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# Extending Shannon's Theory of Information to Viable Dynamic Systems, and the Emergence of a New Physics of Information

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## Abstract

Physics is defined as a branch of science concerned with the structure of matter and the interactions between the fundamental constituents of the observable universe. A simpler definition was given by Sean Carroll, a theoretical physicist. He defined it as what the world is and how it behaves. But within this world, we exclude biological organisms, our socio-economic organizations, and even most of the domains like magnetism and gravitation about which we know very little. This paper introduces an extension to Shannon's theory of information that applies to semantic, or, as we call it, the information causal attribute. The new theory introduces a scale to measure the information semantic/causal attribute complexity of a message, and the condition the receiver has to meet to successfully process the message information semantic/causal attribute.

These two aspects match the original Shannon's theory of information, which is limited to the information message's physical attribute and to its successful processing by the receiver. A generic message that has both physical and semantic/causal content normally carries a list of tasks for the receiver to complete. Only if all these tasks are completed, then the theory declares this exchange complete. Nevertheless, the completion of any task requires that receiver consumes a certain amount of energy.

The next step is to extend Shannon's communication system model to all known interactions from physics. From this association, we introduce a new definition for energy that includes the information context. **Energy** is defined as *the ability to do work or the work in progress*, and **causal attribute information** is defined as *the list of instructions based on which the work is performed*. From this association between energy and information, we demonstrate that a causal attribute has all the properties that qualify it as a **new dimension**, the fifth. Next, we use the new dimension to group all material objects based on the complexity of their interactions. The result is a holarchy, with each holon associated with a certain type of dipole pattern. The list of these dipoles starts from the bottom with the simplest one, which is the gravitational dipole. At the top, we find the most complex entities, which are the software/hardware constructs used to automate business processes.

This new model is called the Information Aware Universe model, and the classical observer used in physics becomes the Information Aware Universal Observer. Because this model extends the current physics knowledge with new laws and principles, we call it **Physics of Information**. Within this new field, the entire Universe is represented, which includes biological organisms, our socio-economic reality, magnetism, and gravitation. The new model of the Universe is fully deterministic, evolutionary, and it has a quantum nature given by the fifth dimension, which is represented by the information causal attribute.

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### 1. Introduction

*In 1860s, Maxwell took the wrong turn, and since then the research in physics was never the same*

Our entire history of physics is dominated by what Niels Bohr called '*Nothing there until it is measured.*' This principle allowed our understanding to make progress in our understanding of how Nature works. When we discovered a new law, we chose to ignore the part that cannot be measured.

That served well for a few centuries until it didn't.

When Newton discovered the law of gravitation, he knew '*how*' it worked, but he ignored '*why*'. The approach was convenient as there was no way Newton could find a way to measure the origin of gravitation.

When electricity came into view, the same approach was used. Maxwell and his laws were focused on how electrically charged particles work with magnetism, cast as mostly non-existent. It was conveniently assumed in a law that its dipole cannot be broken. Their origin, the laws governing magnetic monopoles and magnetic energy carriers, were completely ignored. It was impossible for Maxwell, as it was for Newton, to measure the inner workings of magnetism.

Because this law was added to satisfy a mathematical framework, it ignored reality. In the end, the wrong conclusion was issued, one that exists until today. The fact that we call Maxwell's laws a way to *unify* electricity and magnetism is misleading. By calling the new field '*electromagnetism*', it is also assumed that there is a common explanation that covers both electricity and magnetism, which is also not true. This goes even further when one of the four fundamental forces is identified as '*electromagnetic.*' Maxwell's laws should be identified as describing only the *interaction* between electrical and magnetic fields, with emphasis on the electrical side.

At the end of the nineteenth century, this approach of ignoring the things we could not measure started to catch up with us. Planck's constant, Bohr's model of the atom, Einstein's theories, Schrodinger's equation, and the standard model are all mathematical frameworks not linked in any way to the fundamental question of *why*.

Two examples clearly show this. Einstein's general theory of relativity and his famous equation  $E=mc^2$ . Both theories ignore magnetism and the laws guiding its inner workings. They have cast magnetism as non-existent. A simple experiment with two magnets shows that the force is much greater than the electrostatic one, which leads to the possibility that the energy carrier for magnetic force may travel at a higher speed than light.

Not only this, but the association between light, gravitation, and the spacetime fabric not only completely ignores magnetism, but it also takes the wrong turn. Space and time until then were viewed as abstract concepts used in physics to describe the behavior of various material objects, and they were not part of the explanation. John Archibald Wheeler described [20] this connection as '*matter tells spacetime how to curve.*' But so far, we have found only the photons behaving this way, and we do not know anything about the behavior of magnetic monopoles, or of the magnetic energy carrier particles, if they obey the same law. Never mind a potential graviton particle behavior.

By introducing pure mathematical frameworks to describe Nature's laws, we lost Newton's deterministic view of our Universe, and we didn't make a lot of progress answering the question of 'why.' Also, in the nineteenth century, when Charles Darwin introduced his theory of evolution, a new idea that the entire Universe is the result of a greater evolutionary cycle looked like a possibility. This had no way to fit into the existing model of the Universe.

This pattern of 'ignore it if we cannot measure it' continued with a major discovery of the twentieth century. When Claude Shannon introduced his information theory in 1948, he acknowledged that information has two attributes. One of them is physical, and one of them is semantic. In this paper, the *semantic* attribute is renamed as *causal*, because by processing the message content, it is very likely that the receiver will go through a transformation. In his paper, Shannon was explicit in his approach. He described his theory as being applied to the physical attribute and chose to ignore the semantic/causal one. His explanation followed a tradition in science: if you do not know how to measure it, then it is irrelevant for current and possible future practice.

Shannon's attitude towards the semantic/causal attribute continues today. Processing the semantic/causal content of a message is at the core of 'intelligent' behavior, but so far, we have ignored the ability to measure its complexity. As a result, we have arrived at absurd statements about our ability to achieve 'superintelligence' when, in reality, we have been beaten badly by the ability of a virus to process information. This virus is an organism with no visible ability to think, and to top it all, the same virus uses an infinitesimal amount of power to create trillions of dollars in damage.

This paper's main goal is to introduce a framework that will bring back both parts of our Universe, those that we know how to measure, with those that we don't. Not only this, but the resulting model is deterministic, evolutionary, and it has a quantum nature.

The way this goal was achieved was by going back to Shannon's theory and extending it to the *semantic/causal* attribute. This new extension uncovered a link between *information* and *energy*. And because *energy* is an attribute associated with all material objects, the next step was to identify the information *semantic/causal* attribute as a new dimension of our Universe. When we apply the *invariance* principle to the new dimension, we find the missing links between all different domains of our Universe, including some already well researched, and most importantly, some that were mostly ignored for the past few centuries.

Adding a new dimension and the invariance principle is not a simple extension of what we already know about *how the world behaves*. It can be constructed into a new field called the **Physics of Information**, in which existing laws take new generalized forms, and new laws are uncovered.

## 2. Shannon's Theory and Viable Systems

To understand how extending Shannon's theory became the foundation for the new *Physics of Information*, we are analyzing the next few new aspects. The first one is related to the consequences of ignoring the semantic attributes have over later developments. Next, we introduce the new extension that covers the semantic/causal attribute theory. We continue with a proposal on how to measure the complexity of a message related to a semantic/causal attribute.

### 2.1. Physical Attribute Only

In 1948, Claude Shannon introduced his theory of information. This theory sits at the foundation of the modern digital world. Together with the discovery of the *transistor*, the new theory made possible the development of microprocessors, networks of communications, and computer programming.

In his paper, we find three fundamental concepts related to information.

- **General communication system** – this generic communication system has mainly three basic elements: transmitter, receiver, and the exchanged signal
- **Bit** – the concept of a *bit* is used to measure the physical size of an encoded information signal. It is defined as the smallest unit of information, representing a binary value of either 0 or 1.
- **Condition for a physical signal to be successfully processed** – in its basic form, the theory states that for a receiver to successfully process a physical signal, it needs to be capable of processing a frequency that is at least equal to the one used to encode the signal, plus the noise.

This is why your radio, to be able to reproduce the signal, has to be able to fully capture the radio waves, decode them, and convert them into an audio signal. The same rule applies to microprocessors. All its modules required to participate in the computation cycle need to be able to synchronize their operations with the main clock.

When Shannon wrote his paper in 1948, he also highlighted the limitations of his theory. He stated that [1] '*frequently messages have meaning; that is, they refer to or are correlated according to some system with certain physical or conceptual entities.*' He continues with justification for his decision that '*these semantic aspects of communication are irrelevant to the engineering problem.*'

In 1948, there were no computers, no digital communication networks, and no software. This is not true in today's information-driven society. Although numerous control systems still depend on processing a signal's

physical attributes, most contemporary software tasks differ fundamentally from this approach. We are writing mostly code that is dedicated to reading the instructions contained in the message and then working towards completing the list of tasks contained in them.

And this model of communication can be extended further to cover far more complex problems. A business can use the model to 'listen to the market signals and process them.'

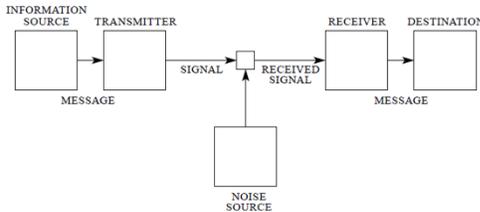


Figure 1. Shannon's generic communication system model's main components are transmitter, receiver, and the exchanged signal. The size of the physical signal is measured in bits.

One particular case of such a communication model is when both *transmitter* and *receiver* are **viable systems**. This type of system is the one that is continuously adapting its internal operations to a changing environment. In practice, there are two examples of such systems: one is *biological organisms*, and the other is a *business organization* that provides a service or manufactures a product that targets consumers. Later in the paper, we call them **Viable Complex Systems**.

### 2.2. Introducing Causal Attribute

To extend Shannon's theory to the information *causal* attribute, we are starting with definitions. A signal from a *generic communication system model* has two attributes.

- **Physical** – a message or a signal, regardless of its content, can be represented as a sequence of symbols encoded in a medium, which can be sound waves, radio waves, or any type of carrier.
- **Causal [Semantic]** – the content of a message or a signal qualifies as *causal* if it carries instructions to be executed by the message receiver.

It is important to note that there is no relationship between the size of physical size of a signal and the complexity of its content.

The attribute is called *causal* because, in its most complex form, and valid for most practical cases, this attribute carries a list of tasks to be executed by the receiver of the message. The execution of these tasks is likely to cause changes to the receiver's operations.

A typical communication setting in which a signal carries both attributes is the exchange that may happen between a pilot and a ship in a war scenario.

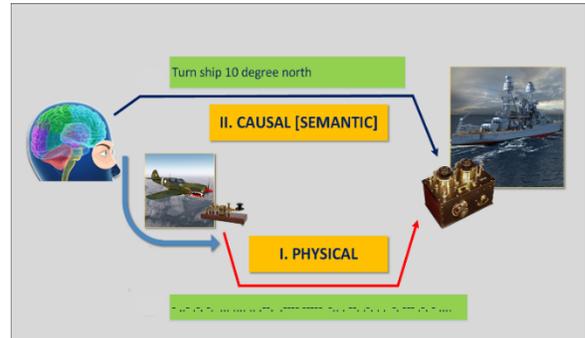


Figure 2. In this scenario, a pilot sends a command to a ship commander. The physical message is encoded using Morse code. The ability of ship commander to follow this command is dependent on many available capabilities. The most important one is having enough fuel as a source of energy to turn the ship.

From this example, we can conclude that the development of a way to measure the *causal* attribute complexity is not going to be as easy as the one used for the *physical* one. In the previous scenario, there is a condition for success that oversees all the other ones. If the ship doesn't have enough fuel to turn, then everything else matters less.

The next example shows the difference in complexity between the content of two messages.



Figure 3. In this scenario, there are two messages exchanged between two users. Their physical size is almost the same. One message has a causal attribute order of magnitude higher in comp.

In one case, the receiver has a simple task to execute. The only condition is to operate in a context that allows it. The second case is orders of magnitude higher in complexity, regardless of the existing context. This shows that *causal* attributes may have a wide range in complexity.

### 2.3. The Complete Communication System Model

Before we define a way to measure complexity, we need to first define what happens in a generic *communication system* when both attributes are accounted for.

In the next example, we are looking at a very popular exchange of information between a *transmitter* and a *receiver*.

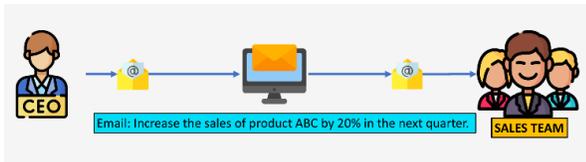


Figure 4. This is a very popular exchange that happens in all businesses. In this case, the executive team sends an email to the business sales team that contains a task to carry out.

The email exchange example follows the pattern of a complete communication model. The email message's *physical* attribute is guaranteed to be successfully exchanged and processed by the email server, email client, and the network configuration.

To guarantee the successful completion of the email exchange is dependent on the ability of the Sales team to achieve the objective highlighted in the task.

There are two conclusions to draw from this scenario. One is that completion of a message may take a long time, and the second is that it may require a certain amount of resources to complete. In the case of the Sales team, such instructions will likely come with additional financial resources attached.

To conclude, a successful message exchange that includes both *physical* and *causal* attributes follows a complex pattern. Next, we are looking at all the required steps.

On the *transmitter* side, the CEO follows three steps.

- **Create causal content [1]** – the executive team creates the list of tasks and adds them to the email message
- **Create physical message [2]** – the email client takes the content and packages it into a physical email message

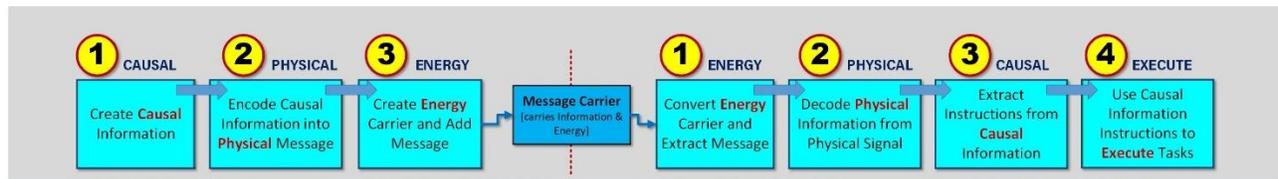


Figure 5. To complete a message exchange, causal and physical, there are three steps to complete on the transmitter side, and four steps to complete on the receiver side.

- **Add energy to carry the email [3]** – the executive team email client adds electrical energy to the email message. This will ensure that the email will reach the *Sales* team's inbox.

Once the email reaches the *Sales* team client email, and a team member opens it, the process goes into reverse.

- **Convert the energy carrier into a physical packet of data [1]** – the email client uses the electrical packets to extract the data
- **Extract physical email information from the data packet [2]** - the email client converts the data packets into a physical email
- **Extract causal information attribute [3]** - the email client converts the email content into a text message

- **Successfully complete the tasks [4]** – this is the last step. The *Sales* team reads the instructions and completes the tasks associated with

The last step is not only the one that completes the exchange, but it is also the one that highlights a special relationship that exists between the information causal attribute and energy. To complete the tasks, the Sales team must have access to additional financial resources. And the size of financial resources is proportional to the complexity of the tasks.

Now that we know the steps, next we look at the role the two *contexts* play in the message exchange. The first one is the *physical context*, and it plays the role of a container for the physical message. Next is the *causal context* that plays the role of a container for the tasks.

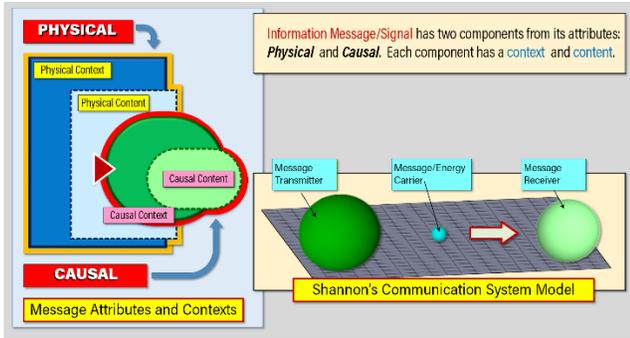


Figure 6. There are two contexts, one physical and one causal. All three elements – transmitter, receiver, and message – have both contexts.

In the previous email example, it is easy to identify the two contexts.

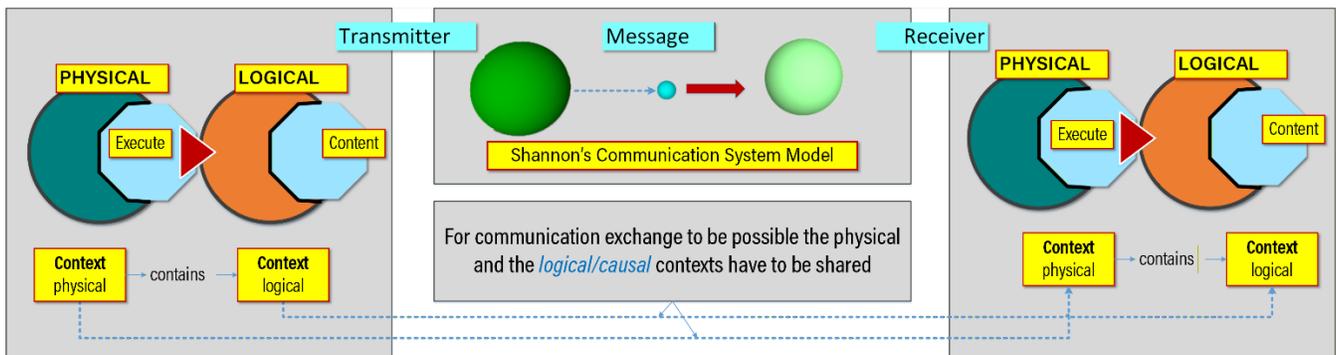


Figure 7. This diagram shows the three elements of the communication system – transmitter, receiver, and message – with their attributes and contexts.

#### 2.4. Message Processing and Causal Context

When we process information, *causal* attributes apply in a wide variety of cases. For example, the observation of a faraway galaxy. When we receive light, we can read the information, but communication is limited to acknowledgement only.

When it comes to *causal* attributes, there are only two types of messages.

- **Notification** – the receiver does process the message, but the content does not include a list of tasks for the receiver to complete
- **Command** – the message content includes tasks for the receiver to complete. This is the most generic case of communication where the extension of Shannon's theory applies.

The *command* type of message is the one that is relevant for communication between viable systems. It is also the one that requires both contexts to be aligned.

The *physical context* is where we find the email clients, the email server, and the network configuration.

The *causal context* is where we find the business processes associated with the organization. Both the executive team and the *Sales* team must be part of the same organization for the message exchange to be valid.

The context is required to model the exchange only if the *causal* attribute is processed. Shannon's theory of information assumes that successful message processing is not dependent on its context.

A more complete picture of a complete exchange shows both the transmitter and the receiver, together with their contexts.

To define a *causal* attribute, the receiver needs information on a few

properties associated with its context. They are space, time, history, classification, structure, and law driving behavior. The most important one associated with message processing is its complexity. It combines all of them with the amount of energy required to complete the list of tasks.

We want to reiterate that, regardless of the knowledge a receiver has about the message, the alignment of the communication system context is always required. For instance, if an executive team sends instructions to a *Sales* team to complete some tasks, but the *Sales* team is from another business, the exchange will never take place. It has to be part of the same organization.

#### 2.5. AI and the Need for Context

Previously, we stated that in practice, we have two types of messages in a complete communication scenario. They are *notifications* and *commands*. Without exception, all current AI interfaces are *notifications*. This type of message exchange has a limited use in practice. Most communications in business, in engineering, in military

operations, or even in the medical field are *commands*.

The advantages of using a *command* type of communication are many. First, it requires that the *transmitter* issue a *command* only after it has assessed the receiver capabilities. For instance, you cannot send surgery instructions to medical personnel who are not surgeons. Second, those instructions need to be synchronized with the object of interest and its context.



Figure 8. A cutaway into Boeing 777-300ER. This plane has over 30 million parts. Issuing a command to an engineer to modify any of them requires full context associated with the message.

To better understand the need for aligned *context* in communication, we can look at the following scenario. Imagine that a mechanic receives a message that contains a simple task, which is to recalculate a bolt in the landing gear of a Boeing 777. While the task looks complicated, any junior mechanical engineer will be able to complete this task successfully, and any attempt to use a current AI-based interface tool will fail. The reason is the lack of *context* in the AI response.

The main explanation why a junior engineer can calculate the *bolt* is that he can walk easily through different *causal contexts* related to the overall functionality, guided by the fundamental laws of physics.

The limitations of AI-based prompt engines originate in the way their training is done. There are two approaches to training AI-based engines.

- **Dataset-driven** – this is the most popular one. It uses massive datasets of texts and images. The result is used to learn patterns, relationships, and the structure of various subjects.
- **Video-driven** – more recently, Yann LeCun released the Video Joint Embedding Predictive Architecture (V-JEPA). While it may provide a better answer in some cases, the main problem remains unchanged. Recreating message *contexts* is still the main obstacle in upgrading the AI engine to issue *commands*.

These training methods overlook the human way of learning, which primarily relies on experience. Even in the case of designing the bolt, the engineer uses the laws of physics to understand the causal context in which the task is performed. And the laws of physics are nothing but a

standardized way to document our experience gained from interaction with the world around us.

To conclude, while the AI-based tools could be helpful when it comes to *notification*-type interactions, they have limited practical use when it comes to *command*-type ones. And *command*-types are the ones playing a key role in complex interactions that are driving business decision-making cycles, the design of complex engineering devices, and the design of software used to virtualize various processes.

## 2.5. AI – Context, Monotonic vs. Nonmonotonic Reasoning

John McCarthy, the researcher who coined the term AI many decades ago, was interviewed by Jonathan Skilling from CNET a while ago. What he said then in 2006 is still valid today after two decades.

When Jonathan asked McCarthy about [12] the current state of AI research in 2006, he said that it is “*a question of basic ideas.*” One of these basic ideas “*was the recognition that computers would have to do nonmonotonic reasoning.*” This type of reasoning is still out of reach for all current AI engines, and it doesn’t look to be added soon.

Nonmonotonic reasoning is where you draw a conclusion, which may be a correct conclusion to draw, but it isn’t guaranteed to be true because some added facts may prevent it. This type of reasoning is mastered by all biological organisms. They can adapt their actions to random changes in their environment.

McCarthy was also asked what would be “*the next big thing, then, to accomplish?*” McCarthy said that “*I would like to see further progress in formalizing commonsense knowledge and reasoning, taking context into account.*” As we mentioned previously, a simple engineering problem may require navigating a complex hierarchy of contexts to reach a solution.

Current AI engines use training methods that add only a simple context to stored information. Also, information stored does not have a complexity index associated with it.

## 3. Viability and Causal Attribute

Many decades ago, Niels Bohr famously stated that ‘*Nothing is there until it is measured.*’ This applies especially to the field of information. Because we do not know how to fully measure it, this lack of knowledge is translated into a confused meaning. And this confusion is extended to all concepts that are information related.

