September 2009

Energy, Matter, and Scale in an Evolving Universe

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Abstract

If we scale down ourselves to the size of simple bacteria, and look at its processes, we can find that its entire existence relies on three basic abilities. One of them is the feeding process by which it accumulates an "internal energy" for the time when food is scarce, the second is the skill to adapt its basic processes when environment changes, and the third is the "regeneration" process by which it self-replicates when conditions permit. With these three uncomplicated strategies it is very likely that billions of years from now, us will find bacteria on Earth. And even if our Sun will cease to exist, somewhere else in the galaxy, where similar conditions exist, we assume that it is very possible that the same bacteria will continue its existence in a cycle that could last forever. If we could build a machine like the one imagined in the movie "Fantastic Voyage" (1966), and use it to vary our scale from the size of the entire Universe to the size of the gravitational particles that keeps everything in place, what basic processes we could uncover during this journey? At the largest scale we assume we find what the Big Bang theory tells us, which is that everything had a rough start few billions ago and it will end few more billion years down the road. However, it is strange that uncomplicated bacteria did discover a way to last forever while the largest structures have their dismissal built into their dawn. Or it is possible that everything we see, stars and galaxies, atoms and quarks, are engaged in a cosmic dance that uses the same basic processes of "regeneration" and "internal energy" accumulation to fight their inexorable fate... This essay proposes a new theory which views all the matter and all the energy, linked together in a layered context-based hierarchy, structure which makes it possible for everything we see to continue their existence for many eons to come. And if this theory holds true, then what we know or assume we know changes in a fundamental way, as it exposes a new realm of possibilities, from opening up the prospect to travel faster than the speed of light, to finding out more about our destiny as a humans. And no matter what are the big theories we may originate from this model, the biggest lesson of all is in finding comfort at the thought that at the foundation of the entire Universe, we find the same familiar mechanisms the humble bacteria uses to survive…

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Introduction

"Throughout my career, I have tried to look beyond the immediacies of this or that calculation to ask how it all hangs together. In my vision of the world there is a reason, a simple reason, not only for every individual phenomenon, but for every general theory."

John Archibald Wheeler

John Archibald Wheeler, a longtime member of the faculty at Princeton University, saw his own career as a three-step process. The first, which he called "*Everything Is Particles*," consisted of a time when he searched for how to construct all basic particles like neutrons and protons from the lightest, most fundamental particles. Next, beginning in the 1950s, he thought particles represented electrical, magnetic, and gravitational fields, as well as space-time itself, and saw the world as the result of these fields. This phase he called "*Everything Is Fields*." In the third and final phase, he focused on logic and information, which he called "*Everything Is Information*."

The model we propose in this essay views everything in the Universe, from atomic particles, to galaxies, to human society, as part of a continuously evolving system which "regenerates" all its entities at different energy scales. As a basic process, all entities are transforming external resources into an internal form of accumulated energy through the interaction with their environment. They also have as their main declared goal the need to extend their existence as far as possible in the future. We base this model on a reasonable assumption that each entity that exists in the Universe doesn't have an infinite existence and it doesn't live in isolation. Some of them will adapt to their environment so well that in the end they may acquire entirely new capabilities in the form of a new organization, with its own rules. This crossing to a higher order gives better opportunities to survive to all its entities. Nevertheless, the opposite holds also true. If caught by the "regeneration" cycles, entities not able to "climb" fast enough on the evolution stairway will lose their right to live another chance. In the end, the combination between the *renewal cycle* and the *acquisition of skills to escape* its unforgiving conclusion is the basic mechanism by which the Universe is continuously evolving in a bottom-up approach. Part of this process is to use these "regeneration" cycles not only as a way to extend the life of all its entities as far in time as possible, but also to ensure that always new entities are "born" to replace the old ones, entities with better chances to learn how to build their escape route...

