

A Simple Toy Universe
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From LEAR in 1980s to AEGIS today, CERN experiments that measure the gravitation interaction between antimatter and matter have all given null results. The CERN AEGIS null experimental results showing that antimatter is neither attracted nor repelled by matter have been ignored in the way that the null Michelson-Morley experimental results were ignored. It is urgent to interpret this precise results while awaiting decades more of ever more precise experiments. In this short paper, I will build a Simple Toy Universe that explains the apparent result that

$$F_{\text{gravity}} = G m_{\text{matter}} m_{\text{antimatter}} / (r_{\text{matter/antimatter}})^2 = 0$$

In 1928 antimatter was predicted, in 1932 it was discovered and since 1980, the CERN LEAR, ATHENA, ATRAP, ALPHA, AEGIS, and GBAR experiments have precisely attempted to determine whether antimatter gravitationally falls upward or downward. The consensus hypothesis amongst professional physicists is that matter and antimatter gravitationally attract one another. A minority hypothesis is that matter and antimatter gravitationally repel. Had CERN experiments shown that antimatter gravitationally attracted or repelled matter; those results would be proclaimed. But the various null AEGIS CERN experimental results for gravitational attraction or repulsion between antimatter and matter have been ignored in the way that the null Michelson-Morley experimental results were ignored.

Granted these experiments have been extremely difficult precision experiments. had any of these CERN AEGIS experiments yielded the expected result; there would be no hand wringing that the precision of this experiment was insufficient amidst all of the electromagnetic noise. No, the precision of AEGIS would have been sufficient! Thus it is urgent to interpret the experimental result that antimatter is neither attracted nor repelled by matter in our visible universe.

In this paper, I will build a Simple Toy Universe to explain the AEGIS null result that

$$F_{\text{gravity}} = G m_{\text{matter}} m_{\text{antimatter}} / (r_{\text{matter/antimatter}})^2 = 0 \text{ in our visible universe}$$

This inconvenient AEGIS result confounds 20th century physics reasonableness; just as the null result of Michelson-Morley's experiments confounded 19th century physics orthodoxy. The CERN AEGIS results are outside the domain of consideration of 20th century physics; just as the Michelson-Morley results were outside the realm of reasonableness of 19th century physics

Feynman described antiparticles as particles going backwards in time. Of course in our visible universe everywhere goes forward in time. So in what sense do antiparticles go backwards in time?

Let's conduct a simple thought experiment using Feynman's idea. Consider particle a and particle b moving parallel to one another. However weakly, these two particles will gravitationally attract one another. It is more convenient in practice if one of these particles is quite large (e.g. the size of the earth). But this is a thought experiment; so we are not troubled by details like charge or mass of these particles. AS well, in our thought experiment, we simply assume that no other interfering particles and forces are present.

So in this thought experiment, the parallel paths of particle a and particle b begins to converge due to the gravitational force between particle a and particle b. (i.e. the distance r_{ab} between these particles gets smaller as time goes forward. That is

$$F_{\text{gravity}} = G m_{\text{a matter}} m_{\text{b matter}} / (r_{\text{a matter/b matter}})^2 = +, \text{ a positive force}$$

Now we apply Feynman's idea. We turn particle a into antiparticle a and particle b into antiparticle b. And though our visible universe is a time forward universe; we have a perfect image of what will happen to antiparticle a and antiparticle b moving backward in time. We use our end observations of particles a and b as our start observations for our antiparticles a and b; and we use our start observations of particle a and b as our end observations for our antiparticles a and b.

We notice that antiparticle a and antiparticle b gravitationally repel. That is

$$F_{\text{gravity}} = G m_{\text{a antimatter}} m_{\text{b antimatter}} / (r_{\text{a antimatter/b antimatter}})^2 = -, \text{ a negative force}$$

Now there are many good theoretical reasons why this conclusion is nonsense. However, the null CERN AEGIS experimental results encourage us to consider that this nonsense may be correct. So let us continue building this Simple Toy Universe until experimental results force us to abandon this nonsense.

In order for the equation

$$F_{\text{gravity}} = G m_{\text{a antimatter}} m_{\text{b antimatter}} / (r_{\text{a antimatter/b antimatter}})^2 = -, \text{ a negative force}$$

to be correct; antimatter particles a and b must have gravitational masses that are imaginary numbers (e.g. $m_{\text{a antimatter}} = m_{\text{a matter}} \mathbf{i} \in \mathbf{I}$). Of course, we must keep $\text{mass}_{\text{inertial}} = +$ to a positive real number for both particles and antiparticles observed in our visible universe, thus a weak version of the equivalence principle.

Now , "The implication of CPT symmetry is that a "mirror-image" of our universe — with all objects having their positions reflected by an arbitrary plane, all momenta reversed and with all matter replaced by antimatter— would evolve under exactly our physical laws." Wikipedia

And according to the cosmic landscape idea, there are many alternative universes in the multiverse of which our visible universe is just one. Well, let's just consider one specific additional sub-universe as part of our Simple Toy Universe.