For instance, we do not have a clear definition for the concept of knowledge, or intelligence, or system viability. Also, the Turing test cannot be considered a scientific method used to measure intelligence.

In this paper, we propose a scientific method to measure complexity, which is equivalent to measuring the information causal attribute. This should apply to the exchanged signal and to the assessment of capabilities to process complexity associated with either the transmitter or the receiver.

The first step in finding this method is to look for existing information processing platforms. The most obvious choice is the biological organisms. They have the most complex information processing architecture we know so far has allowed them to not only survive for billions of years, but also to evolve into our current socio-economic environment. They were able to survive for so long because their entire existence revolved around their *viability*.

A detailed description of the proposed information processing architecture found in biological organisms was presented by me at the AAAI 2009 Fall Symposium. The paper was titled “*Back to the Basics - Redefining Information, Knowledge, Intelligence, and Artificial Intelligence*,” and it highlighted the role viability plays in understanding information complexity. Next is a summary of the main concepts covered by this paper.

### 3.1. What is a viable system?

In the paper, *viability* is analyzed in the context of a complete communication system introduced by Shannon in his 1948 theory of information. Both receiver and transmitter are *viable* systems.

The first researcher who introduced [5] the *viable system* concept, and the idea that a business organization targets *viability* before anything else, was Stafford Beer in his 1972 book called ‘*Brain of the Firm*.’ He is also considered the father of management cybernetics. Norbert Wiener is considered the father of cybernetics [6]. Beer stated that *viable systems* are defined by a few attributes:

- **Environment** – a viable system can absorb and make use of information from its environment
- **Adaptation** – a viable system can adapt to its environment
- **Identity** – a viable system can maintain its identity
- **Learn** – a viable system can learn from its interactions with the environment

The field of **cybernetics** has been defined by Beer as the science of effective organization. Because viability plays such an important role in the existence of adaptive systems, the key to unlocking the concept of complexity can be found in analyzing how these systems process information to maintain it.

### 3.2. Computing power, complexity, and viability

Currently, a very popular trend is to equate the ability to process complex information with computing power. Large corporations are heavily investing in massive data centers to increase their ability to process complex causal information.

When we analyzed the relationship between *physical* and *causal* attributes, we found no correlation between their size. The same lack of correlation exists between *complexity* and *computing power*.

But there is a direct relationship between *viability* and *complexity*. An ultra-primitive biological entity, such as the COVID virus, is very adept at spreading its existence. This is done despite its lack of computer power. In fact, it does this while consuming infinitesimal amounts of energy.

Another example is a nematode called *C. Elegans*. This nematode is a widely used model organism in biological research because it is easy to study in a lab. Sydney Brenner is one of the first developmental biology researchers who [3] proposed its study in 1963. This nematode has a simple structure. Its size is less than 1 mm, and its organism has a little over 1000 cells, out of which a little over 300 are neurons. Despite its size, *C. Elegans* shares many similarities at the molecular level with all the other biological organisms, including humans.

One capability that all biological organisms have is the ability to do nonmonotonic reasoning and operate in different contexts. Not only are current AI engines unable to perform these advanced reasoning tasks today, but based on their current development trajectory, this capability is unlikely to be added soon.

To conclude, larger data centers are useful to support communication with messages that have large information with *physical* attributes. They may also require large amounts of energy for processing. But when it comes to processing messages with *complex causal attributes*, the physical size of the data center and the amount of energy may not apply.

The current approach to AI assumes a relationship between the size of data centers and the information complexity processed. The new information theory does not support this idea.

### 3.3. Viable System Model

Stafford Beer, in his 1972 book [5], introduced the first true representation of a *viable system* called the *Viable System Model* [VSM]. The *VSM* is a model of the organizational structure of any autonomous system capable of producing itself. It is based on the implementation of *viable system theory*. A *viable system* is organized to process information to meet the demands to survive a changing environment.

The single-level *Viable System Model* is a special type of *dynamic system* that is organized around three elements:

- **Process** – this is where we find the main operations that drive the existence of the system; this is also where, in a business, we find the value chain cycle, and in a biological organism, we find the individual cells' ability to convert nutrients into energy.
- **Controller** – this is the main internal mechanism that drives the adaptability of the system to a changing environment
- **Adjuster/Organizer** – this is where we find the processes tasked with acquiring information about the environment.

While the representation is accurate, the VSM has not been used a lot in practice. Stafford Beer tried to improve the model representation of an organization by adding another level of detail. The goal for this new level was to map various aspects of organizational structure.

In the new model, an organization viewed as a single-level viable system is split into five different subsystems. **System 1 "Operations"** in a viable system contains several primary activities. A primary activity is defined by the multi-level VSM as those processes that are direct participants in the value creation cycle. **System 2 "Coordination"** represents the information channels that allow the organization to communicate between different systems. **System 3 "Operational Management"** represents the internal control structures dedicated to the value creation cycle. **System 4 "Strategy Management"** represents the control structures responsible for looking outside for changes to the environment and for developing strategic plans to adapt the organization to them. **System 5 "Governance"** represents the internal structures responsible for governance and policy decisions.

This multi-level VSM has more details than the single-level one. Despite this, it is not used in practice. We see two reasons why this model didn't have success in business management. The first reason comes from its *descriptive* nature. It tells you about *WHAT* the various parts are, but less about *WHY* they work together.

The second reason is a lot more important. A business organization's viability is entirely dependent on its management capability to process information. This information may come from the environment or from its internal operations. Any model that maps internal aspects of organizational structure has to be aligned with the two main information flows. The main information flow is aligned with the *supply chain cycle*. The second information flow is aligned with processing the main enterprise change management cycle.

One is associated with the value creation cycle. The other one is associated with the change management decision cycle.

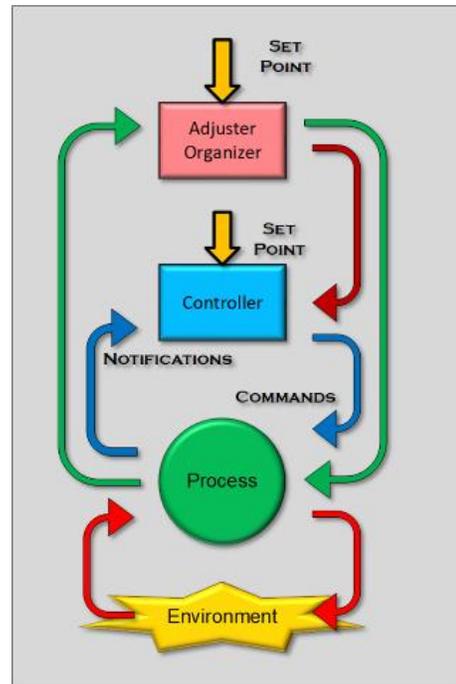


Figure 9. The single-level *Viable System Model* was introduced in 1972 by Stafford Beer. He is considered the father of management cybernetics.

To fix the single-level VSM shortcomings and make it practical, a new extension was introduced in a 2009 paper. I called this extension the *Viable Complex System* model. The main inspiration for this model was the way biological organisms process information that drives their adaptation to environmental changes.

In this model, its components are grouped based on the two information flows. The first one is the value creation cycle, which in practice is called the supply chain cycle. The second one drives the main change management cycle that includes the new product development processes. The model also organizes processes based on their complexity. This makes it easier to allocate resources.

The *Viable Complex Model* is the one used by this paper to introduce the concept of *viability* and the new extension to Shannon's theory of information.

#### 4. Measuring Causal Attribute and Viability

In his information theory, Shannon introduced the concept of a *bit* to measure information *physical* attribute of a signal. On the *receiver* side, the main theoretical condition cares only about the successful decoding of a message into a sequence of **0** and **1**. No *context* required, no condition that

the decoded message makes any sense, and not even the condition that it is in a known language to the *receiver*.

#### 4.1. Information Density

When we want to measure a *causal* attribute associated with a message, the successful processing of its content by the *receiver* is a lot more complex, and a lot more conditions apply.

We begin by examining organism *viability*. A few conditions can be identified to influence the ability of a biological organism to survive when the environment changes:

- **Same physical context** – a biological organism may respond better when it operates in a familiar environment
- **Energy level carried by message** – this is not entirely obvious; to be able to read a message, its level of energy has to be between certain limits; Shannon's theory does not say anything about signals that carry energy outside the *receiver's* capabilities.
- **Internal energy receiver has** – this condition is obvious. A weak organism has fewer chances to adapt.
- **Receiver is fully operational** – when an organism is living in extreme conditions, its ability to adapt diminishes. The same is true for businesses when they are operating in extreme market conditions. Their operations are limited.

To conclude, the ability of a *viable system* to adapt is dependent on many conditions that are difficult to quantify. The best way to measure *viability* is to associate with each *message* the **probability value of that message being successfully processed** by a given type of viable system. We are calling this *probability* that measures the information *causal* attribute the **information density of a message**. The information density value of a message is inversely proportional to its probability of being successfully processed.

**Information Density of a message or a viable system**

$I_d = \frac{1}{P}$

where **P** is the probability for a given type of receiver to complete the tasks associated with the message content

Figure 10. Information density measures the *information causal attribute* associated with a message's complexity, with *transmitter* capabilities to generate complex messages, and with *receiver* capabilities to process complexity.

We are using the inverse value of probability for an easier representation. The more complex the task, the lower the probability, and the higher the *information density* value. Various components of a *viable system* may have different values.

#### 4.2. VSM Processes and Information Density

In a *Viable System Model*, messages processed by the *Operations* layer must be greater than or equal to 1. This is because a probability of less than 1 for this group of processes will result in the possible system dismissal. The failure of a biological organism to process nutritional energy or the failure of a business organization to maintain its supply chain operational means that its capabilities as a *receiver* have an *information density* value less than 1.

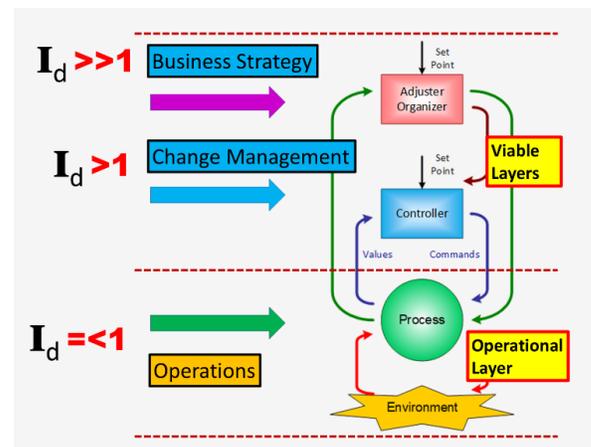


Figure 11. Information density measures the *information causal attribute* associated with a message's complexity.

The most complex messages require the viable system to readjust the entire system, including the way it controls its operations. In business, this is where we find the generation of strategic plans.

The next in complexity are messages that require only adjusting the existing operations. They are the change management processes. Operations are tasked to directly process the messages with the lowest complexity. This is where businesses may make small adjustments in volume, price, or manufacturing.

The more complex the message required to be processed, the higher in hierarchy the control processes are required. A few hundred million years ago, a biological organism evolved to live on land. Its entire organism went through a profound transformation. The message telling those organisms that water may not always be available was the one that triggered the adaptation.

The same is true for businesses. Changing consumer needs most likely will trigger a new strategic plan in many

businesses. The ability to successfully process that message is a measure of its *information density* capability.

### 4.3. Viable Complex System Model

The main reason why VSM is not widely used in practice is that it is too generic, and it doesn't have enough details. The main layers, Operations, Change Management, and Business Strategy, are too generic. It is also difficult to associate this model with the modern physical structure of a business that includes various departments, like Product Development, Sales, Manufacturing, Finance, HR, Legal, IT, and so on.

In the AAAI paper [7], a new viable model was introduced that extends the *Viable Model System*. This model is called the *Viable Complex Model*. The main goal for the introduction of this extension was to make it easier to use in practice. The new model is used to align internal processes to the two main information flows and to organize them based on their ability to process *complexity*.

*Complexity* in this context is associated with the processing of the *semantic/causal* information attribute. The new model arrangement of different processes was inspired by the biological organism's *viability* mechanism. The survival of a biological organism is dependent on two different types of processes. One type is directly responsible for its existence, and the other is responsible for its adaptation.

Previously, we mentioned that a *dynamic system* must have an internal mechanism that will enable its lively behavior, a mechanism that is at the core of its existence. In a biological organism, the cells are responsible for

converting food nutrients into energy. In a business, the supply chain is the one responsible for the value creation cycle. And because it creates value, a business has customers. And because it has customers, the business exists as an organization.

The set of transformation processes that are found in the bottom layer is called *operations*. The top five layers that drive the adaptability are called *viable*. They are responsible for receiving messages from the environment and driving changes to existing operations. For example, eons ago in Earth's history, ocean living organisms were forced to adapt to living on dry land. In business, operations may be required to change when the market dramatically changes.

The relationship between different levels follows a simple pattern, which is a *Hierarchical Finite State Machine*. The existence of all five layers has been inspired by the way biological organisms process information. At the bottom, there is a single layer:

- **Operations** – this is a special level. All processes on this level are core to the existence of the *viable system*. They are the reasons why organisms or businesses exist in the first place.

In real businesses this is where we find the supply chain cycle processes. In biological organisms this layer is where we find the mechanism by which a cell converts nutrients into energy.

In the next diagram, there is a representation of the *Viable Complex System* model applied to biological organisms.

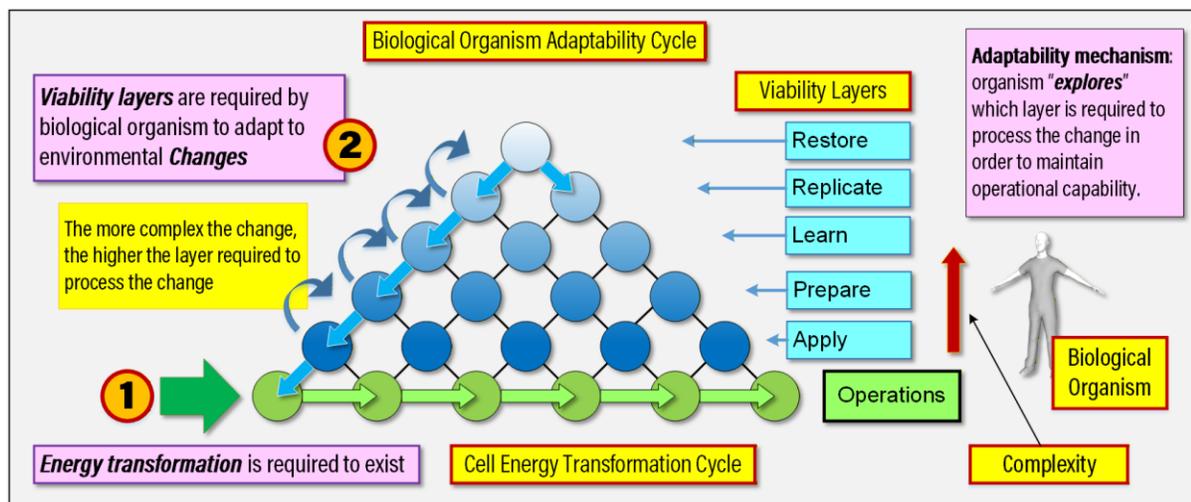


Figure 12. This is the Viable Complex System model. This model splits the internal processes into two groups. The first group [1] is made of five viability layers and is they are participating in the biological organism adaptability cycle. The second group [2] is made up of processes responsible for the energy transformation cycle. This is at the core of a biological existence.

Adaptability and system viability in a Viable Complex System model are represented by five layers of processes:

- **Apply** – processes from this level have direct access to various aspects of system *operations*; for instance, this is where we find processes that will increase the rate of our transpiration in a hot climate. In business, this is where we find a process able to adjust delivery to stores when demand fluctuates.

These processes are responsible for *operational change management*. In a business, processes from this level are organized around the *enterprise master scheduler*.

- **Prepare** – processes from this level are responsible for planning various changes in the system *operations*. For instance, if a biological organism lives longer in a cold climate, the body will make some changes to how it operates permanently. The same is true for a business.

For instance, if a certain market requires constant updates because the sales are frequently increasing, then the business will establish a separate distribution center dedicated solely to that market. In the new structure, adjustments to the market variations are moved to operate at the new distribution center. In a business, processes from this level are organized around the *enterprise planning* platform.

- **Learn** – as we move up from one level to another, process *complexity* increases. This is because in a *hierarchical finite state machine*, with each level, the number of optional paths increases. Processing information signals it receives from its environment and from its internal command and control mechanism may take different forms based on internal decisions.

Biological organisms are capable of learning from long-term patterns, and they adapt their behavior to them. Examples of such behavior are the great migrations that happen in the African savanna during the transition from one season to another. In business, the executive team is in charge of the *learning* cycle.

- **Replicate** – the need for replication in the biological world is simple. It is the one that allowed them to survive for billions of years.

It is important to note that during replication, the new organism needs to inherit all the processes from the lower levels. In a business, the replication mechanism is found at a smaller scale of complexity, which is in the franchise network. Replicating complex operations is not only difficult but also impractical.

- **Restore** – this is by far the most complex set of processes found in any *viable system*. While it exists at the top of all viable processes, it is not fully enabled. This set of processes is tasked with trying to restore *operational* capability when there is a loss of a fundamental function and the overall capability has been diminished.

For instance, when an octopus loses an arm, its body is capable of restoring it back to its original form. In business, this situation doesn't happen too often. Many times, in a post natural disaster world, many companies will need to completely reinvent their operations to survive. A *restore* process may not always be successful.

While it may look different, the *Viable Complex System* model can be easily matched with the *Viable System Model*.

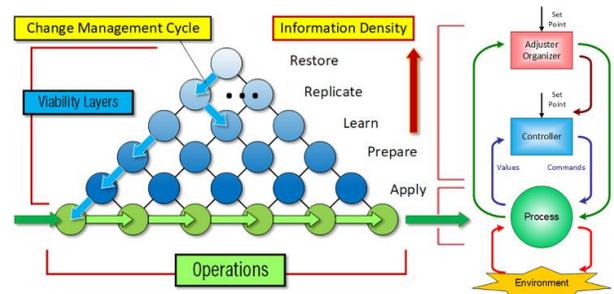


Figure 13. The group of the top three viable layers is a match for the Adjuster/Organizer group of processes. The bottom two viable layers are a match with the Controller group of processes. Operations are matched with the Process group. For some decisions, the Learn group is shared between the Controller and Adjuster/Organizer.

The *Viable Complex Model* is an extension of the *Viable System Model*. Because of this, all its associated definitions apply. The complexity of various layers is measured the same. It uses the *information density* values.

The main difference between different viable layers is in the number of processes associated. The five viable layers can be easily modeled using a *hierarchical finite state machine*, which is a well-studied mathematical construct. The same mathematical model can be used to explain how complexity increases with each level.

There is an interesting analogy that can be made between Feynman's path integral formulation that is used to represent the behavior and interactions between subatomic particles and the way Viable Complex Model selects which viable layer is required to process an external message in order to maintain the system's operational integrity. A simple rule states that the higher the complexity of a message, the more energy is required for processing. Higher viability layers have access to higher amounts of internal energy.

## 5. Physics, Causal Attribute and Energy

In a recent conference, Sean Carroll [18] defined the current field of physics as 'what the world is, and how the world behaves.' But this world doesn't include a wide range of entities, from biological organisms to business organizations. All of them are part of the world we know but

they are not covered by modern physics. While these entities look different, they share a common fundamental conduct. All of their operations have information processing at their core.

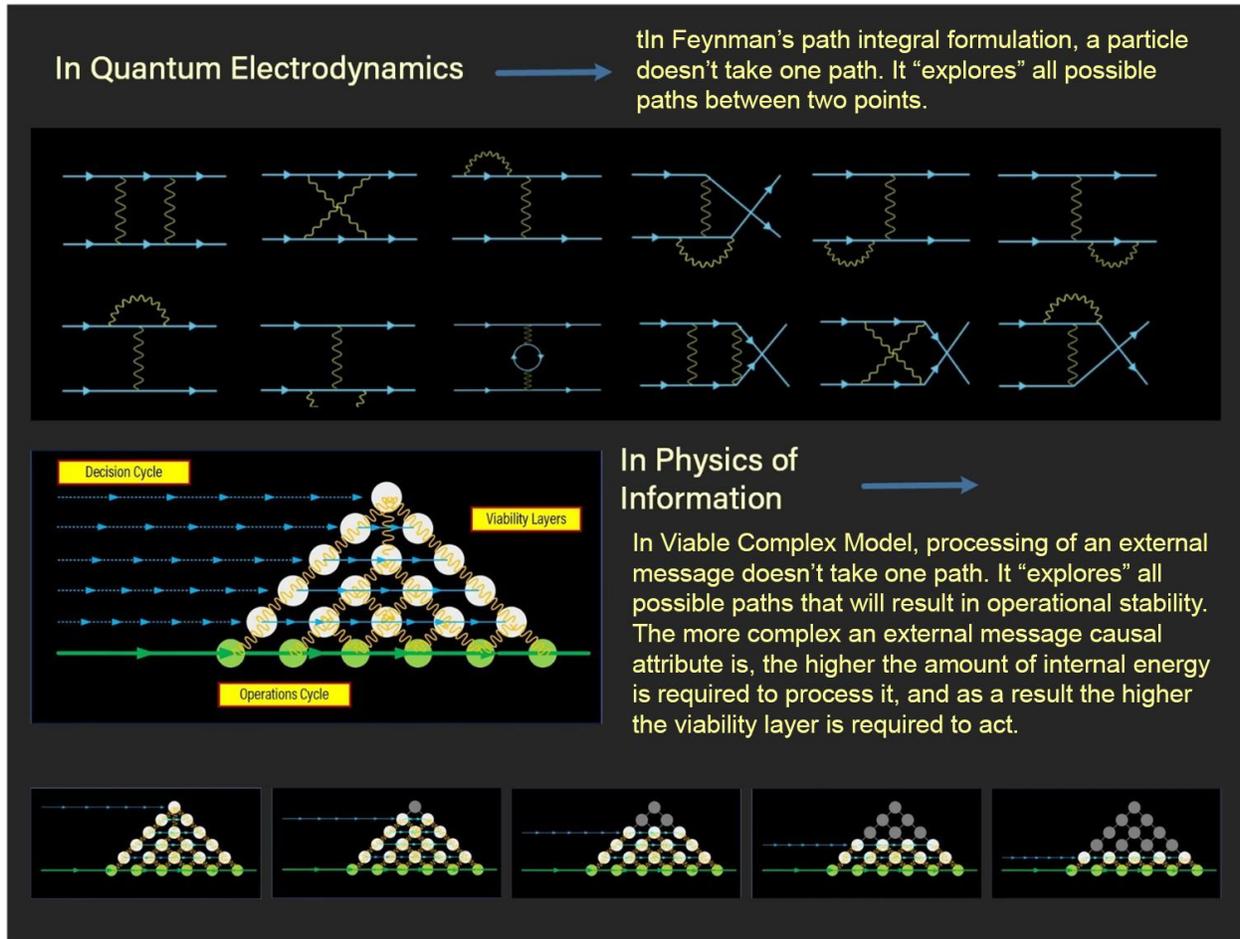


Figure 14. There is a parallel to be made between the way Feynman's path integral formulation acts and the way Viable Complex Model decides which viable layers are required to process an external message. Processing of a higher complexity message requires a higher viable layer to act. The higher the viable layer in hierarchy, the higher the amount of energy is available for processing

Next, we extend Shannon's generic communication system model to all interactions found in the Universe, including those between atomic and subatomic particles.