This essay is not as much about '*How*' as it is about '*Why*'... it is not about complex mathematics but about simple and foundational concepts that can be found in everything we can see in the light or it may hide in the "dark"...it is about the journey an entire Universe takes it to reach an infinite existence... to liberate itself from the *Time* and *Space* constraints, in its struggle towards reaching the perfect viability.

Energy and Matter Are Linked Together by a Viable Model in the Same Context

One important attribute shared by all biological organisms is their ability to process external resources (matter and/or other forms of energy) into internal energy with the declared goal to increase their chance to survive. The first model of an organizational structure that is viable and autonomous was developed by the operations research theorist Stafford Beer. He called it the Viable System Model (VSM). W. Ross Ashby, one of the founding fathers of cybernetics, improved on it with two important concepts: a system has to be self-organizing to be viable, and it has to obey the law of requisite variety[1].

The biological organism has its internal structure organized along two dimensions: one *physical* and one *logical* (functional). When we combine the work done by Ashby and Beer with current observations, we

[1] The law of requisite variety: the larger the variety of actions available to a control system, the larger the variety of perturbations it is able to compensate

arrive to a dual hierarchy. One is for the *physical* structure, which is built in layers around its basic unit, the *cell*. Normal organisms have their cells grouped together in *tissues*, tissues are grouped together in *organs*, organs are grouped together in *systems of organs*, and systems of organs are grouped together to form the entire *body*. The *logical* structure is built as a *controlled hierarchy* around the ability to change. At the top we find the higher functions of the brain, which are deciding on the big changes, as to what path to take when uncertain how to respond to external stimuli. On the lowest level are the organism's *operations*, which are primarily the cell's resource transformation cycle.

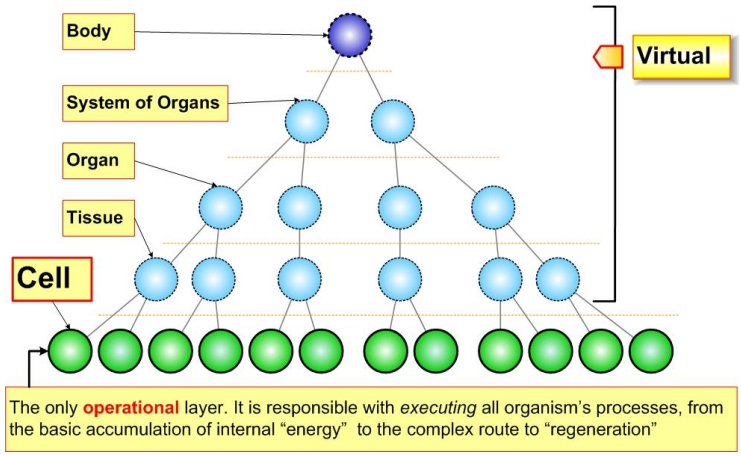

***Fig. 1** – The structural hierarchy of a biological organism*

When conditions in environment are changing, the same cells are adding to the responsibility of running this basic cycle other functions. They will learn also how to add to their operational repertoire improved ways to respond to new conditions, or finding a safer exit in the maze of steps required by the self-regeneration route. Because the cells are the only ones ultimately responsible with *executing on all these processes*, every other structure in the hierarchy plays a virtual role. In the case of a biological organism, this role is to help the entire body to adapt to the environment. This is why, the higher the hierarchy (i.e. has more layers), the better it is adapted to respond to the "uncertainty" embedded in the messages received from environment. Gaining new capabilities is always driven by the need to add new control layers to the internal structure, making this **the basic mechanism of adaptability that applies to individual entities.**

One important aspect is that all entities within an ecosystem have to share the same basic transformation of resources cycle to be able to compete with each other (i.e. being part of the same food chain) and subsequently to evolve. We say that groups of similar systems belong to the same *realm*.