First, I define our visible universe as the sub-universe \mathbf{R} . Matter and space are real numbers quantities (i.e. $m, x_1, x_2, x_3 \in \mathbf{R}$) and as well the usual physics applies in this sub-universe \mathbf{R} of this Simple Toy Universe.

Secondly, I define an invisible universe as the sub-universe \mathbf{I} in which gravitational mass and space are represented by imaginary numbers quantities (i.e. $m_i, y_{1i}, y_{2i}, y_{3i} \in \mathbf{I}$). And in which is CPT symmetric with our visible sub-universe \mathbf{R} assures that usual physics also applies in the sub-universe \mathbf{I} of this Simple Toy Universe.

Thus sub-universe \mathbf{I} is an additional universe that will prove useful in explaining the null matter/ antimatter gravitational interaction results of the AEGIS experiments.

We define sub-universe \mathbf{R} and sub-universe \mathbf{I} both as 3-spheres of sufficient internal dimensions as to be everywhere locally flat. This is essential as we will soon demonstrate. Next, we define the relationship between the sub-universe \mathbf{R} and the sub-universe \mathbf{I} as a T-duality relationship.

What this T-duality relationship means is that the entire sub-universe \mathbf{I} is curled into an infinitesimal 3-sphere from the point-of-view of our visible 3-sphere sub-universe \mathbf{R} . Thus the entire sub-universe \mathbf{I} is everywhere (from our point-of-view) too curled and small to be visible. But I must emphasize that T-duality is similar to perspective. Just as a distant star is bigger than a pinpoint, so too the invisible sub-universe \mathbf{I} is really as big as our sub-universe \mathbf{R} ; but only from sub-universe \mathbf{I} 's own internal point-of-view.

Is it easy to accept the one special sub-universe \mathbf{I} , which we are defining. First, this will explain the null matter/ antimatter gravitational result of the CERN AEGIS. But just as important, this Simple Toy Universe metatheory will speak about several modern physical concepts that continue to be troublesome, ambiguous, or in other ways unclear. Such concepts include the nature of time, and various other non-local phenomenon in addition to the CERN AEGIS null results.

Of course, working out the detailed reinterpretations the mathematics of this Simple Toy Universe will be difficult. We have no false hope in this regard. On the other hand, should the next AEGIS or GBAR experiments give a non-null antimatter/ matter gravitational experimental result; we will applaud.

But in that case, many troublesome, ambiguous, or in other ways unclear physical concepts will still remain; which are unlikely to be resolved within the current framework of modern physics. Revolutionary physics is required.

In string theory, 3 tightly curled dimensions can be represented to a very excellent approximation a 1 tightly curled dimension. Thus the sub-universe \mathbf{I} , in which space is represented by 3 imaginary numbers dimensions ($y_{1i}, y_{2i}, y_{3i} \in \mathbf{I}$), can in fact be represented by 1 imaginary number dimension, ($y_{1i} \in \mathbf{I}$).

Of course, the invisible imaginary number dimension, ($y_1 \mathbf{i} \in \mathbf{I}$), has long been hypothesized by modern physics. IT IS SIMPLE CALLED TIME.

The equations of modern physics which use the time variable are mathematically correct (within their domain of relevance). However, we need to reinterpret the conceptual idea (not the pragmatic application) of time.

Let us start with the equation

$\Delta x = c / (\Delta t \mathbf{i})$, where Δx is a distance, $\Delta t \mathbf{i}$ is time, and c is the speed of light. Most importantly, now the speed of light, c , is primarily the constant of T-duality between our subUniverse \mathbf{R} and the invisible infinitesimally curled subUniverse \mathbf{I} .

T-duality in this Simple Toy Universe means that in both subUniverses, Newton's gravity, $F = G m_a m_b / (x_{ab})^2$, holds for a local observer. Thus from an Observer \mathbf{I} POV in the subUniverse \mathbf{I} , Newton's law would predict as follows.

$$F = G m_a m_b \mathbf{i} / (y_{ab} \mathbf{i})^2, \text{ multiplying imaginary numbers, we get}$$

$$F = G (-1) m_a m_b / [(-1)(y_{ab})^2] \text{ and simplifying, we get}$$

$$F = G m_a m_b / (y_{ab})^2$$

Hence, the laws of physics (i.e. Newton's gravity) in the subUniverse \mathbf{I} are identical to the laws of physics in the subUniverse \mathbf{R} .

$$F = G m_a m_b / (x_{ab})^2$$

Thus from the subUniverse \mathbf{I} POV, an Observer \mathbf{I} perceives his spatial dimensions as being a real number dimensions $y \in \mathbf{R}$. T-duality reciprocity demands that neither Observer \mathbf{I} nor Observer \mathbf{R} can determine if his subUniverse is best described by curled imaginary numbers spatial dimensions or large real numbers; because these descriptions are mathematically equivalent.