### 5.1. Laptop versus Sun

One simple example that shows the need to include information processing in the mix to better understand the world around us is demonstrated by the following scenario.

In this experiment, a Universal Observer, which is a basic concept used in physics, compares the light from two

sources that have the same wavelength. One source comes from the computer screen, and the other one from the Sun. According to current physics laws, both types of photons are the same. Having the same wavelength means they carry the same energy.

But when we account for the information *causal* attribute, then there is a fundamental difference between the two energy carriers. Given the right *causal* context, the photon from the computer carries a lot of extra information. The photons from the Sun are pure operational, which means that they carry only energy that will be exchanged

with the receivers in our visual system. No extra information.

The photons from the computer tell us a story in which the stock of a corporation called ACME has its share price of 86.7, and it has increased from a previous value. Given the right receiver, the processing of this information may trigger the buying of additional shares or the selling of existing ones. This may happen only when we observe the photons from computer screens, and never when we observe the ones from the Sun.

While this experiment is a simple one and it looks obvious for various reasons, there are many cases in which this distinction is not that obvious. Not only this, but certain fundamental laws that we do not know may apply to a message exchange, and we need to be aware of them.

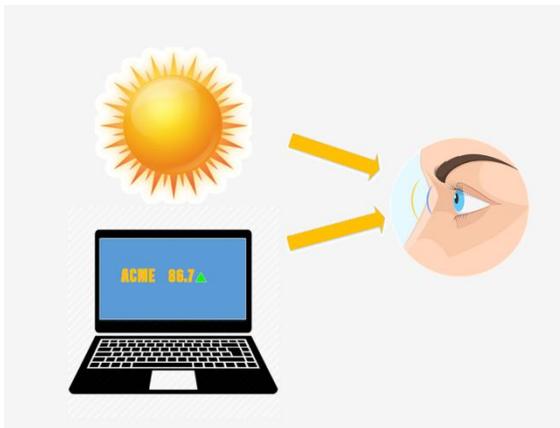


Figure 15. The observer in the case above receives two identical photons, same wavelength. By using the classical Universal Observer, current physics laws do not make any distinction between them, while it is obvious that one of them contains additional causal information

In a previous communication model, we associate energy with processing of information *causal* attribute. Before we add information to the new model of the Universe, we need to review what is our current understanding of this concept.

### 5.1. What is information?

To begin with, *information* is always defined based on the context in which it is used. From Merriam-Webster dictionary, *information* is defined either as *the communication or reception of knowledge or intelligence, or as a signal or character representing data*. When we are looking for *data*, we find it defined as *a collection of factual knowledge about something*. Looking at the way we define the concept of *knowledge*, we find that it can be defined as *the understanding and information gained from being educated*. In most cases, these definitions lead to a circular dependency, which makes it difficult to bring a rigorous scientific framework into the picture.

One of the best attempts to define *information* is found on [16] Stanford Encyclopedia of Philosophy website.

The website acknowledges that '*information is a conceptual labyrinth*' that may have different interpretations based on the context in which it is used. From this map, *information* is defined as *data* when using the mathematical theory of communication, and then it recognizes the *semantic* nature when used in philosophical theories.

The website goes further and warns the reader: "*The reader must also be warned that an initial account of semantic information as meaningful data will be used as a yardstick to outline other approaches. Unfortunately, even such a minimalist account is open to disagreement. In favor of this approach, one may say that at least it is less controversial than others.*"

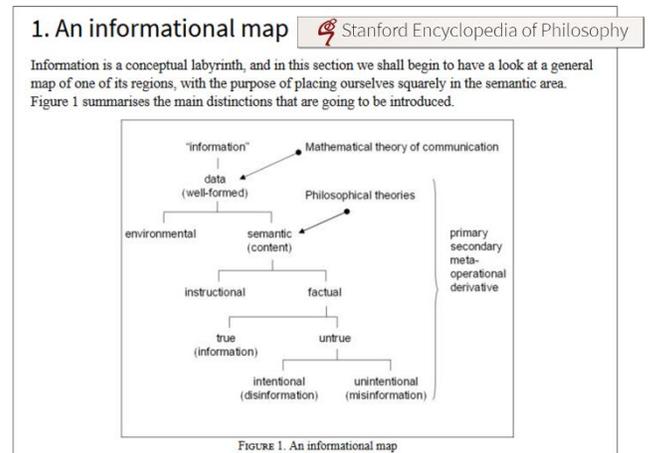


Figure 16. The Stanford Encyclopedia of Philosophy website has one of the best descriptions of different forms of information takes.

The website acknowledges the need to start somewhere with defining information, although it may be incomplete and complicated: "*The difficulty is rather more daunting. Philosophical work on the concept of (semantic) information is still at that lamentable stage when disagreement affects even the way in which the problems themselves are provisionally phrased and framed.*"

This association between the concept of information and its context is also recognized by Shannon and Weaver [17] in their paper. They are supporting a "*tripartite analysis of information in terms of (1) technical problems concerning the quantification of information and dealt with by Shannon's theory; (2) semantic problem relating to meaning and truth; and (3) what he called "influential" problems concerning the impact and effectiveness of information on human behavior, which he thought had to play an equally important role.*"

And the variety of these definitions does not stop there. Several authors have proposed a few variants of the philosophy of information as an attempt to rethink philosophy from a new perspective.

Next there are few topics in which various researchers tried redefining information in different contexts: *Quantum Physics* (Mugur – Schachter, 2002), *Logic* (Brenner, 2008), *Semantic Information* (Floridi 2011; Adams & de Moraes 2016), *Communication and Message Systems* (Capurro & Holgate 2011), *Meta-Philosophy* (Wu 2010, 2016), others (Adriaans & van Bethem 2008; Lenski 2010).

These extensive efforts show a simple truth, which is that **Information** is a fundamental concept that can be found in all contexts associated with our existence, and that includes all material objects found in Universe.

### 5.2. What is energy?

The next topic is **Energy**. In physics, **energy** is defined as having two forms: **Kinetic** and **Potential**. One is related to a material object in **motion**, and the other is related to the object's **location**.

But a generic definition stops there. In the next table, there is a list of some forms of **energy**, and the way each form is defined is based on the context in which it operates.

TABLE I  
Forms of Energy - Wikipedia

Type of Energy	Description
Mechanical	the sum of macroscopic translational and rotational kinetic and potential energies
Electrical	potential energy due to or stored in electric fields
Magnetic	potential energy due to or stored in magnetic fields
Gravitational	potential energy due to or stored in gravitational fields
Chemical	potential energy due to chemical bonds
Nuclear	potential energy that binds nucleons to form the atomic nucleus (and nuclear reactions)
Chromodynamic	potential energy that binds quarks to form hadrons
Elastic	potential energy due to the deformation of a material (or its container) exhibiting a restorative force as it returns to its original shape
Mechanical wave	kinetic and potential energy in an elastic material due to a propagating oscillation of matter
Sound wave	kinetic and potential energy in a material due to a sound-propagated wave (a particular type of mechanical wave)
Radiant	potential energy stored in the fields of waves propagated by electromagnetic radiation, including light
Rest	potential energy due to an object's rest mass
Thermal	kinetic energy of the microscopic motion of particles, a kind of disordered equivalent of mechanical energy

One context missing from this table is the definition of **energy** associated with a biological organism or with a business. In practice, we use the term *economic power* in the same way we use the term *power* when we describe a biological organism's activity. In physics, the concept of *power* is always associated with energy.

But regardless of its context, the best definition is probably the one given by the "**SciShow**" YouTube channel, "*What is Energy? The short answer is EVERYTHING.*" It also acknowledged that "*what is energy*" is the world's most asked science question.

### 5.3. Information, Energy, and Communication System

The next step is to use Shannon's complete communication system model to find the new, more generic definitions.

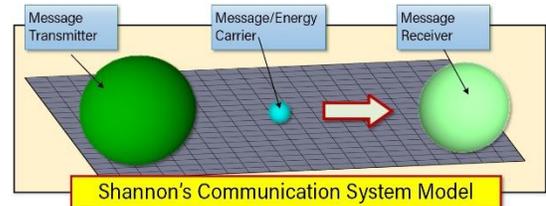


Figure 17. Shannon's generic communication system model.

In this generic communication system, the transmitter and receiver are considered a *Viable Complex System*. Next are the new definitions.

- **Work** – is the activity performed by the receiver as instructed.
- **Energy** – is the ability to do work or the work in progress
- **Physical Information Carrier** – in this model, they are defined as **energy carriers**; a *transmitter*, by sending a message as an *energy carrier*, triggers an *activity* on the *receiver* side
- **Causal Information Carrier** – the instructions associated with *energy carrier* exchange describe how *work* needs to be performed.

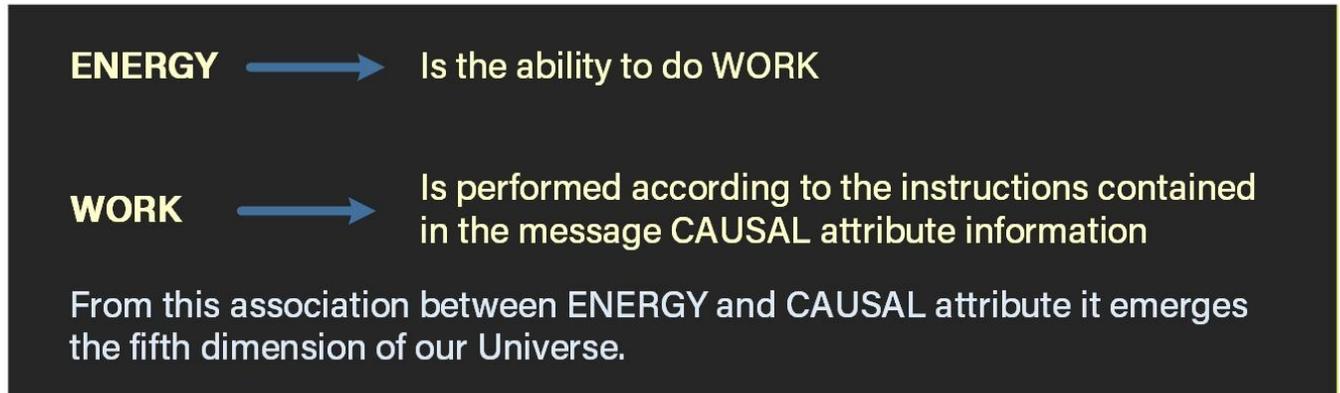
The new definitions gain a unique formulation, regardless of their contexts. **Energy** becomes *the ability to do WORK*, and **Work** is *performed according to the instructions contained in the message CAUSAL attribute*. When it comes to potential energy, *causal* attribute is linked to the capability of the system to process external messages of different complexities.

To conclude, if we are demonstrating that all material objects can be described using the *Viable Complex System* model, then we can extend the *energy* and *work* definitions to the entire field of physics.

When this extension is added, the definition of *physics* includes biological organisms and business organizations. Material objects and subatomic particles can also be viewed as entities that carry processing information capabilities. Because these changes are fundamental, we have a new field called **Physics of Information**.

When we go back to the example of two photons, one from the laptop and one from the Sun, the laws associated with this new field finally help us make a distinction between them, even though they have the same wavelength.

Current *physics* knowledge does not see any difference between the two photons, which is not an accurate representation of “*what the world is.*”



. Figure 18. By using the generic communication model, this is a new definition for the concept of energy not dependent on the context.

## 6. Universe and the Dipole Pattern

In a complete communication system model, both *transmitter* and *receiver* are *Viable Complex Systems*. The existence of *viability* in a physical environment implies the existence of two conditions:

- **Competition** – there is no *viability* without competition; *viability* always implies an evolution of a *Viable Complex System*.
- **Sources of Energy** – competition requires a *dynamic* behavior, and *dynamism* requires *energy*

In physics, there is a behavior pattern that fits these two conditions. This pattern is found in the electrical field, and it matches the one from a charged particle *dipole*.

- **Same Type Monopoles** – there is a *repel force* between similar kinds of monopoles. In this case, there is a repel force between two *positive* or between two *negatively* charged particles.
- **Opposite Type Monopoles** – there is an *attraction force* between opposite types of monopoles. In this case, positive and negatively charged particles are attracted to each other.

In a business environment, we also find two elements matching *dipole* behavior. They are *producers* and *consumers*. *Consumers* are competing between them for access to products and services, while *producers* are competing for access to the same *consumers*.

To note that without *consumers*, there are no *producers*, and without *producers*, there is no business environment or socio-economic fabric. This fundamental condition has been true throughout our entire history, since the first trade.

The dipole configuration has been widely studied in *physics*. This is the pattern that describes the behavior of electrical charges and magnetism. Positive charges and negative charges will always exert a repel force between them, while one positive charge together with a negative one will always exercise an attractive force. At the same time, the energy exchanged between the two charged particle monopoles is using a photon as an energy carrier.

## 7. Holarchy, Evolution, and Complexity

This concept of *holarchy* was introduced by Arthur Koestler [15] in 1967, and it plays a key role in the new information theory and in understanding the viable systems functionality and structure.

A *holarchy* is a system composed of interconnected *holons*, which are entities that act as both independent wholes and as parts of a larger whole. It is a nested hierarchy where each level is self-organized and contributes to the functionality of the higher level. Otherwise said, a holarchy is a system of systems, where each system has its own autonomy, but it is also integrated into a larger, interconnected system.

According to this definition, in biology, a body can be identified as a *holarchy*, and a *cell* can be identified as a *holon*. This is because the *cell* has self-contained autonomy, and at the same time, it plays an important role in a tissue, organ, or system of organs.

In the same way, we can identify a department inside an organization with a *holon*, and the overall business with a *holarchy*. For instance, a *Sales* team has its own internal rules and processes, which points to a certain autonomy. It is also unlikely that business will survive without *Sales*.

Next, we highlight the difference between a *hierarchy* and a *holarchy*.

*Hierarchy* is a structure with the following features:

- **Well defined** – there is a clear top and down layer
- **Structure** – there is a clear chain of commands with well-defined levels of authority
- **Control** – control and commands always come from higher levels
- **Decision-making cycle** – it is centralized, starting from the top

*Holarchy* is a structure with the following features:

- **Undefined** – it doesn't have a well-defined top or bottom
- **Structure** – decentralized structure with authority distributed among holons
- **Control** – emphasize autonomy and self-organization authority within each holon



Figure 19. This set of Russian dolls is a perfect reflection of what a *holarchy* and *holons* are. We do not know how big or how small the top and the bottom dolls are. Also, each doll is a complete entity, which does not need the other ones.

The perfect analogy to represent a holarchy and its holons is a collection of Russian dolls. Each doll, taken as an individual entity, is similar to all the others. At the same time, we do not know how many dolls fit inside, while at the same time, we do not know how many larger ones we can add to the overall construction.

If we use the *holarchy* to group all elements in the Universe, we arrive at the following list of four classes:

- **Social** – Country/City/Community/Family/Person
- **Biologic** – Organ System/Organ/Tissue/Cell/DNA
- **Atomic/Cosmic** – Molecule, Atom, then Planet, Star System, Galaxy, Cluster

- **Subatomic** – Electron, Proton, Neutron, Photon, Quark

It is important to note that physical size and the capability to process *complex* information messages are not related.

To find out the foundations of the new physics, we are using a method highlighted by Feynman. He claimed in one of his lectures that finding new laws of Nature usually follow three steps:

- **Guess** – the first step is always guessing about the new law or behavior
- **Compute** – then we use the guess to calculate or predict behavior
- **Compare** – the last step is to compare the calculation or prediction with the experiment

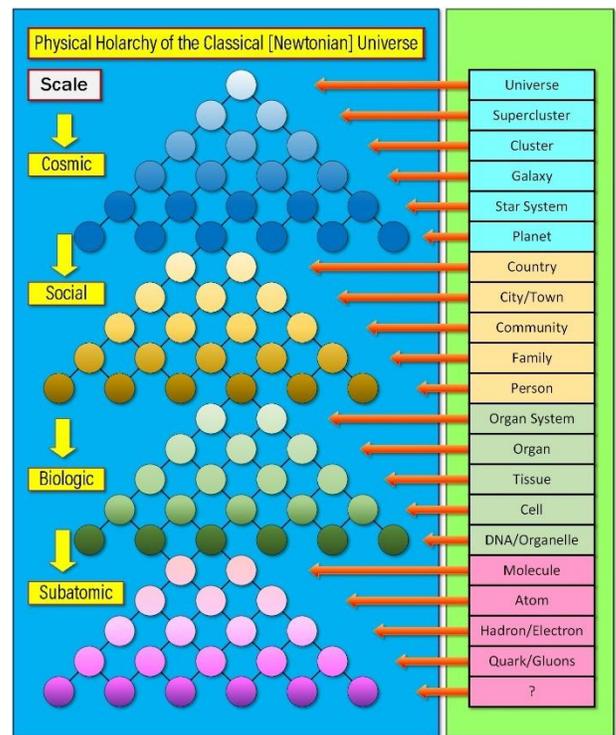


Figure 20. This is the holarchy of our Universe viewed by Newtonian physics

The key step in this three-step method is the last one. To *compare* implies that we can *measure* the results, and only then use them against the *calculated* ones.

But to *measure* anything, the interaction between the *observer* and the *observed phenomenon* can be modeled using the *generic complete communication system*. The *observer* is the receiver, and the *observed phenomenon* is the transmitter.

The first step is to *guess*. This is where we *guess* that

all material objects in the Universe can be organized in classes of *dipoles*. The model for each class is the *electrical charge dipole*.

The classes of dipoles are gravitation, magnetic, electrical charge, biological, and socio-economic dipoles. The gravitational dipole is fully guessed. The biological dipole revolves around the male-female pair; the socio-economic dipole revolves around the producer-consumer pair.

One observation is on the amount of energy associated with each class of dipole. It is easy to *guess* that a potential gravitational dipole has the highest amount of energy associated. Next is the *magnetic dipole*. It is easy to see that the force between two magnets is much higher than the electrostatic force. The attraction between male and female, and the attraction between producer and consumer, takes a different form, but we can *guess* that the energy associated with them is less than the rest of the dipoles.

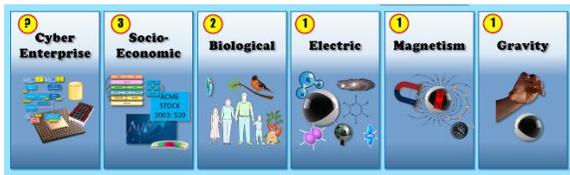


Figure 21. This is why dipoles can be organized in groups

Another *guess* we can make is that the *complexity* associated with classes of dipoles increases from gravitation all the way to the top socio-economic producer-consumer dipole. This *complexity* is associated with processing messages centered around material object *viability*.

## 8. Causal Information Attribute and Fifth Dimension

The final *guess* from Feynman's first step is to organize the classes of dipoles into a *holarchy*. Each *holon* group includes all the material objects that have their foundational behavior derived from the same *dipole*. For instance, all biological organisms have their foundational behavior derived from the male-female dipole behavior.

### 8.1. The holarchy constructed around dipoles

The holarchy assumes a hierarchy that exists between different types of dipoles, together with the conditions that each dipole is built using dipoles from lower holons.

The model has five levels, each with its own dipole. We call them *realms*. Next are their descriptions.

- **Gravitation** – this level is the lowest on this hierarchy; in this case, we assume that there is a dipole with a monopole called a *graviton*. The

existence of a dipole *graviton* assumes that this level must follow the same pattern.

- **Magnetism** – we know from experiments that we have two magnetic poles, one North and one South. We also know from all experiments that all subatomic particles have magnetic properties. So far, we have not detected the magnetic monopole. We do not know anything about the energy carrier for magnetic monopoles.
- **Electrical** – this is the most well-studied level. There are three types of particles: positive [i.e., proton], negative [i.e., electron], and an energy carrier [i.e., photon]. Neutrons can be added to this trio, despite its limited role.
- **Biological** – this is where we find all biological organisms. The dipole in this case is the family unit.
- **Socio-Economic** – this is where we find the *producer-consumer* dipole. Everything in our society revolves around this unit.

Without producers, our communities would not look any different to other ones found in the wild. The energy carrier in this case is the actual product or service exchanged between a *producer* and a *consumer*.

- **Cyber Enterprise** – this is an emergent realm. There is no dipole structure at this level. This is only an emergent one.

What we know for sure is that processing information using computers has different rules and processes than those found in a business; the role of this realm is to host virtualized business processes. They have many benefits, such as higher productivity.

In this model of the Universe, each dipole interaction is more complex than the one below. The highest complexity we find is in the *cyber enterprise* realm. This is the place where we have the *virtualized* business processes replacing the manual ones.

### 8.2. Information density is the fifth dimension

In physics, dimensions refer to a fundamental set of values we use to describe the behavior of a material object. Newtonian physics gives us the space-time set of values to describe the laws of physics. It includes three values from a three-dimensional space, and one value from time. The values associated with both space and time are *scalar* and *always increase* with the increase in size of a distance or time. We also assume that all material objects can be described using the space-time set of values.

In this definition, we ignore Einstein's theory, which associates gravitation behavior with the space-time fabric.

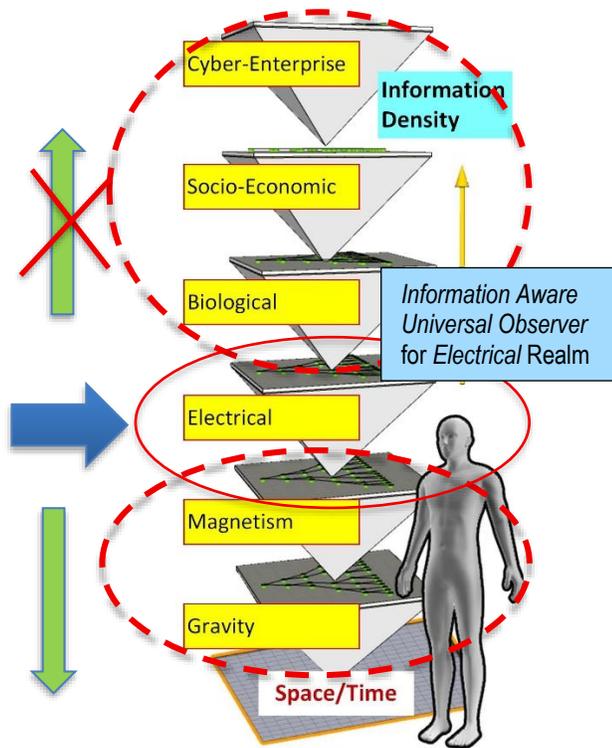


Figure 22. This is the holarchy of our Universe that is the result of the combination of dipoles and the complexity of their relationship. It does display the fifth dimension and the associated three laws. The *first law* associates an *Information Aware Universal Observer* with each realm. The *second law* states that the same observer has full access to the knowledge domain covered by lower realms. The *third law* states that the same observer does not have access to the knowledge associated with all higher realms.