The same link between physical and logical hierarchy can be also extended to the realm itself. For instance, biological organisms are grouped together in ecosystems, forming their own entities. The hierarchy in an ecosystem has the order established by the operational efficiency of the food chain. At the top we find the most successful hunters, while at the bottom we find organisms which use the solar energy to generate the building blocks of the food chain.

Within this ecosystem, the battle for resources is driven by the selection of the most well equipped individuals. This is primarily accomplished by the competing process of finding a mate, **which is the second mechanism of adaptability that applies to groups of entities**.

Nevertheless, the adaptability process doesn't stop here. At the top of the food chain, plenty of options are leading to changes to the competition race, from within the realm, to within the group of the same type of individuals. This is the process by which *society*, as a new realm, emerged. It is also the basis for the **third adaptability mechanism that applies to a single group of entities.**

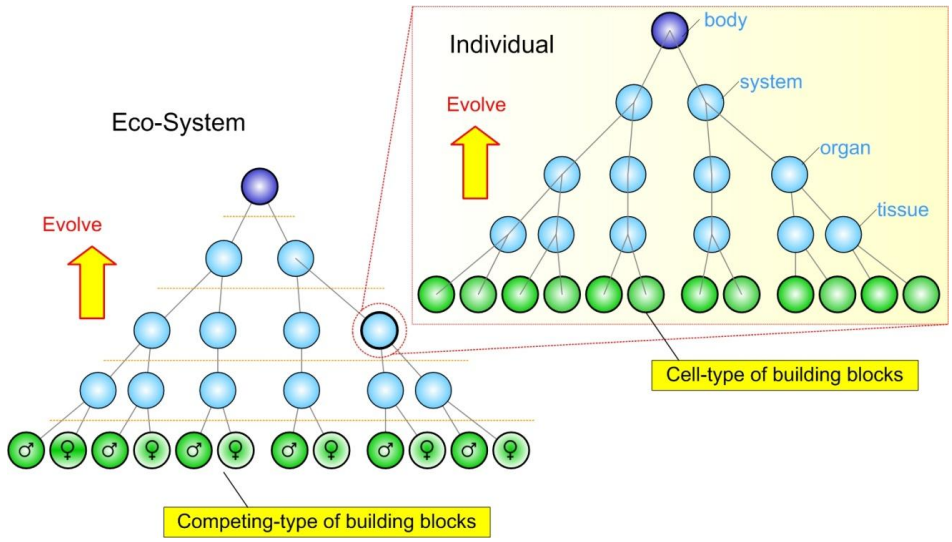

Fig. 2 *– The main adaptability mechanism for similar entities competing within an ecosystem is the finding of a mate*

Two Familiar Realms – Organisms and Organizations

The same viability concept that applies to biological organisms can be easily extended to the socio-economic organizations. Humans have learned during their history how to organize themselves by intuitively copying the basic principles which made the Nature so successful. There are however few differences:

- *The building blocks of the society are built on the consumer-producer paradigm*—while in biological realm the competition was for finding a mate, the socio-economic realm revolves around the battle for consumers. As a result, opportunities for all members improve as this basic mechanism leads to more efficient processes, and higher accumulation rates.
- *The basic unit for the socio-economic realm is the family* –while businesses carry the heavy lifting in society, the basic unit remains the *family*. Because humans are both members of society and biological entities, the family overlaps two roles: one is to ensure the continuation of humans as a species, and the other is to act as the primary executors in the transformation of natural resources. Regardless of the organization type and its role, ultimately it is the responsibility of its individuals to carry on its tasks.
- *Technology is an emergent realm*—in the battle to win consumers, humans found an important ally, *technology*. This is based on a simple rule: the easier way for an organization to win customers is to lower the costs. Technology is about finding new ways to replace hard work with machines which leads to more efficient processes. While there is some apprehension that machines like robots will displace humans one day, the history shows that those fears are not well founded. For robots to take over, they need first to become self-sufficient with their own energy needs (i.e. create their own transformation cycle that will ensure they can store energy), and to establish their own mechanism to compete as the basic mechanism to evolve. This scenario is still far, far away in the future. The last time when a new realm reached this stage it took few million years…

