Generalized Second Law of Thermodynamics

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Any understanding of the irreversibility of the arrow of time should account the quantum nature of the world that surrounds us. [12]

Entropy, the measure of disorder in a physical system, is something that physicists understand well when systems are at equilibrium, meaning there's no external force throwing things out of kilter. But new research by Brown University physicists takes the idea of entropy out of its equilibrium comfort zone. [11]

Could scientists use the Second Law of Thermodynamics on your chewing muscles to work out when you are going to die? According to research published in the International Journal of Exergy, the level of entropy, or thermodynamic disorder, in the chewing muscles in your jaw increases with each mouthful. This entropy begins to accumulate from the moment you're "on solids" until your last meal, but measuring it at any given point in your life could be used to estimate life expectancy. [10]

There is also connection between statistical physics and evolutionary biology, since the arrow of time is working in the biological evolution also.

From the standpoint of physics, there is one essential difference between living things and inanimate clumps of carbon atoms: The former tend to be much better at capturing energy from their environment and dissipating that energy as heat. [8]

This paper contains the review of quantum entanglement investigations in living systems, and in the quantum mechanically modeled photoactive prebiotic kernel systems. [7]

The human body is a constant flux of thousands of chemical/biological interactions and processes connecting molecules, cells, organs, and fluids, throughout the brain, body, and nervous system. Up until recently it was thought that all these interactions operated in a linear sequence, passing on information much like a runner passing the baton to the next runner. However, the latest findings in quantum biology and biophysics have discovered that there is in fact a tremendous degree of coherence within all living systems.

The accelerating electrons explain not only the Maxwell Equations and the Special Relativity, but the Heisenberg Uncertainty Relation, the Wave-Particle Duality and the electron's spin also, building the Bridge between the Classical and Quantum Theories.

The Planck Distribution Law of the electromagnetic oscillators explains the electron/proton mass rate and the Weak and Strong Interactions by the diffraction patterns. The Weak Interaction changes the diffraction patterns by moving the electric charge from one side to the other side of the diffraction pattern, which violates the CP and Time reversal symmetry.

The diffraction patterns and the locality of the self-maintaining electromagnetic potential explains also the Quantum Entanglement, giving it as a natural part of the Relativistic Quantum Theory and making possible to understand the Quantum Biology.

Contents

Author: George Rajna

Preface

Jeremy England, a 31-year-old assistant professor at the Massachusetts Institute of Technology, has derived a mathematical formula that he believes explains this capacity. The formula, based on established physics, indicates that when a group of atoms is driven by an external source of energy (like the sun or chemical fuel) and surrounded by a heat bath (like the ocean or atmosphere), it will often gradually restructure itself in order to dissipate increasingly more energy. This could mean that under certain conditions, matter inexorably acquires the key physical attribute associated with life.
[8]

We define our modeled self-assembled supramolecular photoactive centers, composed of one or more sensitizer molecules, precursors of fatty acids and a number of water molecules, as a photoactive prebiotic kernel system. [7]

The human body is a constant flux of thousands of chemical/biological interactions and processes connecting molecules, cells, organs, and fluids, throughout the brain, body, and nervous system. Up until recently it was thought that all these interactions operated in a linear sequence, passing on information much like a runner passing the baton to the next runner. However, the latest findings in quantum biology and biophysics have discovered that there is in fact a tremendous degree of coherence within all living systems. [5]

Quantum entanglement is a physical phenomenon that occurs when pairs or groups of particles are generated or interact in ways such that the quantum state of each particle cannot be described independently – instead, a quantum state may be given for the system as a whole. [4]

I think that we have a simple bridge between the classical and quantum mechanics by understanding the Heisenberg Uncertainty Relations. It makes clear that the particles are not point like but have a dx and dp uncertainty.

Information engine operates with nearly perfect efficiency

Physicists have experimentally demonstrated an information engine—a device that converts information into work—with an efficiency that exceeds the conventional second law of thermodynamics. Instead, the engine's efficiency is bounded by a recently proposed generalized second law of thermodynamics, and it is the first information engine to approach this new bound.

The results demonstrate both the feasibility of realizing a "lossless" information engine—so-called because virtually none of the available information is lost but is instead almost entirely converted into work—and also experimentally validates the sharpness of the bound set by the generalized second law.