Next, we are demonstrating that *information density*, which *measures* the ability of a material object to process external messages viewed as interactions, can also be defined as a *dimension*. The concept of a material object used here also covers the concept of a system, and other aggregations of parts organized together with a unique focus.

*Information density* is a dimension because:

- **It is a fundamental attribute** – all material objects have an amount of *energy* associated with their existence. And if a material object has *energy*, then it can always participate in an interaction with another material object. As a result, to all material objects we can assign a *probability* value associated with their ability to process a certain type of message.
- **Always increases in value because complexity always increases with each holon** – this behaves the same way as space and time. If we increase the

complexity of a message or the capability of a material object to process more complex messages, the value of *information density* associated increases.

- **It gives the Universe its quantum nature** – this is where the similarity with *space-time* dimensions stops. Because the *information density* values are different for each realm, and different for each type of entity associated with that realm, we cannot have a continuous set of measurable values for complexity. To conclude, in the end we have only a set of discrete values for various entities, which ultimately gives the Universe its quantum nature.

This hierarchy also answers another important question about the Universe. What we know so far is that there is an evolutionary path from electrical realms all the way to the cyber enterprise. By using the same analogy, we can assume that this evolutionary process can be extended all the way to the gravitational realm.

### 8.3. Information density comes with new laws

The quantum nature of this dimension is not the only difference between *information density* and *space-time*. Classical Newtonian physics uses the help of the Universal Observer concept to explain the laws of Nature.

When we are introducing the new dimension, this concept takes a new form. This is called the ***Information Aware Universal Observer***.

Once we introduce the attribute *Information Aware*, there is a question about the ability of an *observer* – plays the role of a receiver in Shannon's generic communication system model - to process messages. Each message has an *information density* value associated. The same value has to be validated by a receiver as part of its capability to process.

By associating an *Information Aware Universal Observer* with a capability to process complexity, the outcome is always restricted to certain values.

Because each realm is a holon, each realm has autonomy when it comes to the internal interactions between its own dipoles. The only way this condition can be met is if we are associating with each realm its own *Information Aware Observer*.

This association leads to a fundamental new concept called *Information Aware Universal Multi-Observer*, which allocates to each realm its own *Universal Observer*.

This becomes the first new law of the five-dimensional Universe.

- **First Law of Information Density:** *Each realm has its own Information Aware Universal Observer associated* – this law is the result of a holon autonomy.

The holarchy structure has an important property. Each realm is built from lower realms' dipoles, and as a direct consequence, they have lower associated complexity. Therefore, an *Information Aware Universal Observer* that is associated with a realm can process all messages that have a *lower* complexity.

From this property of holarchy, we have the second new law associated with the fifth dimension.

- **Second Law of Information Density:** *Each Information Aware Universal Observer associated with a realm DOES have full access to the knowledge domain associated with all LOWER realms* – this law is the result of the way holarchy is constructed.

It is important to note that having to experience the *lower* realms' interactions does not mean that we gain full knowledge about them by default. We as humans can experience light, magnetism, and gravity, but this doesn't mean we also fully understand them and their laws.

The same holarchy has another important property that affects the behavior of our *Information Aware Universal Observer*. In a holarchy, each holon does not know the upper one. This comes from the condition that in a holarchy, we do not know which holon sits at the top of the hierarchy. Therefore, given an existing holon, the one immediately above is not known. It is possible to experience it, but without understanding its laws and rules.

The main reason why we cannot imply the existence of a new holon is that we cannot know which path the evolution takes. The next holon is made from *dipoles* that would have achieved full viability. This means there are *entities* from the current holon that may have achieved the features of a *Viable Complex Systems*, a model that will ensure long-term longevity at a cosmic scale, and it gives them a place in the holarchy.

Because evolution takes a path that cannot be predicted, we have a new law associated with the fifth dimension:

- **Third Law of Information Density** – *Each Information Aware Universal Observer associated with a realm DOES NOT have full access to the knowledge domain associated with all HIGHER realms* – this law is the result of the way holarchy is constructed.

But just because it can't process messages from higher realms, it doesn't mean that it cannot experience its effects.

For instance, an *Information Aware Universal Observer* from the biological realm can observe a dog living among humans only as a need for shelter, food, and protection. It will not experience the concepts of what a *currency* is or what a *paid job* is.

#### 8.4. Universe is Deterministic, Evolutionary, and has a Quantum Nature

When the fifth dimension is introduced in our model of the Universe, classical Newtonian physics gains the same characteristics of determinism over current domains that are covered by quantum mechanics.

In addition to determinism, the new physics adds the *evolutionary* path and the *quantum* Nature to a model of the Universe that, at this stage, does not exclude any material objects or systems from its laws.

#### 8.5. Business is a five-dimensional viable system

One of the most important dipoles for us is the *producer-consumer* one. The business, which is the *producer* side, can be described using a *Viable Complex System* model.

But the *business* side, other than having the collection of processes associated with the value creation cycle, it has also *employees* and *technology-based systems*. They do not follow the same rules that the business processes follow. For instance, the standard language used to communicate with a relational database has nothing to do with the rules that apply to business operations. That language follows the rules from the *technology* realm.

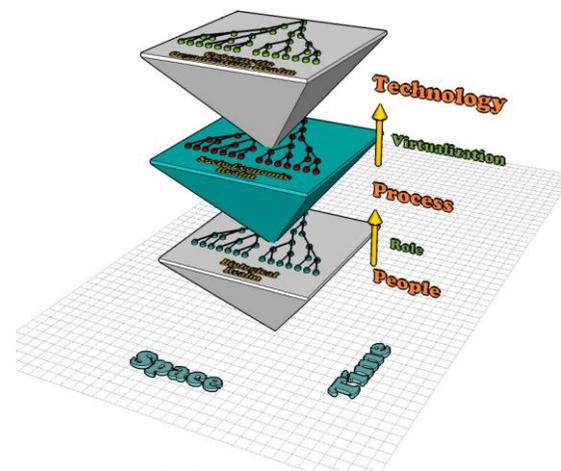


Figure 23. This is the model of the *producer* side of the *producer-consumer* dipole. It covers three realms: *People* [Employees], *Processes* [where value is created], and *Technology* [where we find the Cyber Enterprise]

As a result, we need to extend the value creation realm to include two other ones. The *producer* side of the

*producer-consumer dipole* found in the *socio-economic* realm has three realms, and it operates in five dimensions. They are space, time, and *information density*. The three realms are:

- **People** – this is where we find all employees and their abilities.
- **Process** – this is where we find the *value creation* cycle and the processes driving the business *viability*.
- **Technology or the Cyber Enterprise** – this is where we find all the systems associated with the enterprise software and all automation lines.

Between the three realms, there are two types of relationships.

- **Roles** – all employees play a given role in business; there are two types of roles, one associated with *business processes* and one associated with *technology*.
- **Virtualization** – all enterprise software systems and automation lines are *digital mirrors* of existing processes from the process realm. They are used to replacing manual ones with technology to achieve better productivity, speed, and quality of their operations.

When we are using this model to group various elements in a business, there is a rule that applies and is not that obvious. Technology-based assets have two cycles. One of them is development, and the other one is operational. Only the development cycle is part of the *technology* realm. As we already mentioned, they are designed to replace manual processes.

Nevertheless, their virtual implementation takes the place of the manual process it replaces in the overall value creation cycle. Because of this, the maintenance and support cycle is part of the overall command and control of the entire business, regardless of whether processes are manual or replaced by technology solutions.

One important consequence is how enterprise IT is done. The development of enterprise software and the technical support are done by entirely two different departments, and it requires entirely different sets of skills.

### 8.6. What is next for socio-economic

The next realm above for a business is *cyber*. As we mentioned before, the laws and the rules that govern the enterprise software and automation lines are not the same as those we use to create value in a business.

But this realm is found only in a *producer* entity, and it is an *emergent* one. It hasn't established a dipole

relationship yet.

In the overall socio-economic realm, there is another control hierarchy. This control mechanism exists regardless of the political or economic mechanism in use.

What is interesting is that the *producer-consumer* dipole-type of laws and rules apply only at the *country* context level, and less at the global level. At the country context level, we find *competitive* mechanisms, while between countries, we find a *cooperative* one.

This difference between *competitive* and *cooperative* mechanisms is accentuated by the distribution of local natural resources. Because they are owned locally by country-level organizations, a *cooperative* environment is required to access them by different businesses. This mechanism changes to some degree the *competitive* rules that apply to true value-creation cycles.

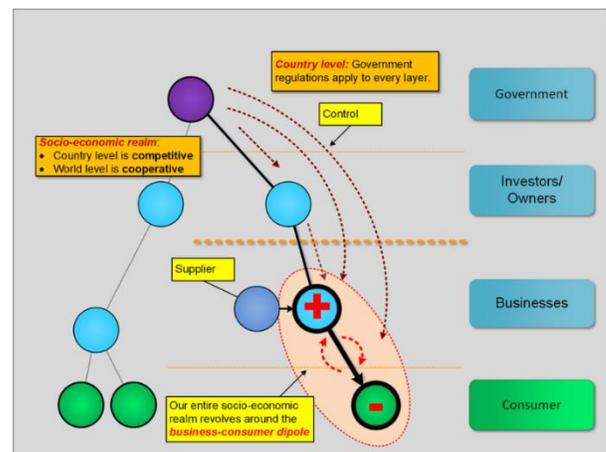


Figure 24. At the socio-economic level, there is another control hierarchy that includes the *producer-consumer* dipole. At the top, we find government agencies, and next, we find business owners, public, private, or political.

When we consider the evolutionary trend, these four layers of control prepare the socio-economic realm for its next one, which eventually will replace the *producer-consumer* dipole. One thing is clear, evolutionary rules tell us that the next realm will completely automate the production of goods and the delivery of services.

## 9. Analogy for the Information Aware Universe model

In one of the episodes from his *Cosmos* series, Carl Sagan described the difficulty, but also the advantages of looking at the world when a new dimension was added.

When the Universe is analyzed from the extra-dimension viewpoint, an *Observer* gains a deeper

understanding of the behavior of its many parts. Carl Sagan equates this with X-ray vision that can go beyond the normal view of the spacetime we are all familiar with. In fact, when the fifth dimension is added, which is based on the *information causal attribute* one, the Universe can be explained as a *deterministic* and *evolutionary* structure. This model takes the same view as Newton's, and our common sense tells us it must be this way.

In the next sections, we are looking into the Universe's laws and rules using the newly acquired X-ray vision. But before we do, we are introducing a model that uses a new analogy to the existing holarchy. This is to make it more intuitive to understand the five-dimensional Universe and its holons.

This analogy uses the concept of an *island* to represent each *holon*, with water acting as a separator between them. This analogy is a better visual image of what a holarchy is. From its definition, a *holarchy* is a special type of hierarchy that doesn't have a bottom or a top element. Also, the *holon*, as the element of the holarchy, plays a special dual role. On one side, a *holon* plays a key role in the existence of overall holarchy, but at the same time, it can be identified as a *standalone, autonomous* structure, with its own internal rules and laws.

For example, in a biological organism viewed as a holarchy, an organ like the *heart* plays a key role. But at the

same time, it has its own internal operational model. The same concept can be applied to the business. A *Sales* department is key to the overall business existence, but at the same time has its own internal command and control structure, independent of the main executive chain of commands.

Within this analogy, there are a few key concepts. The first one is the '*island*' type of entity isolated on both sides by '*water*'. This *island* is an area where a *dipole* rules. All the associated *dipole*-related laws and rules are confined to this area.

The second concept is related to the Universal Observer. Each *island* has an *Information Aware Universal Observer* associated. This *observer* is fully capable of understanding the laws and the rules guiding the '*island*'-bound *dipole*. Because it is part of the *holarchy*, the same *observer* can experience the effects of lower *islands*' interactions. This is true because the current *holon* contains all the lower ones. For example, all electrically charged particles obey gravitational laws.

It is important to mention that this does not apply to higher realms. A charged particle has no awareness of biological or socio-economic entities.



Figure 25. By using an analogy that represents holons as *islands*, and effects from lower realms as *lighthouses*, it is easier to imagine the new, five-dimensional model of the Universe. The significance of the *water* barrier captures the isolation that is required for the Information Aware Universal Observer concept.

The third concept uses the *lighthouse* analogy. An *observer* associated with the current island can only experience the effects from lower realms, but without fully understanding their dipole interactions, laws, and rules.

For instance, an *electron*, a *proton*, and a *photon* have their behavior changed under a magnetic or gravitational field. This is similar to them reacting to the light of the *lighthouse*, but without having access to their host islands and the source of light. Based on the same rules of holarchy, the same electrically charged particles do not have direct influence on elements from higher realms, such as a company's public share price.

This rule that applies to all *observers* is highlighted in the diagram by showing the direction in which their view is pointed. All observers point their view towards the lower *islands* only.

For higher realms, the rule for the *Information Aware Universal Observer* is simple. It is like they do not exist, and the only way they are experienced is by looking at the interactions that are translated into lower realm interactions. For instance, a dog will experience a *producer* only through the same elements found in the biological realm. Elements like shelter, food, and protection can be created by mechanisms owned by the socio-economic realm.

### 9.1. Redefining Energy, Information, Knowledge, and Intelligence

This analogy can also be used to make it easier to understand a few important concepts from the new theory of information.

In classical Newtonian physics, the concept of *energy* has been defined based on the context it operates or exists. This is why we end up with multiple definitions.

When using the new information theory and Shannon's generic communication system model, we arrive at a new definition for *energy* that is unique. In the new model, the concept of *energy* and *work* is always associated with *dipole* behavior, which is common to all realms.

Another concept with the same problem is *information*. Previously, we highlighted the link between *information* and *energy*. With this new model of the Universe, we can do the same by defining the concept of *information*.

- **Information has two attributes – physical and causal:** *information causal attribute* is defined as the fifth dimension of our Universe.

This is true because *information* is always associated with interactions. Interactions are always associated with *energy*, and *energy* is always associated with all material objects. As a result, *information* is a universal attribute.

The *information causal* attribute is used to describe the laws and rules associated with all interactions between material objects. This plays the same role as *space* and *time* attributes.

- **Knowledge is an entity attribute:** knowledge is defined as an *information subdomain* in which an *entity* is fully capable not only of experiencing, but also of gaining an understanding of the laws and rules that guide its interactions.

Knowledge domain always starts with the entity's realm and includes all the lower realms. Otherwise said, an entity's *knowledge* is defined as the collection of interactions to which it has full access.

- **Intelligence is an entity attribute:** intelligence is defined as an *information subdomain* of the *knowledge subdomain*. This is the area in which an *entity* is exercising some form of *control* over its interactions.

*Intelligence* is usually associated with entities that are extending some form of control over multiple realms. For instance, *humans* currently are exercising some form of control over entities from biological and electrical realms.

Next is a diagram that shows how these new definitions can be represented using the *island-type* analogy of the

Information Aware Universe model.

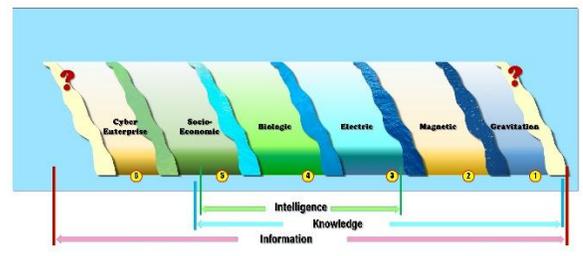


Figure 26. These are the definitions of information, knowledge, and intelligence when associated with the Information Aware Universe model

In summary, when using the **Information Aware Universe** model, *information* is defined as an attribute of all material objects.

*Knowledge* is defined as the *information* subdomain in which an *entity* may gain access to understanding the way material objects interact. *Knowledge* is always associated with an *entity*, and it is a subdomain of the *information* domain. This subdomain covers the current and all the lower realms from the one to which the *entity* belongs.

*Intelligence* is a subdomain of the *knowledge* domain. It is related to *control*. An *intelligent* behavior is about taking the acquired *knowledge* and using it to *control* certain interactions to behave in its favor.

### 10. Invariance of Laws of Physics

The most important consequence of having a new dimension comes from the ***invariance of laws of physics when it comes to local transformations.***

In physics, this concept is referred to as the ***gauge theory.*** It states that the Lagrangian, and hence the dynamics of the system itself, does not change under local transformations.

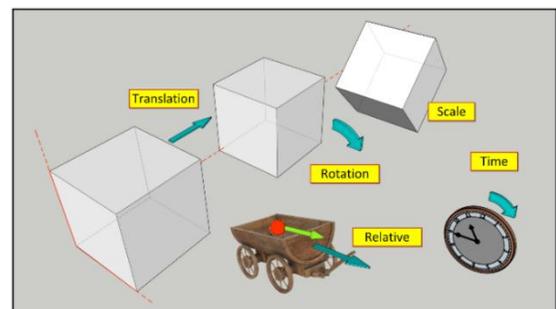


Figure 27. Laws of physics are invariant under local transformations. The one that applies to the fifth dimension is scaling. All laws of physics are invariant for all realms.

The ***gauge theory*** is simple, but it has major implications. The law states that if we rotate, translate, scale,

move in time, or use a moving wagon as the new reference system, the outcome driven by the laws of physics of all our experiments will not change.

This theory tells us that the laws of physics should behave the same when we introduce a new dimension. The fifth dimension has only one transformation that applies, which is *scaling*. There are no other local transformations that apply. As a result, we should expect that all laws that apply to interactions from different realms will act the same.

Let's use Coulomb's law as an example. Two oppositely charged particles are attracted with a force equal to the quantity of each charge, and inversely proportional to the square value of the scalar  $r$ , which is the distance between the charges.

$$|F| = k_e \frac{|q_1||q_2|}{r^2}$$

We may have a similar formula for magnetic realms. And it is not difficult to generalize this behavior. A similar formula can be constructed for the **attraction** between a *producer* and a *consumer* in the marketplace. The  $r$  distance in this case may indeed take a different form, and it is not always treated as a *physical distance*-related value. A *producer* that sells online services will use a different mechanism to measure  $r$ , as being the *virtual distance* that exists between the point of sale and the consumer's location. But, regardless of how  $r$  is calculated, there will always be a rule that the *attraction* between a *producer* and a *consumer* is dependent on how *close* they are.

## 11. Inter-realm interaction and Maxwell's laws

The most important consequence for the *gauge theory* applied to the fifth dimension is the invariance of **Maxwell's laws**. There are four laws, and they describe the interaction between electrically charged particles and magnetism.

$$\begin{aligned} \nabla \cdot \mathbf{E} &= \frac{\rho}{\epsilon_0} \\ \nabla \cdot \mathbf{B} &= 0 \\ \nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t} \\ \nabla \times \mathbf{B} &= \mu_0 \left( \mathbf{J} + \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right) \end{aligned}$$

When it comes to magnetism, it is important to note that the laws do not recognize the role a magnetic monopole plays in this interaction. Maxwell's laws state a few simple facts:

- **Electrical charge in motion** –an electrically

charged particle in motion creates a magnetic field.

- **Variable magnetic field** – there is a force that acts against an electrical charge particle due to a variable magnetic field
- **Electrical charge particles are distinct** – each electrical charge particle has a distinct field of action.
- **Magnetic monopole doesn't exist** – magnetic field is the result of a magnetic *dipole* viewed only as a single particle.

These laws have never changed since Maxwell introduced them over a hundred and fifty years ago. What also never changed is the way they are described as the foundation of classical *electromagnetism*.

Therefore, all laws of physics discovered after Maxwell were careful not to invalidate its claims.

### 11.1. Maxwell's laws are only partially true

Niels Bohr stated in one of his quotes that *if we cannot measure it, then it doesn't exist*. This approach was not very helpful for the discovery of new laws. Once a theory declared that something cannot be measured, all subsequent theories were careful to ignore it completely. But this approach may lead to misleading conclusions.

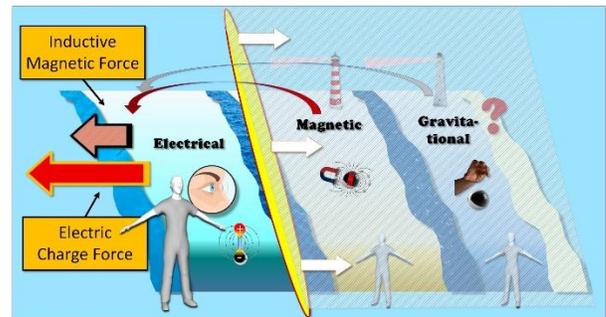


Figure 28. Laws of Maxwell describe only what happens in the electrical realm, and they *ignore* the behavior in the *magnetic* realm. The law that states the non-existence of a magnetic monopole does not reflect the entire reality.

One of the first theories where this principle has been applied was Maxwell's laws. In this diagram, we can see that all four laws are focused mainly on electrical realm interactions. By declaring that magnetism exists only as a dipole, he established a fundamental truth that was never challenged.

The first consequence was the description of these laws as the *unification* of the electrical and magnetic fields. The name picked was *electromagnetism*, and the force is described as one of the four fundamental forces. But what about the force that exists between magnetic monopoles, or

about the magnetic field created by a moving charged particle?

A more accurate description of Maxwell's laws is that of an *interaction* between two different types of dipoles. From this interaction, we have a force as the outcome. The original attraction forces found in dipoles, electrical and magnetic, do not change during this interaction.

So, the question is, which force is a fundamental one? The attraction between two charged particles, the attraction between two magnetic monopoles, North and South, or the force that is generated from the charged particles' movement? All of them should be treated as separate ones. The Information Aware Universe model views them as separate.

## 12. Generalized Form of Maxwell's Laws, Dark Matter, and Dark Energy

One of the most puzzling phenomena in astronomy is the need to add concepts like *dark matter* and *dark energy* to explain the movements of various cosmic objects in the Universe. But this puzzle may become relatively easy to solve if we use the *gauge theory* and the *Information Aware Universe* model.

As we mentioned before, Maxwell's laws describe the interaction between electrical and magnetic realms. Because these laws are *invariant with the scale of information causal attribute*, we can infer that the same laws apply when we are observing the interaction between all other realms, including the one between socio-economic and biological realms, and between magnetic and gravitational realms.

For instance, when a *farmer*, which is a socio-economic entity, works with biological entities, he only looks at them as a *dipole*. He will never differentiate between *male* and *female* when it comes to their economic value.

When we are applying a generalized form of Maxwell's laws to the interaction between particles from magnetic and gravitational realms, the same laws state that *when a magnetic monopole is in motion in a gravitational field, it will create a gravitational inductive force*. This behavior is similar to the one that applies to a charged particle that moves in a magnetic field. The movement of the charged particle will generate a *magnetic inductive force*.

The perception of *dark matter* and *dark energy* comes from unexplained gravitational forces. Nevertheless, current theories do not account for potential gravitational forces that are the result of interactions between moving magnetic monopoles within a gravitational field. This interaction can explain these greater gravitational forces.

A similar type of behavior we have in our Sun. Currents of electrically charged particles from the interior of the Sun are the main source of its magnetic field. But where can we

find places where currents of individual magnetic monopoles are found in our Universe?

To solve this riddle, we have to look into another feature found in the *Information Aware Universe* model, which is its evolutionary attribute. If we are following the laws of evolution, there must be a mechanism capable of generating the most basic electrically charged particles, electrons, and protons.