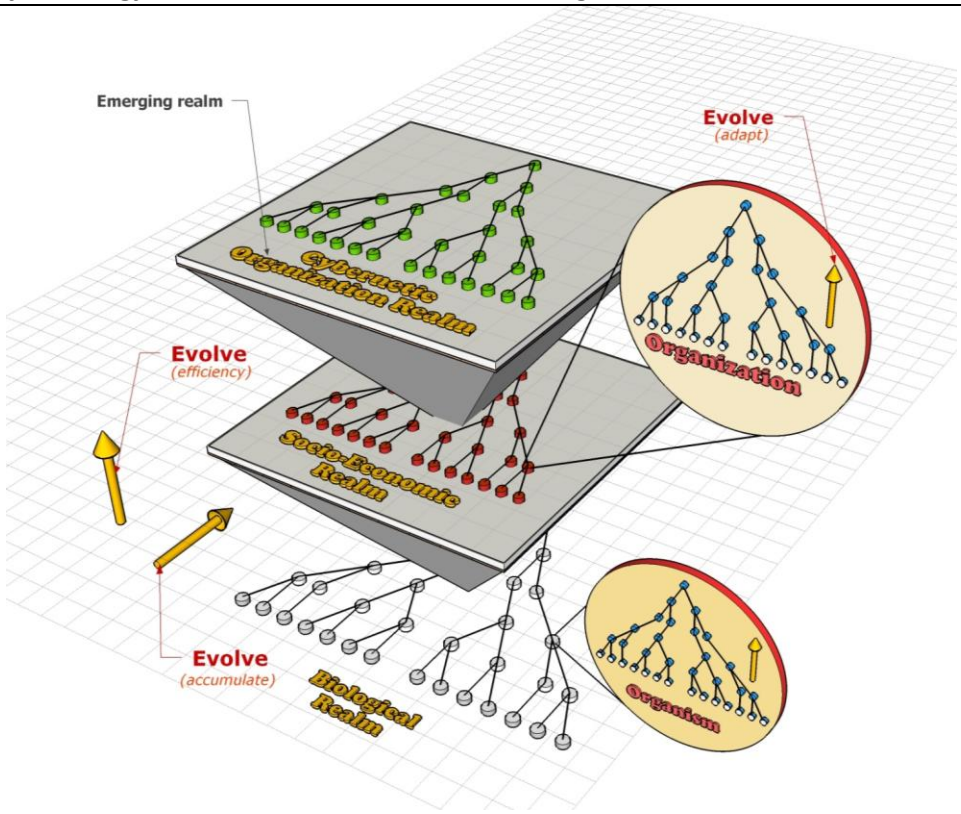

Fig. 3 *– Our environment is built on three realms: biological, socio-economic, and technology*

As a result, the big picture of our world emerges at the confluence of three context-based realms: *biological*, *socio-economic*, and *technology*. Despite their differences, all three are sharing the same basic evolution paths.

The Evolving Universe… It All Started With Gravity

We increase our knowledge about the Universe by looking for patterns. So what would happen if we extend to the entire Universe the model we found it may apply to the biological and socio-economic realms? If simple and extremely fragile unicellular organisms have found a way to survive for billions of years, it is very likely that some of their basic mechanisms could be shared by other entities too.

For instance, in our galaxy the nucleosynthesis is the process by which new atoms are created from existing ones. While this cycle is relatively well understood, there are two facts which have a less obvious explanation. Assuming that the neutrons and protons were created during the Big Bang, there is still a big question how the lighter atoms, such as H and He were created. The second question is, if once created, are all the atoms end up as being part of a cold Universe, which lacks energy and life?