The physicists, Govind Paneru, Dong Yun Lee, Tsvi Tlusty, and Hyuk Kyu Pak at the Institute for Basic Science in Ulsan, South Korea (Tlusty and Pak are also with the Ulsan National Institute of Science and Technology), have published a paper on the lossless information engine in a recent issue of *Physical Review Letters*.

"Thinking about engines has driven the progress of thermodynamics and statistical mechanics ever since Carnot set a limit on the efficiency of heat engines in 1824," Pak told *Phys.org*. "Adding information processing in the form of 'demons' set new limitations, and it was essential to verify the new limits in experiment."

Traditionally, the maximum efficiency with which an engine can convert energy into work is bounded by the second law of thermodynamics. In the past decade, however, experiments have shown that an engine's efficiency can surpass the second law if the engine can gain information from its surroundings, since it can then convert that information into work. These information engines (or "Maxwell's demons," named after the first conception of such a device) are made possible due to a

fundamental connection between information and thermodynamics that scientists are still trying to fully understand.

Naturally, the recent experimental demonstrations of information engines have raised the question of whether there is an upper bound on the efficiency with which an information engine can convert information into work. To address this question, researchers have recently derived a generalized second law of thermodynamics, which accounts for both energy and information being converted into work. However, no experimental information engine has approached the predicted bounds, until now.

The generalized second law of thermodynamics states that the work extracted from an information engine is limited by the sum of two components: the first is the free energy difference between the final and initial states (this is the sole limit placed on conventional engines by the conventional second law), and the other is the amount of available information (this part sets an upper bound on the extra work that can be extracted from information).

To achieve the maximum efficiency set by the generalized second law, the researchers in the new study designed and implemented an information engine made of a particle trapped by light at room temperature. Random thermal fluctuations cause the tiny particle to move slightly due to Brownian motion, and a photodiode tracks the particle's changing position with a spatial accuracy of 1 nanometer. If the particle moves more than a certain distance away from its starting point in a certain direction, the light trap quickly shifts in the direction of the particle. This process repeats, so that over time the engine transports the particle in a desired direction simply by extracting work from the information it obtains from the system's random thermal fluctuations (the free energy component here is zero, so it does not contribute to the work extracted).

One of the most important features of this system is its nearly instantaneous feedback response: the trap shifts in just a fraction of a millisecond, giving the particle no time to move further and dissipate energy. As a result, almost none of the energy gained by the shift is lost to heat, but rather nearly all of it is converted into work. By avoiding practically any information loss, the information-to-energy conversion of this process reaches approximately 98.5% of the bound set by the generalized second law. The results lend support for this bound, and illustrate the possibility of extracting the maximum amount of work possible from information.

Besides their fundamental implications, the results may also lead to practical applications, which the researchers plan to investigate in the future.

"Both nanotechnology and living systems operate at scales where the interplay between thermal noise and information processing is significant," Pak said. "One may think about engineered systems where information is used to control molecular processes and drive them in the right direction. One possibility is to create hybrids of biological systems and engineered ones, even in the living cell." [15]

How small does your rice pudding need to get when stirring jam into it?

Have you ever tried turning the spoon back after stirring jam into a rice pudding? It never brings the jam back into the spoon. This ever-increasing disorder is linked to a notion called entropy. Entropy is of interest to physicists studying the evolution of systems made up of multiple identical elements, like gas. Yet, how the states in such systems should be counted is a bone of contention. The traditional view developed by one of the fathers of statistical mechanics, Ludwig Boltzmann - who worked on a very large number of elements - is opposed to the seemingly disjointed theoretical perspective of another founding scientists of the discipline, Willard Gibbs, who describes systems with a very small number of elements.

In a new study published in *EPJ Plus*, Loris Ferrari from the University of Bologna, Italy, demystifies this clash between theories by analysing the practical consequences of Gibbs' definition in two systems of a well-defined size. Ferrari speculates about the possibility that, for certain quantities, the differences resulting from Boltzmann's and Gibbs' approach can be measured experimentally.

This debate centres around the notion of negative absolute temperature (NAT), seen as a misleading consequence of Boltzmann's definition of entropy. In contrast, Gibbs' theory prohibits NAT and makes the energy equipartition rigorous in systems of arbitrary size. The two approaches, however, converge when the systems have a very large number of elements. So the issue here is to define the minimum size system for which both theories agree.