A potential source of electrons and protons can be the black holes found in the center of galaxies. This hypothesis could also be used to solve another mystery of modern astrophysics, which is the origin of *hydrogen* and *helium* atoms. Currently, the theory claims that both types of atoms were created from a one-time event called the Big Bang. No evolutionary process.

But what if the black hole acts like a recycling engine that takes all kinds of atoms, converts them into magnetic monopoles and magnetic dipoles, and then, through a creation mechanism, turns them into hydrogen and helium atoms?

These two types of atoms are the fundamental blocks of creation for new stars. Evidence shows that at least two black holes from the center of our galaxy and from the center of the Andromeda galaxy are surrounded by many young stars. The emergence of these young stars around the black holes makes the possibility of a *regeneration cycle* true.

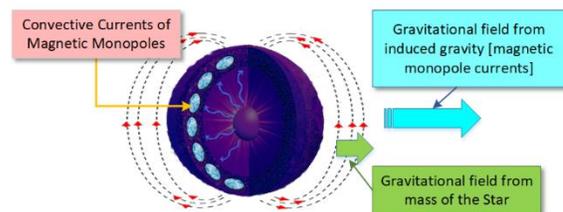


Figure 29. If inside a black hole, there are internal convective currents of magnetic monopoles, then according to Maxwell's laws, there is an extra gravitational force from induced gravity

But one consequence of having such a *recycling* process is the possibility that we also may have *convective currents* of magnetic monopoles running in the interior of a black hole. And with the existence of these currents, we will end up with an additional gravitational force, the inductive one.

This also may explain not only a gravity force that is larger than the one calculated from its mass, but it may also explain the variability of star velocity across the galaxy. The variability of stars' velocity may come from the variability of these convective currents during the black hole lifecycle.

From observations, it is difficult to make a distinction between the origin of *dark matter* and *dark energy*. The

variability of a gravitational field due to its *inductive* component could be the origin of both. No more chasing for exotic particles or unknown sources of energy needed.

If confirmed, the process of recycling magnetic monopoles into atoms would play a key role in the galaxy's lifecycle. But black holes are not the only type of stars where magnetic monopoles may play a key role.

From our observations, we found other types of stars like the *magnetars*, where it is possible that magnetic monopoles, acting as individual particles, and not bound in a dipole, are contributing to their observed behavior.

Another type of stars, the *quasars*, the Active Galactic Nuclei (AGN), or the sources of Gamma-Ray Bursts (GRBs) radiation may also have their enormous sources of energy coming from unknown types of magnetic monopole interactions. From observations, these types of phenomena could also be the source of extremely energetic ultra-high cosmic radiation particles.

### 13. Particle-Wave Duality and Information-Aware Multi-Observer

One of the most important concepts in physics is related to the *duality wave-particle* theory introduced by Louis de Broglie. He postulated the wave nature of electrons and suggested that all matter objects have wave properties.

The *Information Aware Universal Observer* concept makes it easy to understand and explain the duality. Each realm has its own observer associated. When an observer from one realm may observe the phenomenon, it could see

a *wave*, but when another one from a lower realm looks at the same behavior, it may see a collision between particles.

Take, for example, the waves on a lake's surface. At the macro level, they are waves, but when we observe them from the electrical charge realm, they become particles.

#### 13.1. Double-slit experiment

Next, we use the *Information Aware Universe* model to explain the double-slit experiment. This experiment was first performed by Young in 1801, and it cannot be explained by existing theories. What we know so far is that this is one of the core phenomena that sits at the foundations of quantum mechanics.

Photons are identified as *energy carriers* from the *electrical* realm. The double-slit experiment explanation requires the participation of three different *Information Aware Universal Observers*, one from the *electrical* realm, one from the *biological* or *macro* realm, and one from the *gravitational* realm.

- **Particle - Electrical realm observation** – this is the most common type of observation. A photon is viewed as a particle that carries energy. The photoelectric phenomenon is explained by using the *particle* behavior of a photon.

An electron is emitted in certain conditions from a material when photons collide with their atoms. Both are behaving as *particles*, and this is true only when the observer is associated with the electrical realm.

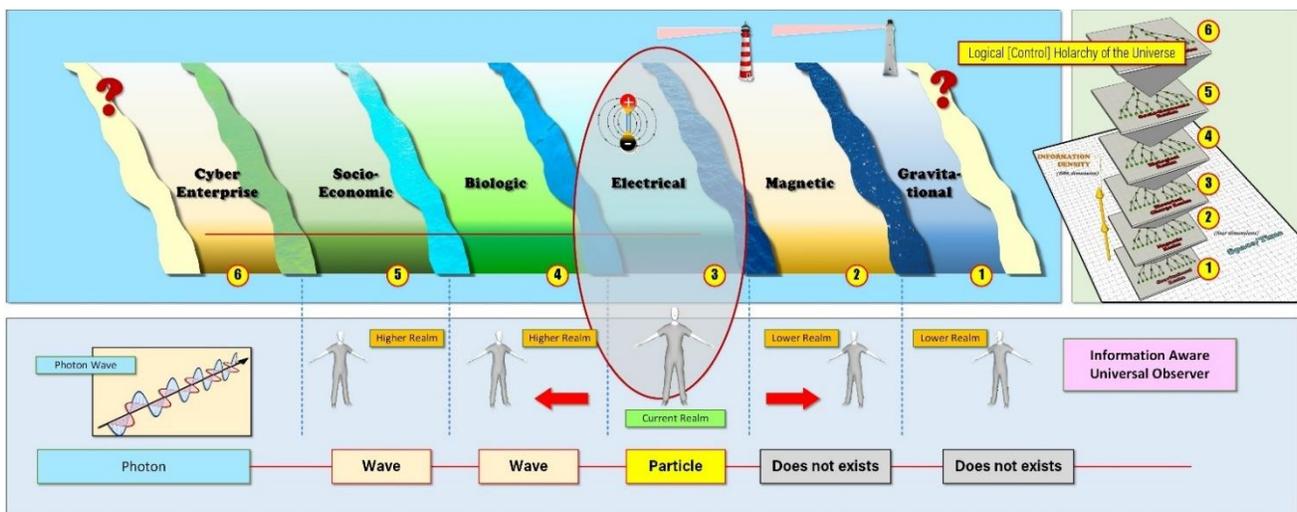


Figure 30. Luis de Broglie's wave-particle duality. A dipole component behavior is viewed as a particle when it is observed within its own realm, as a *wave* when observed in a higher realm, and *it does not exist* when observed in a lower realm. In that case, the realm behavior is given by its lower realm components.

An *observer* from a higher realm has a different view of photon behavior.

- **Wave - Biological realm [macro] observation** – this is the realm where a photon behaves like a *wave* in the presence of a double-slit. The double-slit experiment can be viewed with our own eyes.

We do not see atoms or magnetic monopoles. According to the rules, the behavior of a photon is that of a *wave* when observed from a higher realm than the *electrical* one.

But what happens when photons are observed from a lower realm than electrical? Observation from any lower realm implies that interaction is done only between particles from that realm. For an observer from magnetic or gravitational realm, the concept of a photon doesn't exist, only their components

About the gravitational realm we know very little. In this model we assume that it is run also by a dipole-type of behavior. This assumption is based on extending the current pattern.

- **Particle - Gravitational realm observation** – everything in this realm is a particle, and that includes photons.

Because the *photon* is the energy carrier for electrical charges, we cannot assume anything about the way it behaves for a *magnetic realm* observer. This is based on autonomy associated with realm's laws. We only know that a *photon* is made of *magnetic dipoles* and *magnetic monopoles*.

What we know for sure is that all collisions between subatomic particles, including *photons*, ultimately can be reduced to *collisions* between *gravitons*. This is true because all magnetic monopoles are made of *graviton* particles, according to the holonic model of Information Aware Universe.

When we are using *photon detectors*, what we observe are *electrons* emitted from their impact with photon particles. But electrons are also made of *magnetic monopoles*, which are made of *graviton dipoles*. Energy required to emit an electron comes from *the energy collapse of the entire holarchy* to either the *magnetic* or the *gravitational* realm level. In both these realms, the associated *Information Aware Universal Observer* views both photons and electrons as behaving only as particles [magnetic monopoles or gravitons].

In conclusion, when we observe a photon passing through two slits separated by a certain distance, the outcome is an interference pattern. This wave-like behavior is also extended to electrons, protons, and even molecules.

In all these cases, the properties dominating the particle behavior are those associated with the *electrical* realm observer.

### 13.2. Other examples and Schrödinger equation

This duality of roles can be generalized to other types of entities. One example is *farming*. A biological organism, when it is observed from the biological realm, we identify it as an individual entity, *male* or *female*. But when a *farmer* observes the same entity from an *economic* cycle perspective, the entity is viewed only in the context of the reproduction cycle.

This is because only when we look at both the *male* and *female* at the same time can we identify them as a continuous mechanism of generating value. Without this reproduction cycle, there is no *producer*, and if there is no producer, there is no socio-economic identifier.

The principle behind the duality of roles explanation can be applied in other cases, too. One of them is the Schrödinger equation that governs the *wave function* of a non-relativistic quantum system.

The *wave function* in quantum mechanics evolves deterministically according to the Schrödinger equation as a linear superposition of different states. However, actual measurements always find the physical system in a definite state. Any future evolution of the wave function is based on the state the system was discovered to be in when the measurement was made. This may imply that the measurement “did something” to the system that is not obviously a consequence of Schrödinger's evolution.

In quantum mechanics, this is called the *measurement problem*. It is assumed that quantum systems have superpositions, but when measured it gives only one result.

One of the explanations accepted by quantum mechanics is the “*Many-Worlds Interpretation*”. The *Many Worlds Interpretation* (MWI) advances that all possible outcomes of quantum measurements are realized in separate, non-communicating branches of the universe, effectively creating a multiverse.

The solution to the *measurement problem* proposed by the *Information Aware Universe* model also uses the word “*multi*” in its name, but it refers to *Information Aware Universal Multi-Observer*. Instead of an *MWI*, we have multiple observers interpreting what they experience.

The main observer is associated with the *electrical* realm, but the laws driving its motion exist in the *magnetic* realm. It is very likely that this type of motion is due to the interactions between structures made of *magnetic monopoles*, with laws that are not covered by current knowledge of physics.

When we try to measure the position of the electron, we normally use a photo detector. The collision between the photon and the photo detector atoms is experienced as a magnetic or gravitational collision. This is why there is particle behavior when measurement is taken.

But why is the equation accurate even though it is experienced from the *electrical* realm? This is because the Schrödinger equation uses the Hamiltonian to describe the probability.

The Hamiltonian in quantum mechanics is an operator that represents the total energy of a quantum system. This energy includes both kinetic and potential energy. In the Information Aware Universe model, the total energy is conserved across realms. This makes the equation accurate, even though it describes the motion of the quantum system viewed from the *electrical* realm, instead of the one viewed from the magnetic realm.

To conclude, the observation of *duality wave-particles* is the result of a *multi-observer pattern* required to explain various interactions. The multi-observer pattern is needed to isolate the experience and the interpretation of various phenomena according to the various dipoles' capability to interpret the interactions.

The Many-Worlds Interpretation assumes that there is a unique Universal Observer for both the Schrödinger equation and for measurement. Because the Universe is the result of various collections of fully viable entities, a *single Universal Observer* cannot exist to capture all their interactions.

## 14. Einstein's General Theory of Relativity and the Information-Aware Universe

One of the most important theories introduced in the last one hundred years is Einstein's general theory of relativity. John Archibald Wheeler described this theory in simple terms as '*matter tells spacetime how to curve.*'

Albert Einstein introduced his geometric theory of gravitation in 1916, and it is the accepted description of gravitation in modern physics. It describes gravitation as a geometric property of space and time. However, the equation describes what we observe, but the explanation does not fit any of the traditional laws of physics.

The work Einstein did was based on Maxwell's research. In fact, Einstein said about Maxwell's work that it is the "*most profound and the most fruitful that physics has experienced since the time of Newton.*" He acknowledged that his own theories of relativity and quantum physics relied on Maxwell's discoveries, particularly on the electromagnetic field equations.

We quoted Niels Bohr many times, a statement about physics: "Nothing exists until it is measured." This case was

used by both Maxwell and Einstein in the development of their theories. First, Maxwell ignored the existence of magnetic monopoles when he formulated the electromagnetic laws. But common sense and our experience tell us that magnetic forces must be the result of the interactions between the North and South magnetic monopoles. This contradicts Maxwell's law, which assumes a magnetic dipole that is inseparable.

Then Einstein, by associating the motion of a photon in a gravitational field with the space and time continuum, did the same. His theory ignored the fact that magnetic dipoles can be split into two different magnetic monopoles, and as a consequence, there must be an energy carrier for the magnetic force that links them.

As a note, it is clear that the magnetic force is greater than the electrostatic one. This may lead to the conclusion that the energy carrier particle found in magnetic dipoles must travel at a higher speed than light made out of photons.

In the *Information Aware Model*, many elements are only implied by theory, without any proof of their existence. For instance, the existence of a gravitational dipole is implied by the overall pattern found at the foundation of all known realms. Obviously, there will be a while until this dipole is proven by experiments.

The same principle applies to the existence of magnetic monopoles. The overall pattern that associates a dipole with each realm must be true for the magnetic realm too, even if there are no experiments that prove its existence.

The main problem with ignoring the magnetic monopoles' behavior and their energy carrier particle is that their behavior may invalidate the truth that "*matter tells spacetime to curve.*" We do not know the carrier energy for magnetic dipole behavior in the gravitational field. Does the path of this carrier follow the same curved path in a large gravitational field? It would likely behave differently.

Because Einstein's theory plays a big role in other theories following his discovery, the story of ignoring magnetic monopoles continues. For instance, in all subsequent theories, the speed of a photon is always considered as the ultimate limit. As a result, even the latest discovery of gravitational waves assumes that their speed is the speed of light.

To conclude, while Einstein's theory is accurate, the explanation doesn't add up. And this is because Maxwell chose to completely ignore the magnetic monopole laws and rules. It is also possible that another explanation could be true, one that sees the curved path taken as the result of the interaction between magnetic monopoles that live inside a photon and the gravitational field.

This type of explanation does make it possible to return *space* and *time* dimensions to their original meaning. They are fundamental parameters that define all material objects'

existence. They were also invented by physicists to help with the formulation of the laws. As invented concepts, they are defined to be scalar and built to use a linear framework to measure various parameters.

## 15. $E=mc^2$ Is Only One Form of Energy Conversion Between Realms

The  $E=mc^2$  is the most famous equation of the twentieth century. This formula states that there is a back-and-forth conversion between *mass* and *energy*. This formula states that mass and energy are equivalent.

Before Einstein, *mass* and *energy* were seen as separate fundamental concepts. After Einstein, the  $E=mc^2$  formula showed that *matter* and *energy* are interchangeable and fundamentally linked together.

This formula is derived from Maxwell's laws. We have already shown that Maxwell's laws are incomplete. They address only one side of the magnetism-electrical charge interaction.

But the formula assumes a few things that may not be true. One assumption is that photons are made of energy only. But photons are acting as mass particles in the photoelectric effect. So, this assumption is incorrect. Another assumption is that photons do not contain magnetic monopoles. But the experiments show that photons interact with magnetic fields. To be able to interact with magnetic fields, photons need to contain magnetic monopoles.

### 15.1. Dipole elements and neutral entity

The *Information Aware Universe* model uses a holarchy structure to describe the way material objects are organized and their relationship. Within this holarchy, the interactions between all material objects associated with a holon can be modeled using Shannon's communication system model and the dipole-type of behavior pattern.

As a result, these objects can be grouped into two major categories. In one group, we find those able to play the role of a *transmitter* or *receiver*. The second group is where we find the ones capable of *carrying the message*. The model for the dipole-type of pattern is based on the electrically charged particles.

However, in all holons, we may find some type of entities that do not participate in a dipole interaction. In the electrical realm, we find neutrons. They are particles that do not have an electrical charge. In the socio-economic realm, there are various organizations, like government agencies, that are neither *producers* nor *consumers*.

### 15.2. What is the value of money and the $E=mc^2$

One area where the famous formula can bring some clarity is in the way we measure value in the socio-economic

realm. Currently, we use currency or money as a way to measure the value of a product or service sold to a consumer. But there is no standardized method or scientific theory behind assigning a price to a product or service.

The lack of an evaluation method for value gets extended to transactions worth trillions of dollars. The evaluation of a public business is done using the public share price. The main approach to deciding on the price of a share is done by intuition and a lot of guesses. The *Information Aware Universe* model proposes a different way to evaluate value in the socio-economic realm, and it is based on the  $E=mc^2$  formula.

In the  $E=mc^2$  formula, photons play the role of a mediator between the *electrical* and *magnetic* realms. There are processes in which electrically charged particles are fully converted into photons. And photons have no more electrical charges. They are made of particles associated with the magnetic realm.

Based on the *Information Aware Universe* model, the photon is not only an *energy* and *message* carrier, but also a way to convert an electrically charged particle into a collection of lower realm particles.

In the *Information Aware Universe* model, photons are not the only *message* or *energy* carriers. In the *socio-economic* realm, it is the *currency* or *money* that plays the role of *energy carrier* between *producers* and *consumers*.

By converting a particle into photons, we find out the amount of energy it contains. By using the same principle and according to the formula, by converting a *value* from the *socio-economic* realm into *valuable* information from the *biological realm*, we measure the true value they contain.

Otherwise said, the true value of a product, service, business, or public share is equal to the value of goods that are only associated with individual family welfare and survival. These goods exist only in the *biological* realm. From this principle, it results that the value of a business can be truly evaluated only if it is sold as fast as you can.

By applying the  $E=mc^2$  formula to this evaluation,  $E$  is the money you get after selling a socio-economic valuable to an individual who uses that money for personal welfare. This is true because that individual pays a certain amount for that valuable by comparing it with what kind of benefits he would get for his family for the same amount. This is true for the public share price too. An individual investor compares the price he pays for a public company share with the individual benefits he can get for the same amount. The speed  $c$  is related to the fastest time it takes for a product, service, or business to cash it out.

To conclude, there is a simple process by which the value in money or currency is calculated using the  $E=mc^2$  formula. To find out the real value of the amount of *energy* contained in a valuable from the socio-economic realm, one

must sell everything as fast as possible and then assign that amount of money to family or individual welfare. The initial value can be equated to the  $m$  element from the formula. The speed at which everything is sold can be equated to the  $c$  element from the formula.

Within the biological realm, our existence revolves around the concept of family, and the values are related to our ability to provide our family with shelter, comfort, the ability to travel, and access to various services. This type of relationship between socio-economic and biological realms exists because of the dual role we play in our society. From 9 to 5, we play the role of a *producer*, and the rest of the day, we are *consumers*.

## 16. Physics History – Geometric approach versus analytic functional approach

There is an agreement among researchers that modern physics started with Newton and that the last major discovery that led to many practical applications was made by Maxwell. Almost the entire progress we have made in technology is based on Newton's and Maxwell's discoveries.

### 16.1. Why versus How laws of physics

The emergence of quantum mechanics and various theories associated with the behavior of subatomic particles are far less successful than Newton's and Maxwell's laws in the development of new products and services. In this section, we are analyzing a possible reason behind this lack of success in practice.

**[Why] deterministic laws:** this type of laws is based on fundamental concepts linked directly to the motion and state of a physical system; they use the concept of **force** at the top to describe any action.

By knowing the forces and their current state, we can use Newton's laws to predict the future of a system, and we can calculate its past states. This is why we call it a *deterministic* system.

An example of a *deterministic* system is a planet orbiting the Sun, or the trajectory of an object falling freely from a certain height. Other examples can be found in electromagnetism and thermodynamics.

**[How] functional analysis laws:** this type of laws is based on the identification of a behavior by examining its context.

The second way researchers introduced laws was through observation only. The result is a mathematical model that describes the phenomenon. There are plenty of

examples, like Planck's formula, Pauli's principle, Heisenberg's uncertainty principle, and even Einstein's theory of relativity.

### 16.1. John Wheeler three three-stage career

John Archibald Wheeler was a scientist-philosopher who introduced the concept of wormholes and coined the term "*black hole*". He pioneered the theory of nuclear fission with Niels Bohr. John Wheeler divided [21] his own life into three parts. The first part he called "*Everything is Particles*." The second part was "*Everything is Fields*." And the third part, which Wheeler considered the bedrock of his physical theory, he called "*Everything is Information*."

In the history of discovery the laws of physics, we have three similar periods.

- The **first period** is "*all physical systems have a deterministic behavior*", or as Wheeler would say, "*everything is a particle*."

This period starts with Newton and ends with Maxwell. During this period, classical physics was developed, and the system was deterministic. The main laws discovered are used to calculate forces, momentum, and motion. This field is called classical mechanics.

- The **second period** is "*all physical systems have some deterministic behavior, and some behavior that we choose to ignore*." This can also be called "*Everything is a field*" period.

It starts with discovering Maxwell's laws, and it ends with the introduction of Planck's constant. The behavior of a physical system is viewed as only partially deterministic. Maxwell's laws allow us to calculate forces, momentum, and motion of charged particles in a magnetic field. The system is viewed as electrical, and the new field is called *electromagnetism*.

To make it work, Maxwell ignored what happens on the magnetic side. One of his laws even stated in a mathematical formula that a magnetic dipole exists only as a dipole in Nature.

When we use incomplete mathematical models to describe the behavior of a physical system, it makes it difficult to fully predict all its future states in all contexts. In Maxwell's case, this extra law doesn't make any difference in predicting the behavior of an electrical charge, because the existence of a magnetic monopole is not relevant.

- The **third period** is "*all subatomic particles have quantum behavior*" period. It starts with the discovery of Planck's formula, and it ends today. John Wheeler thought about this third phase as "*Everything is information*."

All the laws discovered during this third period use

Maxwell's laws as the starting point. And because they were incomplete, when researchers tried to add new laws, they had to use mainly mathematical formulas to describe their observations. This is why the physical systems described by these new sets of laws lack the *fully deterministic* part.

This period obeys Niels Bohr's assertion, which says that *if we cannot measure it, then it doesn't exist*. The interpretation of results from subatomic particle experiments would ignore the existence of a magnetic monopole. This is what Einstein did when he developed his theory. He completely ignored that a magnetic dipole may obey different laws, and that a photon may not be the ultimate energy carrier.

There are plenty of such examples from this period. When the consequences related to magnetic monopoles could not be avoided, physicists like Schrödinger introduced probabilities and pure mathematical formulas to describe the motion of a particle like the electron around the nucleus. This led to the "*measurement problem*" from quantum mechanics, which is one of the main obstacles in advancing our understanding of quantum behavior.

To fix these shortcomings, the *Information Aware Universe* model introduces *information* to explain some of the quantum mechanics laws. This approach falls in line with John Wheeler's intuition.

## 16.2. Shannon's theory and Wheeler's third stage

In the history of science, not directly related to physics, there is another period that starts with Claude Shannon's theory of information. This also matches the third stage, which John Wheeler called it "*everything is information*."

What happened with the introduction of the new theory of information is very similar to what happened in Maxwell's laws case. Maxwell chose to ignore the magnetic dipole, and Shannon chose to ignore the "*semantic*" attribute of an information message.

In his paper, Shannon acknowledged that all information messages have *meaning* but that "*semantic aspects of communication are irrelevant to the engineering problem*."

