than the speed of light in air. They emit a similar electromagnetic "sonic boom" which is referred to as "Cherenkov radiation."

In Maxwell's electromagnetic theory the waves are initially produced by ACCELERATING charges. This means that the charge (the source) which produces the wave must be accelerating. Thus the source of EM waves in Maxwell's theory is not in any inertial frame other than instantaneously. To say that the waves have constant speed " $c$ " in the inertial frame of the source overlooks the point that in Maxwell's theory the "source" is not fixed in ANY inertial frame.

Galileo: That was a mouthful. Bottom line is that the EM waves travel at velocity " $c$ ", away from the source, independent of the source.
Isaac: Very good, my esteemed colleague. And now, let us present our interpretation of Maxwell's Theory for a "single" light pulse.

Isaac: A single light pulse is emitted by the source which is attached to the ceiling of a vehicle moving at a constant velocity ( $\mathrm{v}=.5 \mathrm{c}$ )


FIGURE 9

Isaac: The trackside observer will see the "single" light pulse travel downward away from the source. The observer inside the train will see the "single" light pulse travel diagonally towards him, thereby alerting him that the laboratory and the source are in motion relative to the signal. This is contrary to "Galilean Relativity" and proof in favor of "Absolute motion."

Isaac: Your diagram, Albert, illustrates a "bullet" mentality.


FIGURE 10

Hence, according to "Maxwell's Theory" the longer beam of light that you claim to see in FIGURE 2 and in FIGURE 10 is an ILLUSION.

Galileo: And now let us present our interpretation of Maxwell's Theory for a "continuous" emission of light pulses at various velocities:

|  | $v=0$ |  | $v=.1(c)$ |  | $v=.5(\mathrm{c})$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | source |  | source |  | $\begin{array}{lllllll}t_{1} & t_{2} & t_{3} & t_{4} & t_{5} & t_{6} & t_{7}\end{array}$ source source source source source source source |
| $\mathrm{t}_{0}$ | \% | $t_{0}$ | 0 mm | $\mathrm{t}_{0}$ | - 0 - 0 |
| $t_{1}$ | $\stackrel{+}{\square}$ | $t_{1}$ | $\stackrel{+}{\square}$ | $t_{1}$ | $\stackrel{\rightharpoonup}{*}$ |
| $\mathrm{t}_{2}$ | - | $\mathrm{t}_{2}$ | $\checkmark$ | $\mathrm{t}_{2}$ | * |
| $t_{3}$ | . | $t_{3}$ | , | $t_{3}$ |  |
|  | $\vdots$ (c) |  | $\vdots$ (c) |  | $\vdots$ (c) |
| $\mathrm{t}_{4}$ | $\downarrow$ | $t_{4}$ | $\checkmark$ | $t_{4}$ | $\checkmark$ |
| $t_{5}$ | ; | $t_{5}$ | ; | $\mathrm{t}_{5}$ | $\dot{\square}$ |
| $t_{6}$ | $!$ | $t_{6}$ | $\stackrel{\square}{\square}$ | $\mathrm{t}_{6}$ | $\stackrel{\square}{ }$ |
| $\mathrm{t}_{7}$ | $\underset{\text { target }}{\dot{i}}$ | $\mathrm{t}_{7}$ | $\underset{\text { target }}{\dot{\text { ® }}}$ | $\mathrm{t}_{7}$ | $\stackrel{\dot{7}}{\text { target }}$ target target target target target target |

FIGURE 11
FIGURE 12
FIGURE13

Galileo: At low velocities the continuous beam of light pulses will appear to be striking the target.


FIGURE 14


FIGURE 15
Isaac: However, at velocities approaching the speed of light FIGURE 15 illustrates the result. The observer traveling with the laboratory is aware that the laboratory and the source are in motion relative to the "signal."

Isaac: When the source is moving at velocities approaching " $c$ " the angle between the beam of light and the "normal" will be: $\tan \boldsymbol{\theta}=\mathrm{v} /(\mathrm{c})$
This explanation should clear up the paradoxes relating to "Stellar Aberration" and Star-light bending in the presence of a "Gravitational field."