To test the two approaches against each other, the author examines two models; namely a gas of N atoms which do not interact chemically and another system with N interacting spins. His numerical simulations show that it is possible to assess which of the two models is the most accurate using experimental proof. [14]

An apparent macroscopic violation of the second law of thermodynamics in a quantum system

Researchers at UCM and CSS have encountered a partial violation of the second law of thermodynamics in a quantum system known as Hofstadter lattice. This partial violation has no place within the framework of classical physics.

A Hofstadter lattice is a theoretical model with a square two-dimensional network through which quantum particles like electrons or photons circulate. Moreover, when one of these particles completes a closed path in the network, the particle acquires a quantum phase.

This system models a class of two-dimensional materials (similar to graphene) with properties so unusual that they are outside the typical classification of conductors or insulators, and are instead described as topological insulators.

One of the most striking properties displayed by this system is the presence of edge currents, while the interior does not allow for any conduction. In addition, these edge currents are remarkably strong even in the presence of impurities in the material, which has put them on the scientific community's radar for applications in spintronics, photonics and quantum computing.

In an article published in the journal Scientific Reports, researchers Ángel Rivas and Miguel A. Martin-Delgado of the Department of Theoretical Physics at UCM and CCS explain that they have studied the thermodynamic properties of this system by placing it in the presence of two heat sources, one hot and one cold. To do so, they have formulated a quantum theory that describes this situation and solved the dynamical equations.

What predicts the theoretical calculations is that the transport of heat presents a behavior far beyond the typical features of classical thermodynamics. Specifically, on one edge of the material a current is induced that flows from a cold spot to a hot spot. This is contrary to thesecond law of thermodynamics, under which it is not possible for heat to flow spontaneously from a cold body to a warmer one.

From a technological point of view, the second law of thermodynamics limits the practical energy efficiency of devices such as engines, batteries, refrigerators, solar cells, etc.

A Partial Violation

However, when the remainder of the edges and the interior of the material are taken into account, the second law is restored. This "partial" violation is an effect of this type of exotic quantum system that does not fit within the framework of classical physics.

Furthermore, these currents also display robustness to the presence of impurities that observe certain symmetry patterns related to the position of the thermal sources and the dissipative dynamics they induce.

This new phenomenon, called "dissipative symmetry-protection," has never been observed before and could give rise to new applications that are not only interesting but of practical utility.

The research takes places within a quantum simulation framework, a discipline that seeks to study such materials through artificial devices with similar characteristics obtained by quantum control techniques, such as photonic networks and ultra-cold atoms.

These results will lead to new and unexpected applications in the development of quantum technologies, such as quantum simulators or quantum memories, presenting more stability and operating under realistic conditions subject to temperature fluctuations. [13]

Study sheds light on the role of the entropy in a quantum system

Any understanding of the irreversibility of the arrow of time should account the quantum nature of the world that surrounds us. The is the key result of the work carried out by Vincenzo Alba and Pasquale Calabrese of the International School for Advanced Studies (SISSA) of Trieste, recently published in the journal Proceedings of the National Academy of Sciences (PNAS).

According to one of the main laws of thermodynamics, the entropy of a system tends to increase in time until equilibrium is reached. This accounts for the irreversibility of the flow of time for macroscopic phenomena. Since the beginning of the last century, physicists have been dealing with the dilemma of reconciling the laws of thermodynamics with the microscopic laws of nature, which have no privileged temporal direction. The problem becomes conceptually more difficult within the context of quantum mechanics, in which a pure isolated system with zero entropy will remain thus forever, even if not in thermodynamic equilibrium.

The work by Alba and Calabrese illuminates how this perspective, despite being substantially correct, actually fails to explain the problem. In particular, the authors have shown that any single point in an extended quantum system that is far from equilibrium actually has entropy that increases in time, exactly as in thermodynamics. The origin of this entropy is in the entanglement between the part we are looking at and the rest of the system. Entanglement is a peculiar correlation that exists only in quantum mechanics in which pairs or groups of particles interact in ways such that no particle can be described independently of the others. [12]

Research pushes concept of entropy out of kilter

Entropy, the measure of disorder in a physical system, is something that physicists understand well when systems are at equilibrium, meaning there's no external force throwing things out of kilter. But new research by Brown University physicists takes the idea of entropy out of its equilibrium comfort zone.

The research, published in Physical Review Letters, describes an experiment in which the emergence of a non-equilibrium phenomenon actually requires an entropic assist.