And the same questions can be asked as we go deeper in the inner workings of an atom. As we build bigger accelerators, we are also expanding our understanding of the primary components of the world we see: *neutrons* and *protons*. The lower the scale, the more obvious is that inside nucleus there are hidden layers of particles, with their own laws. And we find this when we have very few clues when comes to where the magnetic and gravitational fields are originated. This internal complexity begs for another common-sense question. How come it took billions of years of evolution for the Nature to build such structures as the stars and planetary systems that made possible the nucleosynthesis and life, when the entire order we find it hides in the neutron and proton we claim it was created in only seconds during the Big Bang? The answers to these questions may change completely how we view the Universe.

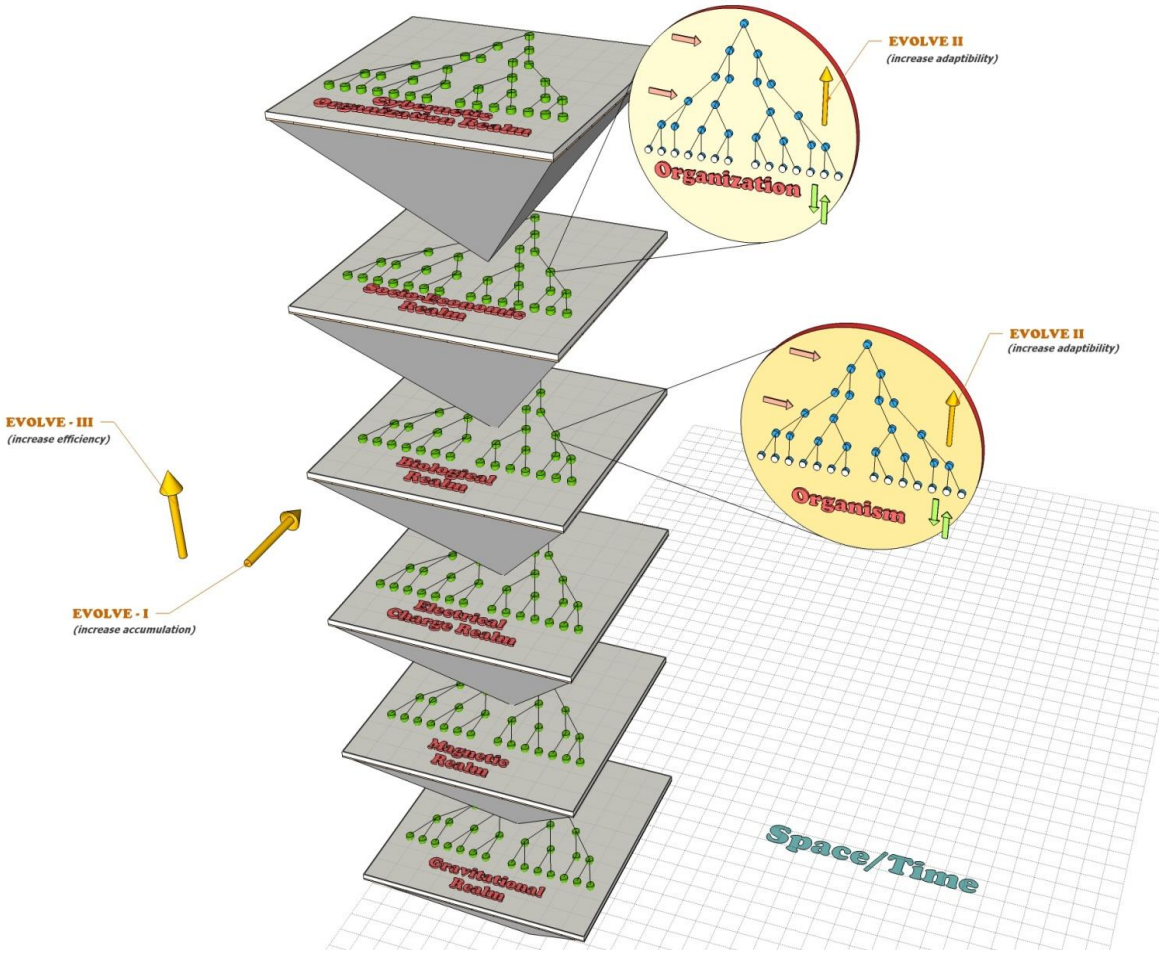

***Fig. 4** – The context-based scale model that links matter and energy in our Universe*

If we extend the self-replicating model found in biology to the atoms we find in our galaxy, the first step is to find the origin of a "regeneration" engine. One very good candidate could be the black holes found in the middle of each galaxy. Black holes can act as a recycler for all the atoms in the galaxy, a process that transforms the existing atoms into H and He, the building blocks of all the stars. This process is hinted by current observations [3] which are pointing to an unusual concentration of young and massive stars in the middle of our galaxy and in close proximity of its centered black hole.

The same process can be extended further to the particles living on a lower scale, which are those making the quarks. It is obvious that they must contain the gateway to a realm in which magnetic particles are the constituents as the source for magnetic energy. While we do not know how they look we have plenty of clues on how they behave. For a start, their energy must be higher than the one found in the electrical charge. We also assume that the existence of magnetic polarity is what creates the variety of quarks, similar to the way positive and negative electrical charges lead to the creation of various atoms. However, if the same model applies, then where could be their "regeneration" engine? One clue, endorsed by observations [1] shows that large galaxies, found in the center of galaxy clusters have a strong magnetic field which permeates their entire structure. Can this fact, together with the fact that many of such galaxies also harbor highly active black holes, point to an internal cycle that is "regenerating" at very high energies the particles which makes the magnetic field possible?