FIGURE 16

Galileo: Albert, your determination to hold on to "Galilean Relativity" and to discard the "Velocity Addition Theorem" prompted the invention of all the science fiction concocted by you and the rest of the "Intelligencia." It was an exercise in futility. Much ado about nothing. My thoughts on the subject are as follows:

1. The "null" results of the Michelson-Morley experiment (an experiment that you claim to have no knowledge of) can be explained by an "aether" (or the geomagnetic field) that may be attached to the Earth. If that is the case, the results will be "null" because the apparatus (interferometer) did not move relative to the Earth/signal. For a shift to be detected the source must move relative to the signal! Another explanation is that the setup and execution of the experiment may be erroneous due to the "bullet" mentality relating to the movement of the "signal."
2. Galilean Relativity does not apply to Electromagnetic Fields, no more than it applies to sound waves traveling through air (except in the special case when the air is "trapped" inside the moving laboratory). Trapping the aether inside the moving laboratory for the Electromagnetic Fields is not a plausible solution.
3. With a correct application of Maxwell's Theory a device such as shown in FIGURE 17 can be constructed so that the movement of the Earth around the Sun can be detected:

- If the device emits a continuous light beam from the source to the target, and the light beam is pointed in a direction perpendicular to the movement of the Earth, the light beam will point in a direction away from the normal (in the opposite direction of the Earth's movement) at an angle given by: $(\tan \boldsymbol{\theta}=\mathrm{v} / \mathrm{c})$.
- If the device emits a continuous light beam from the source to the target, and the light beam is pointed in the same direction, and parallel to the movement of the Earth, a "red" shift will be detected.
- If the device emits a continuous light beam from the source to the target, and the light beam is pointed in the opposite direction, and parallel to the movement of the Earth, a "blue" shift will be detected. This device is a "light" compass for terrestrial travel.

4. Red shift and blue shift is a result of the movement of the target (attached to the Earth) relative to the light emitted by a star. Movement of a star relative to the target will not cause a red, or a blue shift.

Isaac: I totally agree with you as far as Electromagnetic Fields are concerned, but my experiments with light originating from a star (our Sun for instance) led me to the conclusion that Mother Nature has an affinity for "systems." The entire universe is comprised of "systems." Starting with the most basic; the molecular structure of the elements, the DNA molecule, Earth and its gravity, a magnet and its magnetic field, an electromagnetic field, radioactive decay, our solar system with the Sun, the moons and the planets, our Galaxy and eventually the Universe.

Mother Nature has a very subtle way of revealing her secrets. One must search far and wide to discover and understand the hints that she makes available to the human intellect. One of those well guarded secrets is that light is the "Rosetta Stone" of the Universe. A clear understanding of light may have helped Albert with the formulation of a "Unified Field Theory." I shall elaborate on my findings at a later time.

Galileo: As for the present situation, Ockham's Razor: "Pluralitas non est ponenda sine necessitate." which translates as: "Plurality should not be posited without necessity" would dictate to choose the simpler solution. But, rather than engage in endless debates, let us devise and implement a practical scientific experiment and let the results speak for themselves.

Isaac: Agreed!

## EXPERIMENT \#1:

Isaac: Attaching a "Laser" producing device to the bottom of a fast flying airplane would not be practical, because it cannot achieve the necessary velocity; hence we shall devise an apparatus that can be used in a laboratory; similar to the "interferometer" designed by Michelson. Please refer to FIGURE 17 and FIGURE 18:


FIGURE 17


FIGURE 18

Galileo: At low RPM's (FIGURE 17) the laser beam travels straight down through the aperture at a. At high RPM's the laser beam deviates from the "NORMAL" as shown in FIGURE 18.

$$
(v)(D) /(c)=(d)
$$

(v) is the axial velocity of the 2 discs
(D) is the distance separating the 2 discs
(c) is the speed of light
(d) is the amount of displacement from the normal
"Natural Philosophers must accept the universe as they find it, of course, but there is a deep-seated faith dating back to Greek times that the universe exhibits order and is basically simple. Whenever any facet seems to become tangled and complex, they must search relentlessly for some underlying order that may be eluding them."


God provided man with the "magnetic" compass to navigate the seas. God also provided man with the "light" compass to navigate the heavens.