"It's not clear what entropy even means when you're moving away from equilibrium, so to have this interplay between a non-equilibrium phenomenon and an entropic state is surprising," said Derek Stein, a Brown University physicist and co-author of the work. "It's the tension between these two fundamental things that is so interesting."

The phenomenon the research investigated is known as "giant acceleration of diffusion," or GAD. Diffusion is the term used to describe the extent to which small, jiggling particles spread out. The jiggling refers to Brownian motion, which describes the random movement of small particles as a result of collisions with surrounding particles. In 2001, a group of researchers developed a theory of how Brownian particles would diffuse in a system that was pushed out of equilibrium.

Imagine jiggling particles arranged on a surface with undulating bumps like a washboard. Their jiggle isn't quite big enough to enable the particles to jump over the bumps in the board, so they don't diffuse much at all. However, if the board were tilted to some degree (in other words, moved out of equilibrium) the bumps would become easier to jump over in the downward-facing direction. As tilt begins to increase, some particles will jiggle free of the washboard barriers and run down the board, while others will stay put. In physics terms, the particles have become more diffusive—more spreadout—as the system is moved out of equilibrium. The GAD theory quantifies this diffusivity effect and predicts that as tilt starts to increase, diffusivity accelerates. When the tilt passes the point where all the particles are able to jiggle free and move down the washboard, then diffusivity decreases again.

The theory is important, Stein says, because it's one of only a few attempts to make solid predictions about how systems behave away from equilibrium. It's been tested in a few other settings and has been found to make accurate predictions.

But Stein and his team wanted to test the theory in an unfamiliar setting—one that introduces entropy into the mix.

For the experiment, Stein and his colleagues placed DNA strands into nanofluidic channels—essentially, tiny fluid-filled hallways through which the molecules could travel. The channels were lined however with nanopits—tiny rectangular depressions that create deep spots within the relatively narrower channels. At equilibrium, DNA molecules tend to arrange themselves in disordered, spaghetti-like balls. As a result, when a molecule finds its way into a nanopit where it has more room to form a disordered ball, it tends to stay stuck there. The pits can be seen as being somewhat like the dips between bumps on the theoretical GAD washboard, but with a critical difference: The only thing actually holding the molecule in the pit is entropy.

"This molecule is randomly jiggling around in the pit—randomly selecting different configurations to be in—and the number of possible configurations is a measure of the molecule's entropy," Stein explained. "It could, at some point, land on a configuration that's thin enough to fit into the channel outside the pit, which would allow it to move from one pit to another. But that's unlikely because there are so many more shapes that don't go through than shapes that do. So the pit becomes an 'entropic barrier.'"

Stein and his colleagues wanted to see if the non-equilibrium GAD dynamic would still emerge in a system where the barriers were entropic. They used a pump to apply pressure to the nanofluidic channels, pushing them out of equilibrium. They then measured the speeds of each molecule to see if GAD emerged. What they saw was largely in keeping with the GAD theory. As the pressure increased toward a critical point, the diffusivity of the molecules increased—meaning some molecules zipped across the channel while others stayed stuck in their pits.

"It wasn't at all clear how this experiment would come out," Stein said. "This is a non-equilibrium phenomenon that requires barriers, but our barriers are entropic and we don't understand entropy away from equilibrium."

The fact that the barriers remained raises interesting questions about the nature of entropy, Stein says.

"Non-equilibrium and entropy are two concepts that are kind of at odds, but we show a situation in which one depends on the other," he said. "So what's the guiding principle that tells what the tradeoff is between the two? The answer is: We don't have one, but maybe experiments like this can start to give us a window into that."

In addition to the more profound implications, there may also be practical applications for the findings, Stein says. The researchers showed that they could estimate the tiny piconewton forces pushing the DNA forward just by analyzing the molecules' motion. For reference, one newton of force is roughly the weight of an average apple. A piconewton is one trillionth of that.

The experiment also showed that, with the right amount of pressure, the diffusivity of the DNA molecules was increased by factor of 15. So a similar technique could be useful in quickly making mixtures. If such a technique were developed to take advantage of GAD, it would be a first, Stein says.