And what if we glance further into our observations? Recent data shows that [2] even larger structures are at work in our Universe. Can the recently discovered "dark flow," a movement of clusters of galaxies, which extends across billions of light years, points to a "regeneration" engine for the particles which makes the gravitational field possible? These facts may point to dynamic processes at a scale unimaginable by our present theories.

This context-centric structure has plenty of consequences on our theories. Concepts as temperature and absolute temperature, speed limits, energy carriers, symmetry, opposite forces, all need to be redefined completely for each realm. Although many things are specific to each realm, they always may share two simple principles which we infer from the way biological and socio-economic realms are interacting:

- *An inner realm has always its laws apply to all higher realms*—it is obvious that our social structure is impacted by our biological origin, as we are affected by the magnetism and gravity.
- *A higher realm laws will never apply to inner realms*—while this may look obvious for biological realm (the laws driving our economy never applies to ecosystems), it is less obvious to the relationship between electrical charge, magnetism, and gravity. The difficulty in applying this principle is when we try to separate them. The first principle points to the electrical, magnetic, and gravitational fields as being always present together. Because gravity is two realms down from our observation deck, its influence is very weak, but it still leaves a tightly coupled presence for the other two. The weak influence makes improbable that we will find a theory framed as "quantum gravity," where by quantum we understand "quantum mechanics" which applies to charged particles. This is like saying that there is theory that links the electron orbits to the ups-and-downs of the financial market.

As we've seen, the "regeneration" engines play an important role in the overall evolution. Nonetheless, each such cycle happens at energies orders of magnitude larger than any of what normal members of the realm are capable to store internally. As a result the new cycle will wipe them out of their existence. To this process there are two types of exceptions. At one end there are simpler entities from the lower realm, which are requiring even greater energies to be destroyed, such as quarks for the regeneration of neutrons and protons. At the other end are the highly complex entities which had organized themselves to "accumulate" energies comparable with those found in the "regeneration" process, energy which allows them to escape the crushing fate.

On a smaller scale, this mechanism can be compared with the threat our society faces from the collision of Earth with a large cosmic object. Despite our technology, it is very likely that we will be wiped out by such an event if the object is large enough. The laws of the Universe tell us that the question is only "when" and not "if."