But in this Simple Toy Universe, Newton's law comes up with imaginary numbers gravitational forces. The force on a particle m_a in the subUniverse \mathbf{R} from an antiparticle $m_b \mathbf{i}$ a distance $y_{ab} \mathbf{i}$ in the subUniverse \mathbf{I} is:

$$F_g (y_{ab} \mathbf{i}) = G m_a m_b \mathbf{i} / (y_{ab} \mathbf{i})^2$$

$$F_g \mathbf{i} = - G m_a m_b \mathbf{i} / (y_{ab})^2$$

On the other hand, force on a particle m_a in the subUniverse \mathbf{R} from an antiparticle $m_b \mathbf{i}$ a distance x_{ab} in the Toy subUniverse \mathbf{R} is $F_g \mathbf{i} = +$, a positive imaginary number.

$$F_g (x_{ab}) = G m_a m_b \mathbf{i} / (x_{ab})^2$$

$$F_g \mathbf{i} = + G m_a m_b \mathbf{i} / (x_{ab})^2$$

Now, because these two forces of gravity are imaginary numbers; there is no observable real number local action within the subUniverse \mathbf{R} . **What this means is that, the CERN AEGIS null results are consistent with an imaginary number force of gravity acting between antimatter and matter; because such an action is non local in the real number spatial dimensions of our visible universe.**

However, the individual $F_g \mathbf{i}$ force's actions significant accumulate into non-local actions whose results are quite large and visible as non-local phenomenon in our subUniverse \mathbf{R} .

These non-local effects may be thought of as a kind of non-local quantum superposition of many non local actions upon the subUniverse**R** relative to the subUniverse**I**; that are due to classical Newtonian gravity (quantum effects).

To correctly interpretations the $F_g \mathbf{i}$ as non-local phenomenon is based upon logic applied to a higher dimension point of view, i.e. a Simple Toy Universe POV rather than just a subUniverse**R** or a subUniverse**I** POV.

The logic implies that $F_g \mathbf{i} = -\mathbf{i}$ or $F_g \mathbf{i} = +\mathbf{I}$ cause non-local observable phenomenon in Toy subUniverse**R** that can only be understood as non-local phenomenon resulting from infinitesimal (i.e. directly unobservable) cumulative effects of many imaginary number gravitational force interactions, $F_g \mathbf{i} = -\mathbf{i}$ and $F_g \mathbf{i} = +\mathbf{I}$, between particles in subUniverse**R** and subUniverse**I**.

In particular, we visualize the effect of the $F_g \mathbf{i} = -\mathbf{i}$ force upon the subUniverse**R** as an orthogonal force trying to push the particles m_a out of the subUniverse**R** and into the subUniverse**I**. (This would involve a rotation a particle from the subUniverse**R** where it is stable into subUniverse**I** where it is unstable). But the subUniverse**R** particles gravitationally resist; hence the entire 3-sphere of subUniverse**R** spins intrinsically (in a cumulative superposition quantum mechanical sense) relative to the curled subUniverse**I**. As well in pushing each particle orthogonally from its subUniverse**R** dimensions, this orthogonal force manifests itself to an Observer**R** as a nonlocal apparent energy loss of the subUniverse**R**. That is, the energy of each photon (which is both particle and antiparticle), that conveys information across our visible universe, is persistently losing energy (as it crosses our visible subUniverse**R**) due to its persistent gravitational interaction with the entire curled subUniverse**I**.

In a quantum mechanical sense, subUniverse**R** and subUniverse**I** have equal and opposite intrinsic spin. Specifically, the intrinsic spin of elementary particles and the intrinsic spin of the subUniverse**R** are perfectly aligned. Thus particles are stable in the subUniverse**R**; whereas antiparticles are unstable in the subUniverse**R**. Beyond explaining the baryon asymmetry of our visible subUniverse**R**; we must also note that at every point of our visible subUniverse**R** there is an apparent curled subUniverse**I**; which, when correctly accounted for in this Simple Toy Universe metatheory, eliminates the 10^{54} order of magnitude error in the prediction of vacuum energy.

Simply put, our visible subUniverse**R** is rotating relative to time (which is the excellent 1-dimensional approximation of the imaginary number curled 3-dimensional subUniverse**I**). This rotation of the subUniverse**R** relative to the subUniverse**I** is the intrinsic spin against which all cyclical approximations of time (e.g. seasons, pendulums, atomic vibrations, and other change of state patterns) are implicitly compared.

Thus time itself is an illusion. Changes of state are all we have. Whether changes of state are measured in terms of an invisible infinite temporal dimension or an infinitesimal temporal dimension (which is really an approximation of 3 curled

imaginary number dimensions) really doesn't matter. Practical time remains the same very useful fiction, as does continuity.

At this point, we stop sketching this Simple Toy Universe metatheory. We have accomplished our purpose of building a Simple Toy Universe metatheory that **explains the precise CERN AEGIS null gravitational result between antimatter and matter**. M As well this Simple Toy Universe clarifies other physics ambiguities and is expandable to include the other physics forces.

Thank you.

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