"No one has ever harnessed a non-equilibrium phenomenon for anything like that," he said. "So that would certainly be an interesting possibility." [11]

Chewing over the aging process

The Second Law of Thermodynamics states the precise opposite of the optimistic phrase "things can only get better". In fact, the disorder in a closed system, its entropy, always increases…eventually. In other words, things can only get worse. Castles of stone or sand eventually collapse, the bodies of those who build such castles ultimately decay, in the meantime the food they eat is broken and only temporarily rebuilt into muscles. The masseter muscles, for instance, strong and the most prominent chewing muscles in the jaw that are particularly powerful in herbivores, but all mammals use these muscles to chew.

While we live and breathe our bodies have repair systems for mending damaged tissues, but they do suffer wear and tear, mainly through friction. Nevertheless, Mustafa Özilgen of the Department of Food Engineering, at Yeditepe University, in Istanbul, and colleagues, point out that the lifespan entropy concept suggests that organisms have a limited capacity for generating disorder, entropy, during their lifetime. When that limit is reached, the organism dies, essentially "of natural causes".

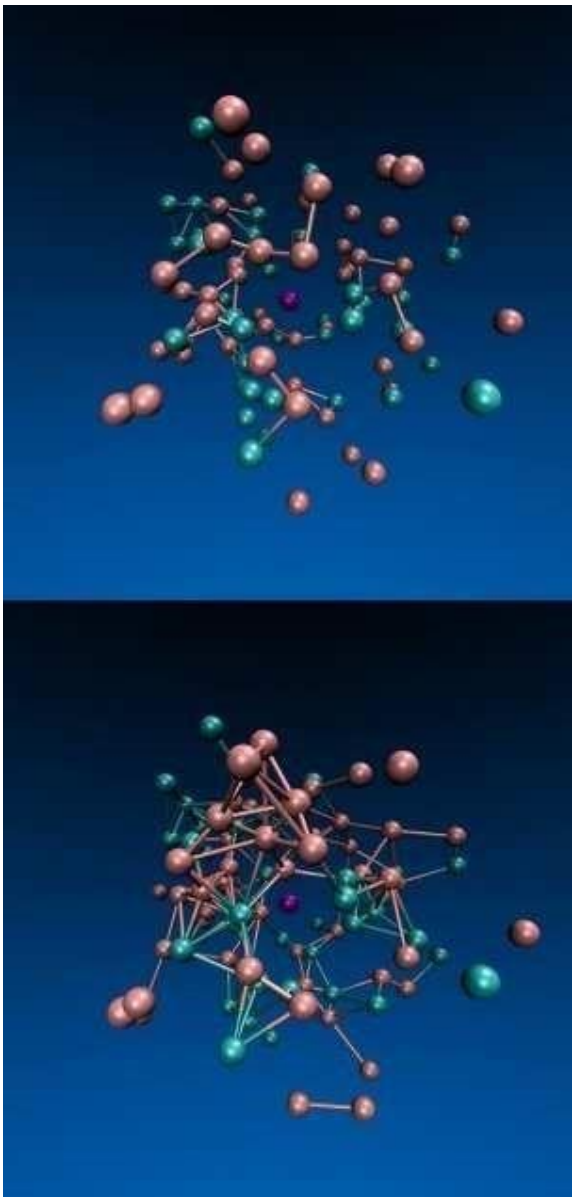
A person living out their three score years and ten, or perhaps more realistically in the modern era, 76 years on average will generate 10 kilojoules per degree Kelvin of entropy in their masseter muscles as they chew from out of the cradle and into the grave. An obese person, who may be taking up 10 percent more nutrients than their slim friend, may generate that same amount of entropy five years earlier. A more efficient body, and specifically more efficient muscles will take longer to generate entropy. As such, the team says, it should be possible to determine entropy of the masseter muscles under laboratory conditions by recording precise energy measurements of the tissue while a person chews and so provide an estimate of lifespan based on likely quantities of food they eat each day through their lives. [10]

This Physicist Has a Groundbreaking Idea about Why Life Exists

“You start with a random clump of atoms, and if you shine light on it for long enough, it should not be so surprising that you get a plant,” England said.

England’s theory is meant to underlie, rather than replace, Darwin’s theory of evolution by natural selection, which provides a powerful description of life at the level of genes and populations. “I am certainly not saying that Darwinian ideas are wrong,” he explained. “On the contrary, I am just saying that from the perspective of the physics, you might call Darwinian evolution a special case of a more general phenomenon.”