To extend his theory to the *semantic* attribute, it required a whole new theoretical field that didn't exist at that time. That field is called *cybernetics*. The theory was introduced by Norbert Wiener with his book called "*Cybernetics: Or Control and Communication in the Animal and the Machine*," published in 1948. This is the same year that Shannon published his theory.

## 16.3. AI – Complexity and Power Consumption

Shannon's theory of information is the foundation on which the entire digital world is designed and operates. For

many decades, that was enough, but lately a new concept called AI [Artificial Intelligence] related to information has taken the center stage.

Mathematically, it is based on an advanced pattern recognition algorithm. Because of this, it lacks context, and it lacks a way to measure the "complexity" associated with both the question and the answer.

Despite all the claims that AI will revolutionize our way of working, advances in AI are dependent on the ability to measure the *semantic/ causal* information attribute.

The word AI contains the word "*intelligence*", and this concept is always associated with the ability to process information content. Because we cannot measure "*intelligence*", we cannot measure how effective the AI engines are in creating *intelligent* responses, and we have arrived at some totally unrealistic expectations. We cannot defeat a simple virus, which clearly lacks advanced capabilities to process information, but we claim that we are very close to reaching *superintelligence*.

The lack of realistic expectations for AI engines is also extended to future expectations of power consumption associated with calculations. This prediction is in contrast with reality. A simple organism like the well-studied *C. Elegans*, with only one thousand cells and a little over one hundred neurons, has more processing power when it comes to *calculating* complex adaptation cycles than any *supercomputer* in operation now.

The reason is simple, and it goes back to the way we measure the complexity of an information message. The current understanding assumes that *complexity* and the amount of calculations are in a direct relationship. This is like saying that a very large mechanical bolt used in a shipyard is a lot more complex than a watch mechanism.

The prediction that future AI frameworks will require large power plants to support their operations is contradicted by reality. The amount of energy consumed by a COVID virus is infinitesimal, but despite that, its damage was measured in trillions.

To conclude, raw computing power has nothing to do with processing complex information. Until we have a way to measure complexity, concepts like AI's chances to succeed in solving complex problems we encounter are low.

<b>Role of Information in the Universe</b>	
Wheeler considered [22] information as a fundamental building block of reality, along with matter and energy	The Information Aware Universe model views information as the core of its fifth dimension.
Wheeler argued [36] that the overall connecting principle of the system should be information, being even more fundamental than matter and energy.	Information as a dimension is fundamental in connecting matter and energy. In fact, it is the energy that introduces information as a dimension for matter.
Verlinde [32] promoted the idea that atoms and their constituting elementary particles can intrinsically store basic and physical information in the form of spin, polarization, and momentum	The Information Aware Universe model views information as the core of its fifth dimension.
<b>Evolutionary Universe</b>	
Davies and Gregersen said that <i>information</i> is essential [37] in understanding the evolution of macrostructures in the Universe	The Information Aware Universe model views <i>information processing</i> as the only driver in an evolutionary Universe.
David Bohm [39] introduces the <i>holographic cosmic consciousness</i> concept. This view of <i>information</i> as the creative force in the physical Universe, which can influence the generation of complexity in all domains.	The Information Aware Universe model views <i>viability</i> as the only creative and destructive driver for all material domains. The entire evolutionary process is driven by the need to adapt to environmental changes.
Wheeler [22] viewed the natural law as being created, or perhaps chosen from the infinity of alternatives, by the very observation process. The bit not only determines the (past) it of the universe, but also the laws.	The Information Aware Universe model agrees that natural laws are being created, but it limits the number of options only to those associated with the emergence of a new <i>dipole</i> that achieves full viability [Viable Complex System].
<b>Physical versus Semantic/Causal Information Attributes</b>	
Foschini [38] argued that there is a physical, engineering, material aspect of information, but it is only one part. There is a second part where humans are using information to assign meaning to material objects.	Shannon states in his paper from 1948 that information messages also have <i>meaning</i> . This attribute contained <i>semantic</i> information. The Information Aware Universe model uses this attribute to measure the complexity of all material objects.
Walker [33] introduced the idea that all information systems require <i>hardware</i> and <i>software</i> . A <i>self-synthesizing</i> system like the one predicted by Wheeler not only creates its own <i>hardware</i> , but it must also create its own <i>software</i> .	The Information Aware Universe model uses Shannon's generic model of communication for all material objects and their interactions. According to Shannon, information, regardless of the context, is always associated with both <i>physical</i> and <i>semantic/causal</i> attributes linked together.
<b>Quantum Nature of the Universe</b>	
To the question "Why does the world appear to be quantized?", Zeilinger [28] replied, "Because information about the world is quantized."	The Information Aware Universe model goes one step further. This model views the world as quantified because the fifth dimension [information density] does not have a continuum scale of values associated. The ability to process complexity is not only dependent on multiple factors.

## 17. John Wheeler, Information, Energy, and Matter

Next, we are looking at John Wheeler's tenet "Everything is Information" related physics theories. In his paper [22], Dirk Meijer wrote about the scientific vision of John Archibald Wheeler. Wheeler considered information as a fundamental building block of reality, along with matter and energy. In fact, he was convinced that information is more fundamental than matter and energy.

Wheeler was an early advocate of the "*Participatory Anthropic Principle*" that was put forward by Brandon Carter [34] and Robert Dicke [35]. They were indicating that the laws of physics are fine-tuned to permit the existence of life. Later, various variants of the anthropic principle were proposed. Some of them are covered next. They are compared with the model presented in this paper.

From this short list, there are a few conclusions. While all these researchers recognized the role information plays, they stopped going all the way with their explanations.

- **Incomplete definitions** – the concept of *information* was considered as fundamental to material objects as the concept of *energy* in many theories. Researchers stopped short of declaring *information* as a *dimension* because they did not know how to measure its complexity.
- **No evolutionary theory** – Some theories recognized that many parts of the Universe must be a combination of a cosmic regeneration process and an evolutionary cycle. They just could not find how to fully combine them. For instance, our socio-economic realm is bounded by the Sun's lifecycle. When the Sun is gone, the matter could be recycled by another planetary system.
- **Human society is another step on the main evolutionary path** – The anthropic principle theories identify humans as being at the end of a long evolutionary cosmic cycle, with some special capabilities. The model promoted by this paper views human society as another not-so-special step towards a future that so far is unknown. The evolution is measured by the ability to control various levels of energy. So far, we do not know anything about magnetism and gravitation, so there is a long way to go.
- **No association with Shannon's theory** – The anthropic principle theories failed to associate themselves with the only one that practically targets information. Shannon's theory is the only one that introduced a generic communication system model and the conditions for a physical message to be successfully processed.

Next, we are introducing the Information Aware Universe model, its structure, its laws, and the emergence of a new field called *Physics of Information*.

## 18. The Information Aware Universe Model

Anthony Oettinger, a German American linguist and computer scientist, said that "*Without matter, there is nothing; without energy, matter is inert; and without information, matter and energy are disorganized, hence useless.*" Anthony recognizes that information acts as a glue that links together matter and energy. And because energy is an attribute associated with all material objects, then *information* must also be associated with all material objects. The only way that this can be true is if the *information* attribute qualifies as a *dimension*.

In this section, we are introducing the *Information Aware Universe* model and the *Information Aware Universal Multi-Observer* concept associated. This model introduces the fifth dimension that uses the *information density* concept to measure the *information causal* attribute associated with all material objects. The new dimension is the result of the association between *energy* and the *information causal* attribute.

Within this model, all interactions between material objects or systems use Shannon's generic communication system model to describe them, together with an extension of his theory of information that covers *causal* attributes.

Next, we are looking at various elements used to describe the five-dimensional Information Aware Universe model.

### 18.1. Structure – Holarchy, Dipoles, and Realms

We start with the structure. The *Information Aware Universe* is organized as a holarchy, with each holon being the domain built around the laws and the rules of a dipole. We call this domain *realm*. This name shows that each holon is not only autonomous, but also it is ruled by a unique set of laws and rules.

The model behavior used for all dipoles is the one used to describe the behavior of electrical charges. All elements from a single holon share the same laws and rules. For instance, electrons, protons, neutrons, atoms, molecules, and all non-living material objects made of atoms and molecules are grouped by the *electrical* realm. Photon particles are the energy carriers. The range in physical size is wide. Even when we are observing clusters of galaxies, elements like momentum, kinetic energy, and photon energy still apply.

This model proposes six realms. Next is the list from the lowest to the top.

- **Gravitation** – this is the lowest realm; we assume that a *graviton* dipole exists to match the overall pattern; it is important to note that gravitational waves are only perturbations in the gravitational field, and they have nothing to do with an energy carrier for the gravitational field
- **Magnetism** – we can experience magnetism using a simple table experiment; nevertheless, we do not know much about magnetic monopoles or about the magnetic energy carrier.
- **Electric** – this is a well-studied realm; most engineered devices are based on electricity.
- **Biological** – biology plays a key role in our life and in our environment; human activities are still revolving around the family unit; despite a lot of research, there are still many aspects that we do not fully understand from biology.
- **Socio-Economic** – this realm revolves around the *producer-consumer* dipole; humans are playing a dual role in society. From 9 to 5, they play the role of a *producer*, and the rest of the day, they play the role of a *consumer* as a member of a family.
- **Cyber** – this is an emergent realm, with its own laws and rules, but without any dipole type of interactions; for instance, the rules used to connect a software application to a database have nothing to do with the *value creation cycle* from the *socio-economic* realm; the main role is to replace socio-economic processes with their virtual images; this replacement is done to achieve higher productivity, better quality, and better handling of complexity.

It is important to note that this structure has humans and their society at the top. But this may be different for other forms of life.

### 18.2. Fifth Dimension – Scale of complexity

The six realms introduced previously are organized based on their ability to process complex information. A photon that is generated by the Sun and a photon generated by a laptop screen can be uniquely identified only by humans. We can make a difference because we can understand the context from which the two photons are transmitted.

Previously, we associated the capability to process generic information messages with an amount of *energy* consumption. The greater the complexity, the higher the amount of *energy* required to successfully process the message. It is easy to see that the *energy* required by an *atom* to *process* a received *photon* is far less than the amount of energy required by a *producer* to respond to a market change.

To conclude, the *complexity* of an information message is measured using the *information density* concept. The same concept is also used to measure values associated with material objects or systems along the fifth dimension of the Information Aware Universe model.

### 18.3. Evolutionary Universe – Achieve full viability

The existence of the fifth dimension points also to another important mechanism, which is an overall evolutionary path.

Current theories are pointing to an evolution cycle that looks like the following. Stars are assumed to be the result of large clouds of gas and dust that collapse under their own gravity. Associated with this star formation, part of these clouds may end up as planets. Given the right conditions, life may evolve on some of these planets. Then, when a star like the Sun runs out of fuel, the matter may become part of another cloud of gas and dust, and the cycle continues.

From the outside, a process like this may look like there is only one big evolutionary cycle. In reality, the Information Aware Universe model splits this cycle into many smaller ones, one for each realm.

The Information Aware Universe model states that all material objects are capable of processing *information*. The ability of a material object to process *information messages* is linked to its ability to maintain its *viability*. A *viable* system can successfully adapt its operations to environmental changes.

For example, a large change in consumer needs may require *producers* to change their *value creation cycle* or their operations. A large climate change may require many species to change their metabolism.

Adaptation to environmental changes is not the only mechanism that drives system *viability*. This alone would not be enough for life on Earth to evolve and survive for billions of years. A biological organism is helped by the ability to reproduce and even partially restore some functionality when lost.

We call that a system achieves *full viability* when to system can successfully respond to environmental changes, the system can fully replicate itself while maintaining all its capabilities and at least be capable of partially restoring some lost functionality.

Only when the elements of a dipole, through evolution, are capable of achieving *full viability*, then a new evolutionary cycle is born, and it is added to the overall one that runs the entire Universe. The entities that are participants in this new evolutionary cycle will form a new *realm* in the Information Aware Universe holarchy. Its position is determined by the level of message complexity a system is capable of processing.

#### 18.4. Physical Laws Invariance Principle – Realms and Dipoles

The invariance principle in physics is fundamental to our understanding of the world. It simply states that the laws of physics do not change under local transformations. One of these local transformations is the *changing of scale*. For instance, Newton's laws do not expect to change if we are experimenting with objects that weigh a few kilograms or a few tons in weight.

When we are using the fifth dimension, which is the *information density*, the invariance principle tells us that the laws of physics do not change when we move from one value of information density to another. This is because it is assumed that this value change is only a change in scale.

It is important to note that these information density values are *quantified*, because the realms are grouped based on complexity. Realms do not share information density values between them, and they are not continuous. As a consequence, the invariance principle applies to a collection of groups of values, one for each realm.

For the Information Aware Universe model, there are two types of physical laws where we can apply the *invariance principle*.

- **Realm/Dipole-based** – these laws of physics are associated solely with dipole behavior

Because of grouping, the *invariance principle* states that the laws of physics take the same form, regardless of the realm. The only difference is in the way constants are calculated, or concepts like distance or units of measure are defined.

The *invariance principle* that applies to the laws of physics is also endorsed by the use of the same *dipole* pattern for all realms grouped along the fifth dimension. All realms share the laws of *attraction* and *repulsion*, which are common to all dipoles.

- **Inter-realm based** – these laws of physics are associated solely with interactions between dipoles from two different realms.

The invariance principle also applies to the type of laws that are specific to inter-realms only. These laws describe the interaction between entities from two adjacent realms. In this category, we find Maxwell's laws. Typical of these interactions are the *inductive* forces.

Two of the most interesting cases are the interactions between the *cyber enterprise* entities – software applications or automated assembly lines – and socio-economic entities such as *producers* and *consumers*.

#### 18.5. Fundamental Forces – Dipole and Inductive

Modern physics recognizes only four fundamental

forces found in nature: gravitational, electromagnetic, strong nuclear, and weak nuclear forces.

The Information Aware Universe model takes a completely different approach that changes the way we define interactions. This model recognizes *five fundamental forces*, one for each dipole, and *four fundamental inductive forces* associated with four inter-realm interactions. The number of fundamental forces is nine in the Information Aware Universe model.

Outside these nine fundamental forces, we can find some *derivative* ones. When we have entities that combine a collection of dipoles, we may encounter residual weak forces that may act between them, caused by fluctuations in the way they are configured. An example of such a force is the Van der Waals force, a distance-dependent interaction between atoms or molecules. Another example from a different realm is the *cooperation* or *competition* between two different business alliances.

The five fundamental forces are:

- **Gravitation realm dipole force** – the attraction [or possible repulsion] force that exists between assumed graviton monopoles
- **Magnetic realm dipole force** – the attraction and the repulsion forces that exist between magnetic monopoles, North and South
- **Electrical realm dipole force** – the attraction and the repulsion forces that exist between positive and negative electrical charges
- **Biological realm dipole force** – the attraction and the repulsive that exists between male and female entities
- **Socio-Economic realm dipole force** – competition is a force that exists between producers and between consumers; searching for a consumer by a producer, and searching for a producer by a consumer, captures the attraction forces between producers and consumers.

The *Cyber* realm is an emergent one. A dipole-based internal structure of all its internal processes does not exist.

The four fundamental inductive forces are following Maxwell's laws:

- **Inductive Gravitational Force** – This force originates from the interaction between particles from gravitational and magnetic realms; a magnetic monopole that moves in a variable gravitational field is subjected to an *inductive gravitational* force. This is in addition to an existing gravitational force.
- **Inductive Magnetism Force** – this force

originates from the interaction between the magnetic and electrical realms; this force is well covered by existing Maxwell's laws

- **Inductive Electrical Force** – this force originates from the interaction between the electrical and biological realms. A change in electrical charge energy is used to boost life in a biological ecosystem.

A perfect example can be some special deep ocean ecosystems that thrive near submarine volcanoes.

- **Inductive Biological Force** – this force originates from the interaction between biological and socio-economic realms. In this category, we have a wide variety of agriculture and farming activities.

Without the activity of farming, which implies creating a variation in the number of biological entities, the population of humans would be much smaller.

These forces are playing a key role in the viability of all material entities and systems, and in the main evolution cycle.

### 18.6. Information Density and Information-Aware Multi-Observer-based Laws

The Information Aware Universe model associates a separate observer with each realm. A Classical Universal Observer can understand all laws of physics and execute any task required during experiments.

Because the Information Aware Universe model's basic structure is a holarchy, organized around complexity, the ability to understand all laws of physics is impossible, regardless of the level of abstraction we use to define a Universal Observer.

A holarchy is a hierarchy that doesn't have a top or a bottom layer. Because each level in this hierarchy can process a limited range of message complexity, a unique Universal Observer must be able to support an unknown set of complexity values. Because of this, it is impossible to define a unique Universal Observer for all realms.

The only way to support a successful observation of all interactions in this holarchy is if we introduce the concept of the **Information Aware Universal Multi-Observer**. This concept follows three rules:

- **One Observer per Realm** – all realms or holons have associated its own Information Aware Universal Observer that can participate in all realm interactions
- **Lower Realms Observer Access Rule** – an Information Aware Universal Observer *does* have access to all interactions from **lower** realms other

than its own. Having access means that the Observer can experience their interactions, and it can process their messages because they have *lower* complexity.

- **Higher Realms Observer Exclusion Rule** – an Information Aware Universal Observer *does not* have access to all interactions from **higher** realms other than its own. Being excluded from access means that the Observer can experience their interactions, but it cannot process their messages because they have higher complexity.

There are two consequences of these laws. The first consequence is that instead of having a unique observer, we need to have **observers** to explain the laws of physics. The second consequence is that we need to use these three rules to determine if an *Information Aware Universal Observer* is capable or not of processing an information message that originates with a realm entity.

### 18.7. Deterministic Universe – Information Aware Multi-Observer

At the heart of Newtonian physics is the idea of *determinism*. In simple terms, it means that based on the current state, we can calculate its past and predict its future state. But what about the role *determinism* plays in the Information Aware Universe model?

First of all, the laws of physics governing the realm-bound forces, both dipole-based and inductive ones, can still be used to predict a future state with perfect accuracy. This is because these forces are acting at the *operational* layer of an entity viewed as a *Viable Complex System*.

To reiterate, a Viable Complex Model can process two types of messages. The first type of message targets system *operations*. This type of processing drives the energy transformation cycle, and it is at the core of the entity's existence. For biological organisms, this is the transformation of food into energy. Without energy transformation, the entity cannot exist.

The second way to process information messages is associated with entity *viability*, or its ability to survive when there are environmental changes. A Viable Complex System model introduces the adaptive framework with processes organized in five viable layers. A response to environmental changes may be processed by any of these layers based on the required complexity. For instance, an octopus is able to fully restore a lost arm.

To conclude, *determinism* in the Information Aware Universe model has three components.

- **Newtonian determinism** – this is associated with the laws associated with an *operational* way to process messages.

This is where we find the laws governing the competition between *producers*, or the laws governing the relationship between *producers* and *consumers*.

- **Realm viability-based determinism** – this is associated with an entity's response to an environmental change.

An entity's response to environmental change can only be measured by using *probabilities*. *Information density* used to measure *complexity* is fundamentally calculated as a probability. The *deterministic* part of this behavior is based on the limits an entity has when it comes to providing a response to environmental change.

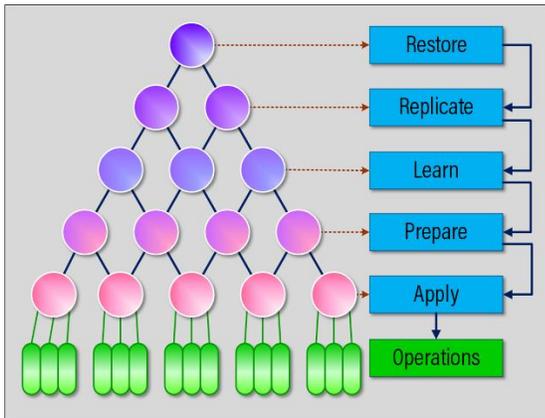


Figure 31. The Viable Complex System model has one *operational* layer and five *viable* layers. Each one can be used to process information messages.

For example, regardless of how well prepared a biological organism is to respond to a drop in temperature, there is a limit that is beyond its capabilities to adapt. The same is true for a *producer*.

A dramatic drop in market share may drive the costs to be much higher than revenue. It is very unlikely that such *producers* will survive as a normal business.

- **Cross-realm viability-based determinism** - this is associated with an entity that achieves a new full-viability capability, and it forms a new realm.

The laws governing transition to a higher realm can also be used to predict the future of an entity with a certain degree of accuracy. It is important to note that the laws and probabilities are linked to the laws driving the realm *regeneration* cycles. More about these cycles next.

One example of cross-realm viability determinism is the emergence of humans as members of the socio-economic realm from biological ones. By learning how to produce tools and by learning how to farm the land, humans were able to create new entities called *producers* or businesses. The business lifecycle and its capabilities go way beyond the capabilities associated with a family unit or

those associated with a local community.

To conclude, the Information Aware Universe model is fully *deterministic* if we are able to combine classical physics with the associated limits of various entities' abilities to process environmental changes.

### 18.8. Use Determinism to calculate the past and predict the future

To conclude, the *deterministic* nature of all physical laws associated with the *Information Aware Universe* model has three components: classical Newtonian determinism, entity viability determinism, and cross-realm viability determinism. For a deterministic system, we should be able to calculate the past and predict its future states.

- **Calculate the past** - to calculate the past of an entity behavior, an observer has to consider Newton's laws that apply, if the current entity state is the result of processing an *operational message* or is processing the one that targets its *viability* capabilities, and if the current state is the result of a transition to a new form that has full viability.
- **Predict the future** – to predict the future, an observer has to consider Newton's laws that apply to the current state, and to evaluate what type of impact current environmental changes have on the entity's operations.

To fully predict a future state, we need to add to our calculations the probability of having a *regeneration* cycle during the entity lifecycle. For instance, despite the best efforts, humans can be wiped out by a cosmic event that has a probability of happening greater than zero.

### 18.9. Regeneration cycles – Viability and Energy

Many theories about our Universe and our common sense tell us that everything we see must be the result of an evolutionary process. In fact, the accepted theory of the Big Bang is based on this idea of a single event that started everything. This states that everything we can observe has a single beginning.

Nevertheless, there are some questions we have about the Big Bang theory that have no clear answers. One of them is regarding the age of our galaxy. The fact that the answer is that the age of our galaxy is the same as the age of the Universe, it looks like somehow, we live in a privileged place. This contradicts common sense.

The most studied evolutionary process so far is Charles Darwin's theory of evolution by natural selection. His theory states that all species we see today arise and develop through a process called *natural selection*. This process drives the ability of a biological organism to adapt and survive various environmental changes.

When an aquatic animal was forced to live outside the water, it needed to adapt its metabolism to use the oxygen from the air. Two things happened at the same time. The first thing was learning to survive and to protect its existence. Second, it was that at the same time, life on land evolved towards an easier existence and better adaptability. In the end, an organism was able to adapt to places, like deserts, where water was scarce.

The Information Aware Universe model already has a mechanism driving the evolution of an entity, from a graviton to the latest socio-economic organizations. This path follows the ability of an entity to increase its ability to process messages of increased complexity.