One of the most important consequences of this model is that we can be almost certain that advanced civilizations, if they exist, must have mastered the high energies contained in the inner structures of the atom. Because of this, when every new cycle takes place, it gives them the possibility to survive. As a result, it is possible that the entire Universe is filled with them in every corner, and the longer they last, the better chances they had succeeded in controlling ever higher energies. As a direct consequence of this control, they can also gain greater access to the processes controlling their own internal energy cycle, which can lead to having a much longer productive life. This is why acquiring the skill to control higher energy, leads to greater control over matter, which is directly linked to the mechanism behind Universe evolution.

The proposed context-based structure for our Universe is summarized in the next table:

	Competing Building Blocks	Type of "energy" carrier	Speed limit	Temperature Scale	Observations
Cybernetic Organization Realm	Not yet defined	Note yet defined	Note yet defined	Note yet defined	*Emergent realm. May take millions of years to evolve*
Socio-Economic Realm	Consumer-Producer	Financial currency	Very slow	Entropy of financial transactions	*This realm is few million years old*
Biological Realm	Male-Female	Calorie	Speed of sound	Defines the range for life	*This realm is few billion years old*
Electrical Charge Realm	Positive-Negative	Photon	Speed of light (c)	Higher than absolute temp.	*This is the realm of the electron and proton. It is regenerated by all black holes living in the center of galaxies*
Magnetic Realm	North Pole – South Pole type of magnetic polarity	A carrier for magnetic field	Higher energy may lead to speed limit higher than c	There must be a new limit for lower temperatures where all the magnetic entities stop their movement	*This is the realm of the quark building blocks. It is regenerated through magnetic synthesis cycle in the active black holes living in the middle of the cluster of galaxies*
Gravitational Realm	Attraction - Repulsion	A carrier for gravitational field	This could be the highest speed limit	There is a possibility that gravity particles are the only ones that never stop their movement	*The gravitational realm is two levels down from our realm. As a result its influence must be very weak. Dark flow for regeneration?*

***Table 1** – High level, proposed context-based structure that links energy and matter in the Universe*

Questions… and Possible Answers

If this layered model of contexts and realms holds true, it could be used to find answers for many of today's fundamental questions:

- *Second postulate (invariance of c) of special relativity combined with E=mc^2 states that no object can travel at speeds higher than speed of light* – one of the consequences of this postulate is that no object can travel at speeds greater than the speed of light. This is because current laws require for the object to have an infinite energy to accelerate to the speed of light. But this doesn't say anything if we use for our propulsion system the carrier of energy for magnetic field, or gravitational. The main reason why we cannot see the postulate broken is because in observations of our galaxy or other cosmic structures

we are reading only "signals" from the electrical charge realm. As a result, it is obvious that at this macro level no object will reach speeds over the light speed limit by using only its internal energy without any other process-based "accumulation" of energy present.