At the heart of England’s idea is the second law of thermodynamics, also known as the law of increasing entropy or the “arrow of time.” Hot things cool down, gas diffuses through air, eggs scramble but never spontaneously unscramble; in short, energy tends to disperse or spread out as time progresses. Entropy is a measure of this tendency, quantifying how dispersed the energy is among the particles in a system, and how diffuse those particles are throughout space. It increases as a simple matter of probability: There are more ways for energy to be spread out than for it to be concentrated.



A computer simulation by Jeremy England and colleagues shows a system of particles confined inside a viscous fluid in which the turquoise particles are driven by an oscillating force. Over time (from top to bottom), the force triggers the formation of more bonds among the particles.

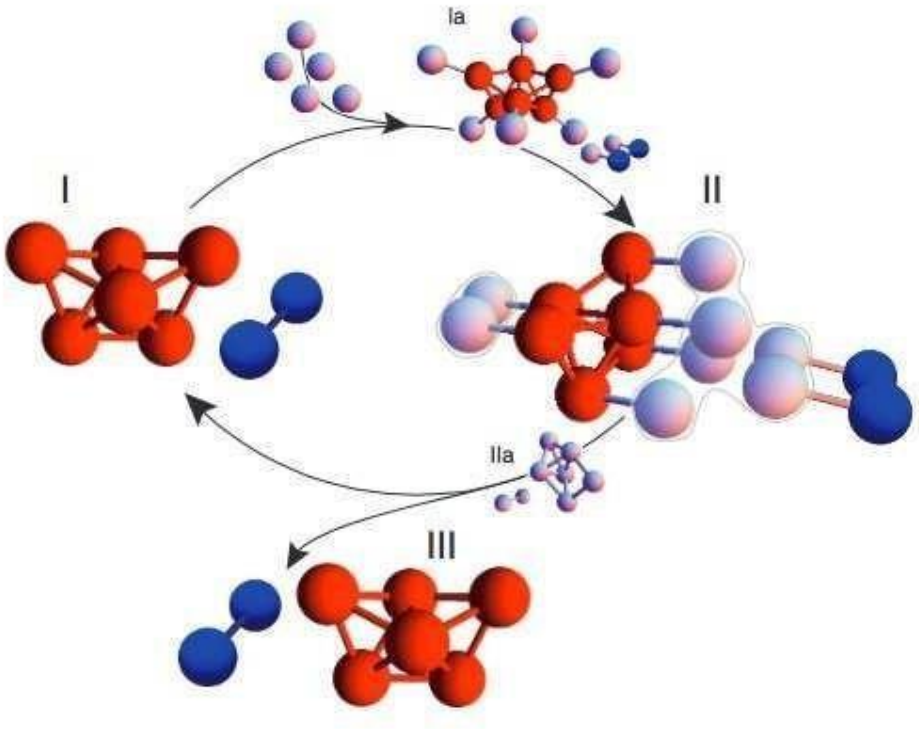
Thus, as particles in a system move around and interact, they will, through sheer chance, tend to adopt configurations in which the energy is spread out. Eventually, the system arrives at a state of maximum entropy called “thermodynamic equilibrium,” in which energy is uniformly distributed. A cup of coffee and the room it sits in become the same temperature, for example.

Although entropy must increase over time in an isolated or “closed” system, an “open” system can keep its entropy low — that is, divide energy unevenly among its atoms — by greatly increasing the entropy of its surroundings. In his influential 1944 monograph “What Is Life?” the eminent quantum physicist Erwin Schrödinger argued that this is what living things must do. A plant, for example, absorbs extremely energetic sunlight, uses it to build sugars, and ejects infrared light, a

much less concentrated form of energy. The overall entropy of the universe increases during photosynthesis as the sunlight dissipates, even as the plant prevents itself from decaying by maintaining an orderly internal structure.

Self-replication (or reproduction, in biological terms), the process that drives the evolution of life on Earth, is one such mechanism by which a system might dissipate an increasing amount of energy over time.

As England put it, “A great way of dissipating more is to make more copies of yourself.”



Self-Replicating Sphere Clusters: According to new research at Harvard, coating the surfaces of microspheres can cause them to spontaneously assemble into a chosen structure, such as a polytetrahedron (red), which then triggers nearby spheres into forming an identical structure.