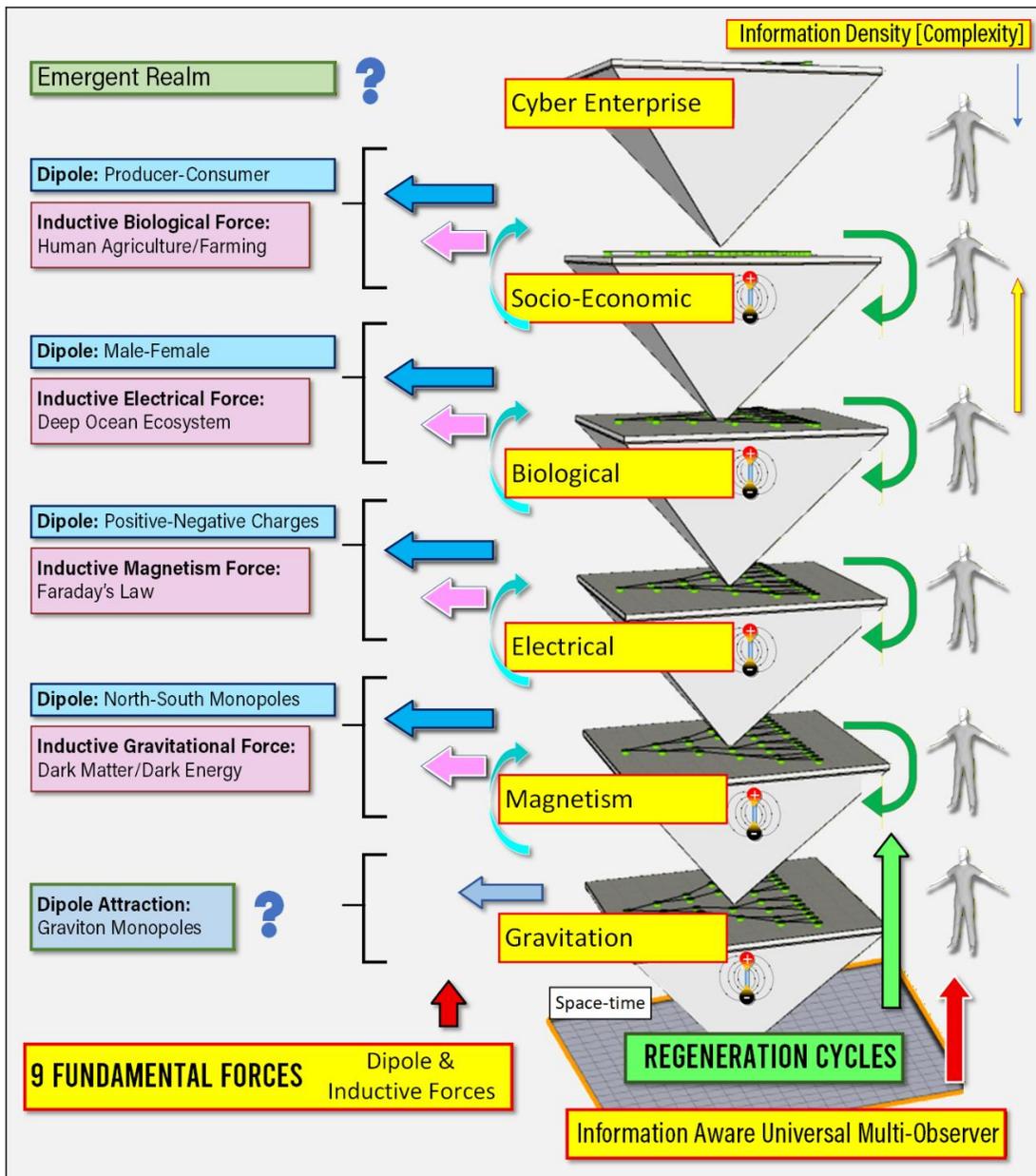


Figure 32. This is the Information Aware Universe model, and all its associated Information Aware Universal Multi-Observers.

Within a single realm, the path an entity takes towards higher viability is simple. But there is one question that still remains, which is *what are the main factors that allow only the right entities to evolve from one realm to another?*

The answer to this question, given by the Information Aware Universe model, is based on the existence of *regeneration cycles*, one for each realm. They play the same role as the factors driving *natural selection*, but at the cosmic scale.

One important aspect associated with each *regeneration cycle* is the amount of energy involved. For instance, human civilization can be wiped out by a collision between Earth and a large cosmic object. The amount of energy in this case is the deciding factor.

Stars could also have their own *regeneration cycle*. This cycle is the one that drives the galaxy formation cycle. At the center of each galaxy, we will likely find a black hole. And each black hole may act as a recycle bin for stars.

During its lifecycle, stars may fall on the black hole, where they could be converted into magnetic dipoles and magnetic monopole particles.

Through some unknown transformations, black holes may convert the magnetic dipoles and magnetic monopoles into helium and hydrogen atoms. These two types of atoms are the building blocks for the formation of new stars

Based on the number of known realms, we can identify four *regeneration cycles*:

- **Magnetic dipoles converted into gravitons** – this transformation may happen at a level of energy that is hard to imagine. We do not know anything about the energies associated with magnetic dipoles, or about such mechanisms.
- **Electrical charged particles to magnetic monopoles** – this transformation takes apart atoms, molecules, electrons, protons, and neutrons into their lower realm components, such as magnetic monopoles and magnetic dipoles.

As mentioned before, there is a potential mechanism that may drive this type of *regeneration cycle*. Because of strong gravitational forces and other processes, a black hole may be able to rip apart atoms and other charged particles into magnetic monopoles and dipoles. Associated with this mechanism, new atoms could be created from these primary magnetism-based components. This could explain the Active Galaxy Nuclei galaxies, the large number of young stars close to the black hole from the center of our galaxy, together with the existence of an unusually strong magnetic field configuration.

This *regeneration cycle* could also be used to explain the origin of hydrogen and helium atoms. Currently, they are assumed to be created only during the initial period of the Big Bang explosion.

- **Biological organisms to electrical charges** – we are very familiar with this type of transformation.

During Earth’s history, there were many events leading to great extinctions of life. They not only wiped out a large number of species but also promoted organisms that were more capable of adapting to different environmental changes. Such events as the ice age could be found throughout the entire Earth’s history.

- **Socio-economic organizations to biological ones** – this is a transformation that is possible, but unlikely to happen.

The socio-economic realm is only a few thousand years old. Before that, humans played the role of pure *consumers*. – hunters and gatherers. During the transition to the new realm, the *consumer* role split into roles of a *producer* and *consumer*. It is not difficult to imagine that a human community, given certain conditions, may revert to becoming hunters and gatherers as a way to survive. Many communities in the world that are still using hunting and gathering as the main way of life are the exception.

## 19. Physics of Information... A New Kind of Physics

By introducing the Information Aware Universe model, a new dimension, the fifth, and the concept of a Universal Multi-Observer, the existing laws of physics are taking an entirely new form, one that extends way beyond what the current field of physics tells us. We are calling the new field *Physics of Information*.

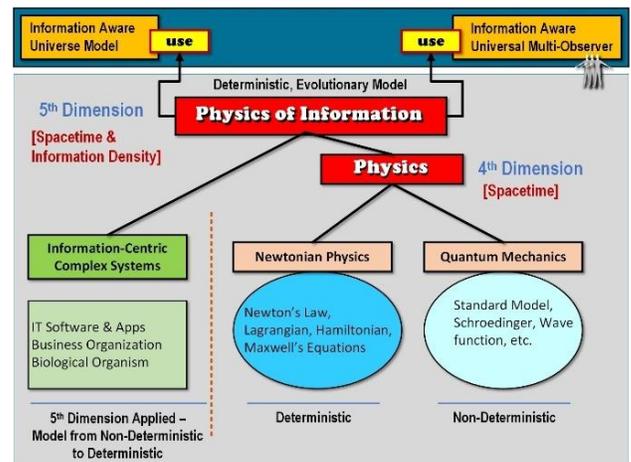


Figure 33. Physics of Information is an extension of the existing field of Physics.

Sean Carroll is an American theoretical physicist. In one of his lectures presented at Cambridge University College in the UK, Sean gave one of the best definitions for the field of physics. He stated [41] that “*physics is what the world is, and how it behaves.*” Obviously, this definition should have implied that *physics* includes biological organisms, business organizations, and even computer software, because they are part of the world we experience. In reality, current laws of physics were never extended to cover many of these new entities' behavior.

Enter the *Physics of Information* field. The main role this new field plays is to act on Sean Carroll's promise on what physics must cover, which is *what the world is*. The extended laws of physics apply not only to traditional material objects but also to biological organisms and business organizations.

In the next few sections, we introduce a few short topics associated with the new *Physics of Information* field.

### 19.1. Fermions and Bosons

The new Information Aware model of the Universe assumes that all interactions can be modelled using Claude Shannon's generic communication system model. This assumes that in all interactions we always have a *transmitter*, a *receiver*, and a *causal information/energy carrier*. This model can also be extended to subatomic particles.

Current physics knowledge states that there are only two types of fundamental particles known in the entire Universe: *fermions* and *bosons*. Every particle — in addition to the normal properties you know, like mass and electric charge — has an intrinsic amount of angular momentum to it, colloquially known as spin.

*Fermions* are a class of particles that have half-integer intrinsic spin, like  $\frac{1}{2}$ , etc. Examples include electrons, protons, and neutrons. *Bosons* are particles with integer spin [0,1,2...]. Examples of such particles include photons and alpha particles.

Another important distinction is that *indistinguishable fermions* cannot be in the same state. They obey the Pauli exclusion principle. Bosons, however, have no such restriction.

When we are using Shannon's generic communication system model, we can identify *fermions* as *transmitters* and *receivers*, and *bosons* as *energy carriers*. This type of equivalence endorses the use of Shannon's model to describe all interactions between all subatomic particles. Current theory does not recognize any other type of particle other than *bosons* and *fermions*.

### 19.2. Quantum Mechanics and Measurement Problem

The link between the *measurement problem* and the *double-slit experiment* has been described in detail in a previous section of this paper. Here we are providing only a short overview.

According to the Schrödinger equation, a quantum system evolves deterministically into a superposition of possible states. However, when we do a measurement, we always observe only one definite result. This paradox revolves around the act of *measurement* that causes the *wave function* to ‘collapse’ from many possibilities into one reality.

There are many interpretations and proposed solutions. They are called the Copenhagen interpretation, decoherence theory, hidden-variable theories, and so on. One of them is called the “Many-Worlds Interpretation” (MWI) theory. This looks similar to the Multi-Observer pattern introduced by *Physics of Information*.

In the Multi-Observer interpretation, no ‘collapse’ occurs, and all possible outcomes may happen in parallel. This is possible because in the new physics, we do not have many worlds, just many Information Aware Universal Observers, one for each realm, each one with its own way to process the reality, based on the associated *dipole* behavior.

In the double-slit experiment case, the Observer from the electrical realm can only see the effects of magnetic dipoles on electrical charges, but without knowing the laws guiding the behavior of individual magnetic monopoles.

Next, we are looking at the interpretation of the time-dependent Schrodinger equation.

$$i\hbar \frac{d}{dt} |\Psi(t)\rangle = \hat{H} |\Psi(t)\rangle$$

In this equation,  $t$  is time,  $psi$  of  $t$  is the state vector of the quantum system, and  $\hat{H}$  is the Hamiltonian operator. The Hamiltonian of a system is an operator representing the total energy of that system, that is, the sum of both kinetic energy and potential energy.

Schrodinger's equation describes the experiment as viewed by the Observer associated with the *electrical* realm.

According to the old and the new physics of information, energy is conserved across realms. What is not conserved across the realms is momentum. An Observer from the *electrical* realm needs to know the motion laws from the *magnetic* realm to make an estimate on a particle's position, if the origin of forces driving the movement lives in the *magnetic* realm.

Because energy is conserved, the Hamiltonian operator can help us find out the pattern in which a particle can be located. But for a precise location in time, we need the motion laws from the magnetic realm, and they are not 'visible' from the electrical realm.

This is the reason why we need to actually *measure* a charged particle's position to find out its location.

But why when we try to measure the position of a particle, we lose *wave*-like behavior? According to current theory, once a measurement is made, the wave function "*collapses*" into one of the possible states. In this case. The system no longer remains in superposition but takes on the measured value.

By using the *Physics of Information* to describe what happened, the explanation takes a different form. The act of *measurement* implies that the charged particle collides with atoms from the sensor device. Any direct collision between any two material particles will result in a different type of "*collapse*" than the one described by quantum mechanics.

And because all material objects are made ultimately of a combination of gravitons, the '*collapse*' is experienced as a transfer of momentum and kinetic energy that happens between two collections of gravitons while colliding. The laws that guide this collision event are the same laws associated with the gravitational realm. And in the gravitational realm, all interactions take a particle-to-particle form, without any '*wave*'-like behavior.

### 19.3. Louis de Broglie's wave-particle duality

The *wave*-particle duality has been described in detail in a previous section. Here we are providing only a short overview.

There is a historical context associated with this duality. Light was first thought of as particles by Newton, then it was thought of as waves by Huygens and Young's double-slit experiment and later thought of as both by Einstein's photoelectric effect. In 1924, De Broglie extended this duality to all material particles, suggesting that electrons and other subatomic particles can also behave like waves. He came up with a formula:

$$\lambda = \frac{h}{p}$$

In this formula, *lambda* is the De Broglie wavelength, *h* is Planck's constant, and *p* is the particle's momentum. From the *Physics of Information* laws, we know that each realm has its own laws of motion, which makes this formula dependent on only one type of observer. In this case, this formula is valid only when we use the *electrical* realm *Information Aware Universal Observer*. The calculation of the De Broglie wavelength for an object that lives in a biological or socio-economic realm doesn't make any sense.

By using the diagram from *chapter 13.1*, it is easy to understand when a particle *can be observed acting as a wave and when as a particle*. We can use the *photon* to show the difference. The photon as an *energy* carrier is associated with the *Electrical Universal Observer*. The photon behaves like a *wave* when viewed by the *Biological Observer*, which is the macro level, and by the *Socio-Economic Observer*. The only observer who views the *photon as a particle* is the *Electrical Observer*. Obviously, the *photon* does not exist in its current form for the *Magnetism Observer* or *Gravitational Observer*.

### 19.4. Why do we have a Planck constant?

According to *Physics of Information*, there is a transition between *wave* behavior and *particle* behavior when we switch between the *Biological Observer* [macro] and the *Electrical Observer*. The *Planck constant* formula is the law that describes *HOW* the photon moves, but not *WHY*. Likely, the origin of *WHY* the photon moves in a *wave*-like pattern comes from magnetic realm laws. The *Biological Observer* does not have access to the magnetic realm laws.

Fundamentally, with each realm, an Information Aware Universal Observer has a limit related to the level of energy it can observe. The smaller the particles, the higher the amount of energy exchanged between the dipole components. As a result, each observer associated with a realm has a limit beyond which it can observe a dipole only as a single entity.

In the case of the Information Aware Universal Observer associated with the *electrical* realm, this limit is described by the Planck constant.

### 19.5. Heisenberg Uncertainty and Pauli Exclusion Principle

The Heisenberg Uncertainty Principle is a fundamental concept in quantum mechanics. It states that there is a limit to how precisely certain pairs of physical properties, like position and momentum, can be known simultaneously. The more accurately one property is measured, the less accurately the other can be known. The accepted explanation is that this isn't due to limitations in measurement tools, but it is an inherent property of quantum systems stemming from their *wave*-particle duality.

The Information Aware Universe model provides a different explanation. Our current measurement capabilities are limited by the use of the Universal Electrical Observer to capture interactions, while behavior may have its roots in the magnetic realm. And current theories know almost nothing about magnetic monopoles, or about the energy carriers for magnetism. Trying to pin down the particle position, we first have to know the cause that created the motion in the first place.

The Pauli exclusion principle is fundamental to

quantum mechanics. It states that no two identical *fermions* can occupy the same quantum state simultaneously.

Earlier in this paper, we identified *fermions* as playing the roles of *transmitters* and *receivers* in Shannon's generic communication system model. This implies that fermions are made of a combination of magnetic monopoles and magnetic dipoles.

The explanation could be that two combinations of magnetic realm particles that have the same state may end up with the same magnetic monopoles facing each other, like North-North or South-South. Because the two monopoles of the same kind are repelling each other, the same combinations that define a state may be excluded from a quantum configuration.

### 19.6. Is everything a quantum field?

The short answer is no. The accepted theory is that everything can be explained at the fundamental level by a quantum field theory, which assumes that everything is a *wave*. That includes electrons, protons, neutrons, and photons. Interestingly enough, current quantum field theory conveniently ignores magnetism. This avoidance of the use of magnetic field properties in theory started with Maxwell.

The reason why this quantum field theory does not reflect reality can be proven by a simple experiment. When we place a piece of uranium in a vapor chamber, we see particles instead of waves. The same experiment can be used to visualize electrons, protons, or cosmic radiation.

The results cannot be explained by the quantum field theory. This is called the Mott problem. An alpha particle with a spherically symmetric wave function produces a straight, linear track in a cloud chamber, rather than a diffused, mist-like sphere.



Figure 34. Uranium emitting alpha particles shows that we have particle behavior and not a wave.

( @ScienceExplainedOfficial )

Ideally, if we want to check if everything is a wave, we need to go beyond the *electrical* realm observations and look for the behavior of a magnetic monopole or a graviton particle.

The Information Aware Universe model offers a simple reason. To explain why we see waves everywhere in the subatomic world, it is because the forces driving their motion are very likely to originate from the magnetic or gravitation realms. That means magnetic monopoles and magnetic dipoles are responsible for those forces.

When we are applying the wave-particle duality law, the new Information Aware Universe model states that all observers from higher realms, like the *electrical* one, will observe those motion patterns as *waves* only. This is the main reason why everything we see is a field.

### 19.7. Wave-like photon motion and origin of electron orbit

This section uses the Information Aware Universe model to try to find an explanation for why photons are moving as waves. A photon is a particle, so according to Newton's laws, a photon ejected from an interaction should move in a straight line. Then what is the reason why it starts waving in space when it moves? And it is possible that the same reason why photons move in waves could be the same reason why electrons orbit the atomic nucleus.

Previously, in this paper, we introduced the *invariance* principle and the way it applies to Maxwell's laws. One area is for Maxwell's laws applied to the interaction between the magnetic and gravitational realms. According to these laws, when a magnetic monopole moves in a field created by a graviton dipole, an inductive gravitational force is generated.

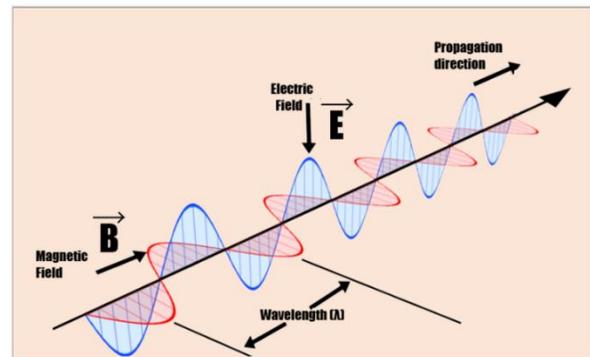


Figure 35. There is a correlation between the magnetic and electric fields. An internal structure of a photon that has a magnetic monopole moving in a variable gravitational field may generate a variable gravitational inductive force.

This can be the explanation for why a photon moves in a wave-like pattern. If the photon has an internal structure made of magnetic monopoles and gravitons orbiting around each other, then variable gravitational and magnetic fields may be created.

A magnetic monopole orbiting in a gravitational field would generate a gravitational inductive force that would push the photon up and down on its path. This force obeys a generalized form of Maxwell's laws.

The same interaction between the electron's magnetic monopoles and the variable gravitational field generated by the orbiting of gravitons from the nucleus may be the source of the electron's orbital motion.

### 19.8. Massless propulsion?

Most mechanical work in factories is done by electrical motors, which are a massless way to produce forces and movement. The way an electrical motor generates force is described by Maxwell's laws. But the same laws can be used to generate a different type of force, which is a gravitational one.

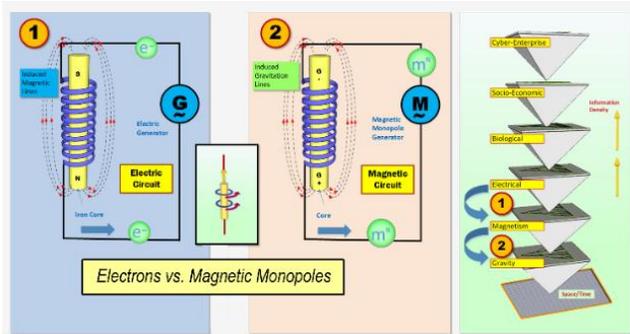


Figure 36. Generalized Maxwell's laws state that an electron moving in a magnetic field generates an inductive force. The same type of inductive force applies to a magnetic monopole that moves in a gravitational field.

In this arrangement, a generator [1] output is a flow of electrons routed through a coil. A magnetic field is generated based on inductive magnetic lines. If we replace the generator output with a flow of magnetic monopoles, then the coil should generate a gravitational field according to the same Maxwell's laws. This new field is generated based on inductive gravitation lines.

By using this principle in the construction of a rocket, we may have a vehicle with massless propulsion. The speed this vehicle can achieve is very likely to be much higher than the speed of light. To allow a human to survive the extreme acceleration, the same vehicle may have another coil running a magnetic monopole in counter current, which can shield the occupants from its effects. In the end, the design would have two inductive gravitational fields.

If we consider how all electrical motors operate using a massless construct, it is also possible that this type of massless propulsion may work too.

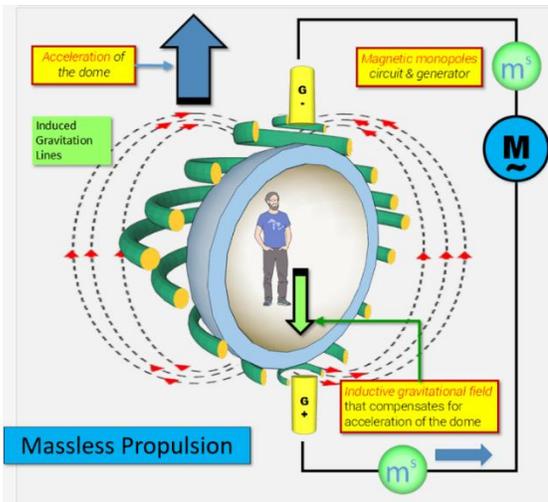


Figure 37. A proposed massless propulsion system uses a generator of magnetic monopoles running through a coil that surrounds the vehicle.

### 19.9. Higgs boson and Standard Model

While the Higgs boson has been considered validated by experiments, a major question remains. Only a tiny fraction of the proton's mass—about 1–2%—comes directly from the Higgs boson. The overwhelming majority (roughly 98–99%) is considered to arise from the strong nuclear force, specifically the energy of gluon fields and quark interactions inside the proton. Nevertheless, this raises the question of proton internal structure. The current explanation of using the equivalence between energy and mass to explain this difference is not that simple.

If we can answer this question of missing mass in a proton, we open a new key chapter in our understanding of "what the world is, and how it behaves." The proton is one of the main building blocks of all visible matter in the Universe. Among its intrinsic properties are its electric charge, mass, and spin. These properties are assumed to emerge from the complex dynamics of its fundamental constituents—quarks and gluons—described by the theory of quantum chromodynamics.