- *Black holes do not escape any information* – this is true only if we view 'information' only through the 'electrical charge' realm viewpoint. However, it is obvious that black holes are "escaping" plenty of gravitational and magnetic "information."
- *The roles for black holes in the middle of a regular galaxy, black holes in the middle of a large galaxy (in the center of a cluster), and the dark flow* –Can they be the "regenerating" engines for the electrical charge realm, magnetic realm, and gravitational realm? This could go a long way to provide an explanation for the unusual number of young stars found near the center of our galaxy and the strong magnetic field found in the larger galaxies. One direct consequence, there is no need for a Big Bang theory to explain how elementary atomic particles were created initially.
- *CP-violation* – Experiments have shown that the CP-violation happens only with particles called kaons, which are pure quarks, with no electrical charges. Are they the sign of the new symmetry which belong to the magnetic realm, one which has its laws completely different from the electrical charge realm we can usually see in our experiments? It is obvious from our observations of the biological and socio-economic realms that the laws of the symmetry are not the same across realms.
- *Why gravity is so weak* – by using this layered model, the explanation could come very easy: this is because all of our observations of the gravitation field are separated by the magnetic realm.
- *The Big Bang theory* –while the existence of a background radiation has been already demonstrated, there are signs that it may not come from the far corners of our Universe. To add to this is the fact that so far, our observations failed to find signs of widespread early development of galaxies. The further we see, the more galaxies look the same as the ones closer to us.
- *Ultra high energy cosmic particles* – this model could also provide an explanation to the existence of ultra high energy particles reaching our Earth atmosphere. In the layered realm model they could be the particles carriers for the magnetic and gravitational energy. By traveling at speeds much faster than the speed of light and at energies much higher regular particles can have, their collision with any atom will end up with as a big release of energy. This is true because the model doesn't prevent particles from lower realms to interact with objects in the higher realms.
- *The electron elusiveness*—modern technology is highly dependent on them. Despite the fact that we have obtained accurate measures of many of its properties, we still are miffed by the humble electron. One explanation provided by the realm model is in the virtualization of higher layers. It is possible that as individual particles only protons are playing the primary role of "execution" engines, while the electrons are only the result of a virtual hierarchy created by grouping them together. While we can run experiments showing that laws from all the three realms, electrical, magnetic, and gravitational are applying to the electron particle, their physical dimension and composition was not able to be pinned down.
- *Theory of relativity*—because light is the energy carrier for the electrical charge realm, it must embed magnetic energy and even traces of gravitational energy. When the theory of relativity is applied to energy carriers from the magnetic realm it is possible that their experience the same type of curvature of their path when passes near large gravitational objects, only much smaller.
- *Quantum mechanics*—it is also possible that the realm model will lead back to the physics in which the *space* and *time* concepts are viewed as a continuum. The explanation of the quantum effects could be that we experience a phenomenon which exists at the border of two realms.
- *Dark matter and dark energy*—we invented them to fill the gaps in our knowledge. However, their explanation could be found when we uncover all the laws about the gravity and magnetism, especially at larger scales. The realm-centric model can be a starting point.

- *Fermi's paradox* – while it looks that life has great chances to emerge everywhere, and there is a distinct possibility that there are many advanced civilizations in the entire galaxy, we see no signs of them. One explanation could be that advanced civilization are living in a higher realm, which makes the communication if not impossible at least very difficult.

Possibilities Opened Up by This Model

If the matter and energy are linked together in this cosmic dance, which eliminates the weak and makes stronger those able to adapt fast enough, then the pool of what is possible will never end. However there are few "low-hanging fruits" we can assume become possible when we accept the proposed model:

- *We can build ships which can travel faster than the speed of light*—by using a type of propulsion engine that uses magnetic and gravitational energy carriers as a source of energy it should be possible to accelerate the ship at speed faster than the speed of light. This is like breaking the speed of sound by using chemical reactions instead of pure mechanical energy.
- *We can build communications devices that can exchange messages in real-time or near within the galaxy and beyond*—if we assume that speed limit is orders of magnitude higher for magnetic and gravitational realm, then we can assume that we can apply the same principles we use in lasers to synchronize the release of energies in photons (i.e. energy carriers for the electrical charge realm) to the energy carriers from the other two, inner realms. The result is that we can build a communication device able to transmit information at speed faster than the speed of light and with very little interference as our galaxy doesn't have a very strong magnetic field.
- *Enable us to live a productive life that may extend much further in the future*—understanding the processes generating our "internal energy" and driving our adaptability can lead to many ways to improve the control over our aging process.

While we are exploring about new possibilities it is important to mention also at least one that can be made impossible by such model: the travel in time. The space and time are relegated by this model to their benign existence, as they are pushed back into their primary role as the foundations of a Universe that needs their continuum to lay down the entire context-centric structure.

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