Scientists have already observed self-replication in nonliving systems. According to new research led by Philip Marcus of the University of California, Berkeley, and reported in Physical Review Letters in August, vortices in turbulent fluids spontaneously replicate themselves by drawing energy from shear in the surrounding fluid. And in a paper in Proceedings of the National Academy of Sciences, Michael Brenner, a professor of applied mathematics and physics at Harvard, and his collaborators present theoretical models and simulations of microstructures that self-replicate. These clusters of specially coated microspheres dissipate energy by roping nearby spheres into forming identical clusters. “This connects very much to what Jeremy is saying,” Brenner said. [8]

Photoactive Prebiotic Systems

We propose that life first emerged in the form of such minimal photoactive prebiotic kernel systems and later in the process of evolution these photoactive prebiotic kernel systems would

have produced fatty acids and covered themselves with fatty acid envelopes to become the minimal cells of the Fatty Acid World. Specifically, we model self-assembling of photoactive prebiotic systems with observed quantum entanglement phenomena. We address the idea that quantum entanglement was important in the first stages of origins of life and evolution of the biospheres because simultaneously excite two prebiotic kernels in the system by appearance of two additional quantum entangled excited states, leading to faster growth and self-replication of minimal living cells. The quantum mechanically modeled possibility of synthesizing artificial selfreproducing quantum entangled prebiotic kernel systems and minimal cells also impacts the possibility of the most probable path of emergence of photocells on the Earth or elsewhere. We also examine the quantum entangled logic gates discovered in the modeled systems composed of two prebiotic kernels. Such logic gates may have application in the destruction of cancer cells or becoming building blocks of new forms of artificial cells including magnetically active ones.

Significance Statement

Our investigated self-assembly of molecules towards supramolecular bioorganic and minimal cellular systems depends on the quantum mechanics laws which induce hydrogen and Van der Waals bindings (Tamulis A, Grigalavicius, M, Orig Life Evol Biosph 41:51-71, 2011).

In the work presented here, quantum entanglement takes the form of a quantum superposition of the active components in synthesized self-assembling and self-replicating living systems. When a quantum calculation of an entangled system is made that causes one photoactive biomolecule of such a pair to take on a definite value (e.g., electron density transfer or electron spin density transfer), the other member of this entangled pair will be found to have taken the appropriately correlated value (e.g., electron density transfer or electron spin density transfer). In our simulations, the separation distance of supramolecular bio systems changes took place during geometry optimization procedures, which mimic real-world intermolecular interaction processes.

Our discovered phenomenon of the quantum entanglement in the prebiotic systems enhance the photosynthesis in the proposed systems because simultaneously excite two prebiotic kernels in the system by appearance of two additional quantum entangled excited states (Tamulis A, Grigalavicius M, Baltrusaitis J, Orig Life Evol Biosph 43:49-66, 2013; Tamulis A, Grigalavicius M, Krisciukaitis S (2014) , J Comput Theor Nanos, 11, 1597-1608, 2014; Tamulis A, Grigalavicius M, 8:117-140, 2014.). We can propose that quantum entanglement enhanced the emergence of photosynthetic prebiotic kernels and accelerated the evolution of photosynthetic life because of additional absorbed light energy, leading to faster growth and self-replication of minimal living cells.