The spin property is the one that points us to magnetism and its realm. Unless we can add the laws that guide the magnetism realm – magnetic dipoles and magnetic monopoles - into the theory of quantum chromodynamics, there are very few chances to make any progress in explaining the proton mass or even the Higgs boson theory.

Standard Model equations used to describe the behavior of subatomic particles have the same problem. We know that the Standard Model predicts the existence of quarks, gluons, and strong forces. But we also know that all subatomic particles have magnetic properties. Nevertheless, the Standard Model doesn't leave any room for the existence of magnetic monopoles or magnetic dipoles.

Because we avoid an explanation for *magnetism*, it is possible that we cannot explain a place for particles such as *neutrinos*. Neutrinos do not have an electrical charge, but they do have a very tiny magnetic moment. This concludes that such particles could be considered components that can be fully observed only from the *magnetic* realm, which leads us to believe that they are directly related to *magnetic monopole* behavior. Without a way to incorporate the magnetic realm into our view of the world, it is impossible to find a place for them in the current Standard Model equations.

### 19.10. Supersymmetry does not exist

The new Information Aware Universe model becomes deterministic and evolutionary when the multi-observer pattern is used to interpret reality. Within this model, the creation of a new realm is accompanied by an evolutionary process. During this period, an entity evolves to the point that it acquires new *full viability* properties. By *full viability*, we understand that the new entities can be described using the Viable Complex System model of operation.

We can use as an example the emergence of the producer-consumer centric socio-economic realm from the family centric biological realm.

And this evolutionary process still continues today. Currently, we are witnessing the emergence of a new realm, *cyber*, which is the one that is used to replace business processes from socio socio-economic realm with virtualized images. These virtual images are more productive, easier to control, deliver better quality, and enable better collaboration between different departments of a business. They can be software applications or highly automated lines.

Because this is an emergent realm, we do not yet have a dipole at its core. Any guess on what kind of symmetry the new dipole will support is almost impossible to make.

The same story repeated itself throughout the history of our Universe with the emergence of each new realm. All evolution paths, from electrical to biological realms, and from biological to socio-economic realms, always took unexpected paths. The only common pattern that is shared across all realms is the dipole one, because it is the one that drives a continuous increase in viability.

Add to these steps the fact that the entire Universe is a holarchy, with no bottom or top layers. That simply means that any form of previous arrangements of particles.

This leads to the conclusion that the evolutionary path does not follow the supersymmetry pattern. The only pattern it follows is the dipole one. The relationship between different types of monopoles is not guaranteed to be preserved when new, unknown realms can be created in the future. Same with any symmetry.

### 19.10. Why is gravity weak when compared with electrical charges force

This is probably one of the easiest relationships to explain using the Information Aware Universe model. We know that gravity is immensely weak compared to electrical force. We are looking at about  $10^{36}$  to  $10^{40}$  times weaker.

To better understand why the two forces, *electrical* and *gravitational*, are so different, we need to look at their position in the hierarchy. Between the two realms, we have the *magnetic* one. Any realm will shield most of the interaction effects from a lower realm.

We can use another example to show this difference. Let's measure the difference between the forces acting in the socio-economic realm and the electrical realm. We can evaluate this measurement by assessing the impact of the electrostatic force on the price of a public company's share.

A public company is an entity from the socio-economic realm. There is a biological realm between them. This is similar to the way we are assessing the impact of the gravitational force on charged particle interactions. We do not know if we can say that the impact of the electrical charge force is  $10^{36}$  to  $10^{40}$  times weaker than the main force that drives the price of a public company share, but we know for sure that it is almost nonexistent.

### 19.11. Quantum gravity

One concept that is always in the news is *quantum gravity*. This is a field of theoretical physics that seeks to unify the principles of quantum mechanics, which governs the subatomic world, and general relativity theory, which describes gravity and large-scale spacetime interactions.

By using the Information Aware Universe model, we know that the source of the quantified nature of our world is in the way the fifth-dimension attribute behaves. This answers the question of quantum property.

The quest to unify the principles that govern the subatomic particles with gravitational laws doesn't make much sense. Subatomic particles are subject to gravitational laws, regardless of the realm. In this case, the question is related to charged particles from electrical realms, which definitely are subjected to gravitational laws.

If we look into the behavior of charged particles versus gravitons, then there is another answer. The Universe is organized as a holarchy, which gives each realm autonomous behavior. The laws that guide graviton monopoles are entirely different from the laws that guide the interaction between positive and negatively charged particles.

To conclude, gravitation behavior, driven by *graviton* dipoles, must already be quantified from its association with *information causal attributes*.

### 19.12. String theory

The idea that everything is made of strings goes directly against the fundamental principle that guides most of the Universe, which is evolution.

Without explaining how these strings can contribute to this cycle that starts with simple material objects and entities and ends up with complex structures we have in our society today, it is impossible to take it seriously.

### 19.13. Big Bang theory and regenerative cycles

Current theories in physics assume that the Universe is flat when it comes to energy. Nevertheless, this assumption is mainly about only one type of energy. The idea is that if we go to higher energy, we should learn more about the Universe. This is the main reason why one of the main trends in research is to build more expensive, higher-energy accelerators.

But this trend ignores some basic knowledge. First, the amount of energy is not always relevant to uncovering new phenomena. A virus consumes an infinitesimal amount of energy, but despite this, it is very successful in surviving for billions of years, maybe. Second, is that by smashing particles, we eventually find out how their components work together. It is like trying to throw a car against a wall and then figure out how it works from the resulting parts without knowing material science, thermodynamics, hydraulics, chemistry, and so on.

A far simpler example is using a hard drive to learn about the software stored in its memory by simply taking it apart and reading each storage unit. This task is impossible without the right documentation.

From this model of a flat Universe and its association with energy, it was relatively easy to assume that by going towards higher energies, we actually are going back in time, to the time of creation. And because this model is not only flat, but it is also linear, the result is that the entire trip would be done in one take. And this is how the Big Bang theory was born.

And because evolution is viewed as one continuous event, and it has a starting point, it is easy to see that it must also have an endpoint. On top of this, all material objects could have their lifecycle related to this unique cycle.

To begin with, there are a few problems with the Big Bang theory. One of them is regarding the origin of Helium and Hydrogen atoms. The Big Bang theory assumes that they were created only during the initial phase of this explosion. These atoms are building blocks for all stars, so if the Universe doesn't make them anymore, the conclusion is that we will run out of stars at some point, with all the implications.

The Information Aware Universe model takes another path. This model proposes that dipoles from one realm may develop their own complete viability cycle and then form a new realm. The perfect example is the evolution of early communities of humans organized around their families into a *producer-consumer* dipole-based realm.

But what happens with the lifecycle of this evolution cycle? When does it end, and what happens after? In our case, the future is clear and is based on two options. Either we disappear when the Sun ceases to exist, or we evolve to the point where the colonization of other planetary systems is possible. There is no third option. Without reaching a new evolutionary phase, our entire existence revolves entirely around the Sun's existence.

In this case, when the Sun ceases to exist, its matter and the Earth's matter will not be lost forever. It will likely be reused by other stellar systems where new planets will form, and possible new civilizations will develop.

And with each new civilization cycle, there are the same two options. Either learn how to travel between stars or be gone when your own star runs out of fuel. It is easy to see that the Universe's evolution runs on a basic principle which can be stated as "*evolve or perish*". An immediate consequence is that all significantly older civilizations must be able to travel between stars to escape their fate.

The star in this case acts like a trigger of a *regeneration cycle* for human-like civilization. If you are not able to evolve enough, matter will be recycled as the foundation for a new possible civilization.

Observations show that a *regeneration cycle* may also happen in the electrical realm. All galaxies have a black hole in their center. And there are many observations that show many young stars orbiting close to these black holes. We also know that black holes can consume cosmic objects that are orbiting too close to their surface.

One explanation for the existence of these young stars is that black holes play the role of a *regenerative engine* for charged particles and all their combinations. Particles like electrons, protons, neutrons, atoms, and molecules are converted into a collection of magnetic monopoles. Through an unknown mechanism, they can be recycled back into Helium and Hydrogen atoms, which are the building blocks for the new stars.

To conclude, the main evolutionary cycle of our Universe is not a continuous one, but it is made of a multitude of smaller ones, each one associated with one realm. The amount of energy plays a significant role, but not the one promoted by the Big Bang theory.

There are a few consequences of this new interpretation. The most important one is that the current Universe is continuously evolving.

Another consequence is that it is impossible to point to a beginning in time, the same way it is impossible to point to the beginning of life on Earth. The third consequence is that all material objects we observe exist because they have acquired full-viability capabilities. For instance, we can see electrons, protons, and neutrons only because they were the only entities capable of surviving the black hole *regeneration cycle*.

#### 19.14. General Theory of Relativity and the Speed of Light

In a previous section, we already introduced the  $E=mc^2$  formula and the speed of light properties. Next, we are adding a summary that highlights a few facts about the general theory of relativity.

First of all, we mentioned that Einstein's theory uses Maxwell's laws as a starting point. And Maxwell's laws are incomplete. To avoid questions about the laws that apply only to magnetism, Maxwell eliminates them by declaring that magnetism exists only as a dipole. This way, a lot of questions about the energy carrier that must exist between North and South magnetic monopoles, or about the laws of attraction between them, do not need to be asked.

The approach Maxwell took was to declare that electricity and magnetism are basically unified by the laws he introduced, even though the laws describe what happens on the electrical side with the electrically charged particles.

By doing this, Maxwell didn't leave Einstein much to work with. If a photon follows a curved path around a gravitational object, the only explanation left is that spacetime is changed by the gravitational field. No word about the magnetic dipole energy carrier, or about the magnetic properties of a photon.

The same thinking goes for the speed of light. Because a magnetic dipole exists in Maxwell's laws only as a component of a force that acts on charged particles, any other behavior associated solely with magnetic monopoles has been ignored. Obviously, the only conclusion from this assumption was that there is no other energy carrier beyond photons, so their speed must be the ultimate one.

A while ago, John Archibald Wheeler stated that "*matter tells spacetime how to curve.*" Nevertheless, by looking at the big picture in which we include magnetic dipoles, magnetic monopoles, and gravitons, it is clear that such a statement is way too simplistic to reflect the complexity of laws guiding the interaction between photons and gravitational fields.

#### 19.15. Gravitational waves and gravitons

The magnetic realm is not the only one ignored by Maxwell's laws and Einstein's theory. The gravitational realm received the same treatment.

More recently, researchers have built instruments capable of detecting extremely small variations in gravitational fields. In the Universe, these perturbations occur when there is an event in which large cosmic objects undergo a big transformation in their masses. This can happen when, for instance, two black holes may collide.

In this case, there is an assumption that these perturbations are travelling at the speed of light. These perturbations are called gravitational waves. Obviously, we did not measure how fast they travel, but the assumption is also a consequence of ignoring the laws and rules of the magnetic and gravitational realms.

It is important to make a distinction between the speed of perturbation of the gravitational field and the speed of energy carriers for gravitons. It is like the difference between the speed of a perturbation that travels over a water surface and the speed of sound. They have entirely different contexts.

#### 19.16. Matter and Antimatter

One of the important questions modern astrophysics has is about the distribution of matter versus antimatter.

If we are using the evolutionary model to describe various dipoles, Nature doesn't pick sides. Electron versus Proton, Male versus Female, Producer versus Consumer, North magnetic pole versus South magnetic pole, all are the result of a transformation process that leads to an existing viable realm.

Within this model, there is no difference between matter and antimatter. Both are particles from the electrical realm that have their internal structure made from combinations of magnetic dipoles and magnetic monopoles. The explanation could be that the combination of North and South magnetic monopoles that exist in a normal charged particle got switched to a South and North magnetic monopole combination in the antimatter particles.

The reason why normal matter has been favored could be that in a black hole, the *regeneration cycle* driving the creation of electrons, protons, and neutrons is the one that takes the least amount of energy.

Once the black hole generates combines them into Hydrogen and Helium atoms, and the rest of the nucleosynthesis process follows the same pattern, which favors the matter versus antimatter creation cycle.

#### 19.17. Ultra-high energy cosmic rays

On October 15, 1991, in Utah, United States, a particle with an energy estimated to be 320 exaelectronvolts was detected. This energy is equivalent to a 140-gram baseball travelling at about 28 m/s. Its energy was 20 million times greater than the highest photon energy measured in electromagnetic radiation emitted by an extragalactic object.

And this is not the only event registered by various observatories.

Current theory in physics does not have an explanation. The reason is relatively simple. In the *electrical* realm, there is a limitation on how much energy a photon can carry, and by extension, how much energy a charged particle is also able to carry.

The only explanation for such high energy is if the particle was the result of a process that led to the creation of particles from magnetic or gravitational realms. So far, we do not know anything about the energy carrier for magnetic or gravitational dipoles. But one thing we can safely assume. The amount of energy they can carry must be much higher than that carried by a photon. And this energy can be the one exchanged during the collision with the atoms inside the detector from Utah.

It is important to note that since the first observation of this ultra-high-energy cosmic ray by the University of Utah in 1962, at least fifteen similar events have been recorded.

### 19.18. Information Aware Universe model and Conscience

Another topic that has seen a lot of debate and speculation lately is the concept of *conscience*. Most scientists and physicists consider *consciousness* to be defined as an emergent property of complex biological processes in the brain, fully explainable by classical physics and chemistry, without requiring new or exotic fundamental physics.

This definition is only half true. This is because humans are the only entities we know that have their existence fully committed to two different realms, biological and socio-economic. The main reason is the short history of the socio-economic realm, and because of this, there are many properties associated with its viability that are not mature enough compared with those found in the biological realm.

In the Universe, the evolution transformation from one realm to another normally would take billions of years, with some of these transitions taking even longer. So, a transition that is only a few thousand years old is still in its infancy. The duality of our role, family-centric and producer-centric, is the main reason we are still vulnerable to primitive biological organisms like viruses, and our lifespan has not improved a lot.

Within this context, we describe *conscience* as the collection of laws and rules that help us to adapt to the socio-economic environment, and the *subconscious* as the collection of laws and rules that guide our existence as a biological organism.

In the end, to survive and be successful in the socio-economic realm, humans have developed a set of rules and laws they need to learn to become a productive part of the

community. Many of these laws and rules have no equivalent in Nature. Their main focus is on learning to cooperate around the *producer-consumer* dipole, while the benefits from all these efforts will always be directed to family welfare.

### 19.20. Black hole information paradox

The black hole information paradox arises from the conflict between quantum mechanics and general relativity. This paradox suggests that information about matter falling into a black hole may be lost forever, challenging fundamental principles of physics. This is because black holes are considered regions of spacetime from which nothing can escape, not even light. In the 1970s, Stephen Hawking's calculations suggested that a black hole may evaporate via Hawking radiation. And because the emitted radiation appears randomly, carrying no record of the original matter, it suggests that information is permanently lost when the hole disappears.

The Information Aware Universe model for black holes has a different behavior associated with their lifecycle. First of all, matter falling into a black hole is recycled into hydrogen and helium atoms. The internal process takes apart the falling atoms into magnetic dipoles and magnetic monopole particles.

The second assumption is that nothing escapes from a black hole. This ignores the existence of the magnetic field. Observations show that the black hole at the center of our galaxy is surrounded by a very strong magnetic field. And magnetic fields carry information. This is true for all computer hard drives. They store our data based on the magnetic field's ability to store information.

### 19.21. Quantum Computing

Quantum computing, like AI, is two of the hottest domains of study today. Nevertheless, the use of quantum behavior to try to build a computing platform has many roadblocks. Next, we are describing a few of them.

When we are looking at any computing device, there are two separate platforms that are needed to operate. The first one is the *hardware*, and the second one is the *software*.

To be practical, the *hardware* platform has to be relatively easy to mass-produce and easy to interface with a wide variety of peripherals. The quantum computing hardware is not easy to mass-produce and so far, there are no standardized peripherals to connect with.

The *software* practically for this platform also doesn't exist. To be practical, a software stack has to have the following components: the equivalent of assembly language, an operating system, a language, and a compiler. Because the type of computation tasks running on a quantum computing platform is not the same as those running on

regular computers, it will be difficult to adapt the existing computing stack to work on a quantum computing platform.

The researchers in quantum computing claim that there is a unique advantage that such a platform provides, which is speed and parallel computing. This type of advantage assumes that there is a direct relationship between *solving complex calculations* and *computing power*. As we mentioned before, this is not entirely true. A super simple virus is clearly able to process information from its environment far better than many supercomputers put together. The ability of a virus to make these calculations enabled the virus to survive for possibly hundreds of millions of years or more.

One advantage claimed by the quantum computing platform is its ability to break strong encryption algorithms. This feature is not very useful, as the changes to existing encryption algorithms are easy to make to defeat any current or future advanced computing platforms. This leaves the current research in quantum computing as an experimental device for the foreseeable future.

## 19.22. AI and its future

Previously, in this paper, we described in detail the AI versus the new information and system theory that extends Shannon's theory of information.

Current AI is based on pattern recognition. The training for patterns is done using either text-based documents, a collection of images, or videos. Next, we are highlighting four fundamental problems with this training approach.

- **Complexity is not measured** – when a current pattern is identified to be part of a response, there is no standardized method to measure its complexity. This limitation is the result of the training methodology. None of the topics extracted from documents, images, or videos used for training are evaluated for complexity.
- **Lack of different contexts** – almost every topic covered by AI training may have multiple interpretations based on different contexts in which it exists. For instance, the same vehicle can be used as a family transportation car, as a taxi, or as a military transportation unit for troops. The different contexts should influence the AI responses.
- **Lack of hierarchy of contexts** – ignoring a context in which a topic exists translates into a weak response. Ignoring a hierarchy of contexts in which the same topic exists translates into an impossible evaluation of a complete response.

This is the most complex criterion to meet. Many entities not only may take on different roles, but they could

also be part of a hierarchy of roles.

For instance, a bolt can be part of a hydraulic pump, which is part of a control mechanism, which is part of a landing gear, which is part of a plane. Clearly, none of the training methods and the processing of results cover a hierarchy of contexts.

- **Notifications versus commands or actionable responses** – previously, we have classified messages or signals in a generic communication system model as being either *notifications* or *commands*. Current AI engine responses are only of the *notification* type.

The difference between *notifications* and *commands* is that *commands* contain a list of actionable tasks that are generated using an alignment between the *transmitter* and *receiver* contexts. These contexts are *physical* and *causal*.

In engineering projects and business operations, almost all messages received by engineers or business participants are of a *command* type. To upgrade the existing AI engines to support *commands*, they need to first add a complex context-based framework to their training methods.

But adding a context-based framework to training this goes against the way Large Language Models are used by the current AI engines to generate responses. It renders them useless.

To conclude, for current AI to have a successful future, it needs to change fundamentally their approach to training. The data needs to be stored with multiple contexts. Only this way the AI engines can extend their support to tasks from engineering projects and from business operations.

Nevertheless, these requirements change how fundamentally current AI engines are constructed, which makes it unlikely that better versions of the same algorithms will succeed in practice. These tasks now require highly trained professionals to complete. This is possible because our information processing mechanism can be trained to manage information coming from a complex hierarchy of contexts.

## Conclusion

Current theories from physics view the Universe as a four-dimensional flat structure organized around energy levels. The main goal of this paper is to change this view.

This paper captures the research efforts done over the last few decades. Not all topics covered here may be proven to be true in the future. But the main reason why I introduced them, together with this new kind of physics, is to free the current theories from over one hundred years of relatively fruitless research.

This direction started with Maxwell's tenet that a magnetic dipole is indivisible, a truism that is still in use today. A simple experiment with iron filings shows the magnetic field lines of a bar magnet.

Previously, we highlighted that this type of interaction can be seen as a field only when the observation is done by the Electrical Universal Observer from the Information Aware Universe model.

If we switch to an *Information Aware Universal Observer* from the magnetic realm, we should observe how the magnetic monopoles and the magnetic energy carrier from the magnetic bar interact with the iron filings.

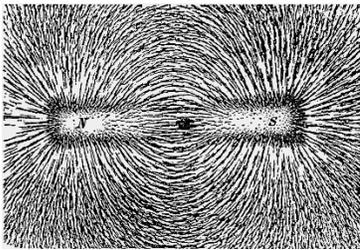


Figure 38. An experiment with iron filings shows the magnetic field lines and two magnetic poles.

The consequence of ignoring magnetism didn't stop with the effort to explain the magnetic forces. Because Maxwell ignored magnetism, Einstein used spacetime as a stopgap and declared that it would curve to explain photon behavior in a strong gravitational field.

One important consequence of using the new Information Aware Universe model is to stop using Niels Bohr's argument, which recommends ignoring everything we do not know how to measure. The correct approach should be to always highlight the boundary of what we know how to measure, but at the same time, to really try to incorporate knowledge related to what we cannot measure.

The perfect example is the *Standard Model*, which claims that it is the most complete representation of what happens in the Universe. Lee Smolin, a theoretical physicist, published a paper in 1992 called "*Did the Universe Evolve.*" In this paper, he introduced the concept of "*cosmological natural selection*". Lee's main idea is that the Universe evolved towards discovering the parameters of the standard model. This is very close to the idea proposed by the *Information Aware Universe* model that everything we observe is the result of a selection mechanism driven by achieving full viability capability.

Lee Smolin was not the only researcher who made this observation. Stephen Hawking also noted that "*The laws of science, as we know them at present, seem to have been very finely adjusted to make possible the development of life.*"

Nevertheless, Lee's idea didn't go far enough. The Standard Model still doesn't have a place for magnetic monopoles. A simple experiment using two magnets shows that there must be a separation between the North and South poles.

It is possible that many researchers know the difference, but they may forget that this model is used to teach future physicists about "*what the world is, and how it behaves.*"

In conclusion, to move forward, physics research should chase bigger instruments or the validation of some exotic theories. We should go back to the basics, like finding more about the overall patterns in Nature. We should also go back to trying to find explanations for simpler experiments, which in the past we were not well prepared to analyze.

Intelligence is defined by this paper as the amount of knowledge we can extend our control over. Magnetism can be the next frontier that will increase our understanding of the Universe significantly if we are able to learn more about it.

We mentioned before that John Wheeler divided his own life into three parts. The first part he called "*Everything is Particles.*" The second part was "*Everything is Fields.*" And the third part, which Wheeler considered the bedrock of his physical theory, he called "*Everything is Information.*" Maybe it is time to use the new *Physics of Information* field to move back to "*Everything is Particles.*" By doing this, we can go back to determinism and to an evolutionary Information Aware Universe model, a view that will help us to advance our understanding of "*what the world really is and how it behaves.*"

We are closing this paper the same way we began, which is with some advice from Shannon, the creator of the mathematical theory of communication. In one of his [40] papers, he viewed the field of information as requiring further study. He said that "*The word 'information' has been given different meanings by various writers in the general field of information theory. It is likely that at least a number of these will prove to be useful in certain applications to deserve further study and permanent recognition. It is hardly to be expected that a single concept of information would satisfactorily account for the numerous possible applications of the general field.*"

## Acknowledgements

This new information theory and the development of the new Information Aware Universe took decades of effort. During this time, the focus was mainly on modeling the business.

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