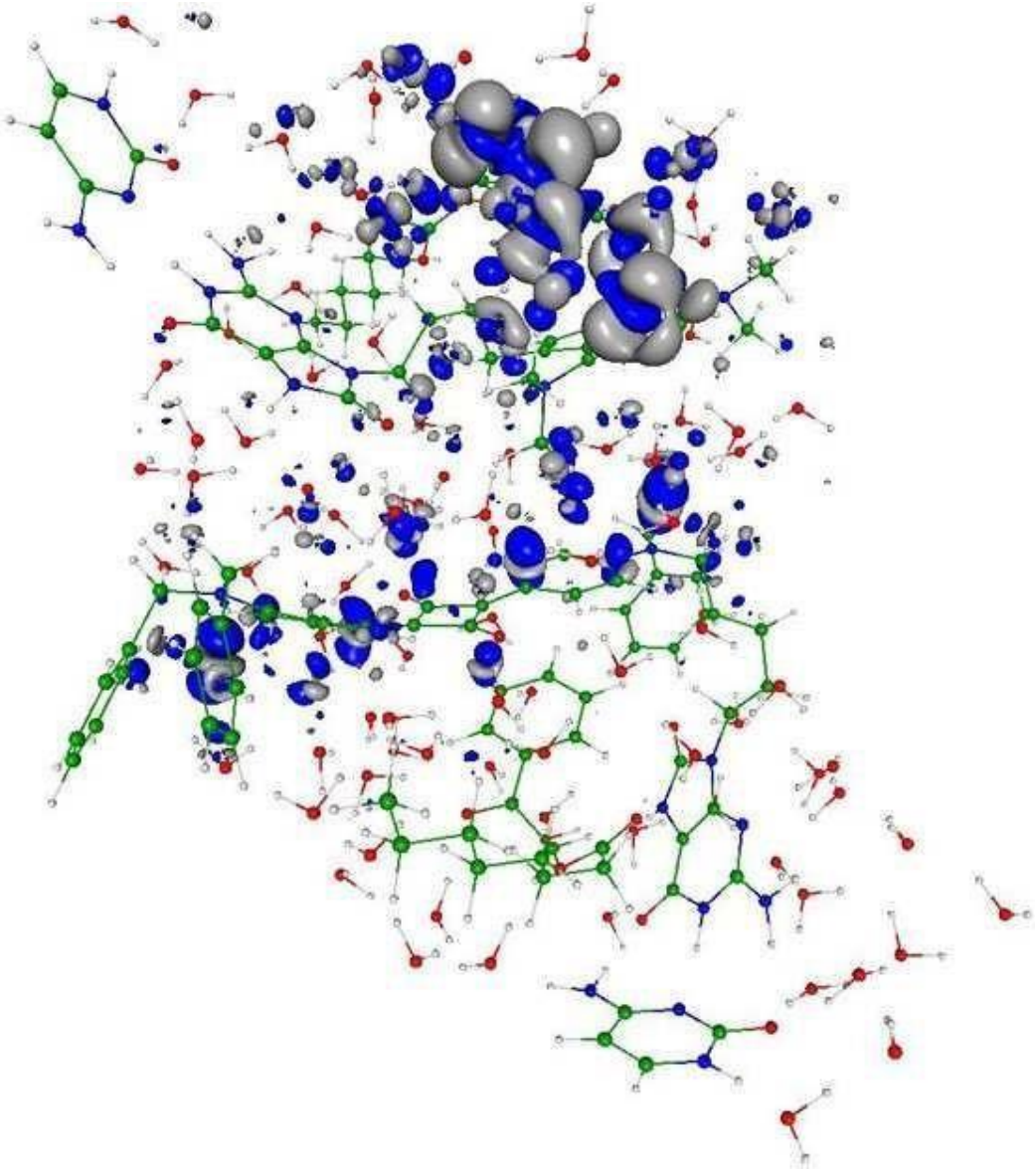
We can state that: Livings are self-assembled and self-replicating wet and warm stochastically moving supramolecular systems where quantum entanglement can be continuously generated and destroyed by non-equilibrium effects in an environment where no static entanglement exists; quantum entanglement involve the biomolecule inside one living or between other neighboring livings.

This warm quantum coherence is basic for the explanation of DNA stability and for the understanding of brain magnetic orientation during migration in more than 50 species of birds, fishes and insects. Exists experimental evidence for quantum-coherent is used for more efficient

light-harvesting in plant photosynthesis. Quantum entanglement exists in supramolecules determining the sense of smell and in the brain neurons microtubules due to quantum vibrations.

In the work presented here, we started to design and quantum mechanical investigations of the molecular logical devices which are useful for construction of nano medicine biorobots against the molecular diseases such a cancer tumors, and against the new kinds of synthesized microorganisms and nano guns.

Figure legend



You can see in the enclosed figure the quantum entanglement phenomenon in the closely selfassembled two synthesized protocell system due to the photo excited electron charge transfer from one protocell to another that leads to closer self-assembly and exchange of energy and information.

Visualization of the electron charge tunneling associated with the 6th (467.3 nm) excited state. The transition is mainly from squarine molecule of the first protocell situated in the bottom of this bi cellular system to precursor of fatty acid (pFA) molecule of the second subsystem (in the top) and little from the 1,4-bis(N,N-dimethylamino)naphthalene molecule (in the top-right) to the same pFA molecule of the second subsystem (in the top). The electron cloud hole is indicated by the dark blue color while the transferred electron cloud location is designated by the gray color.

As a result, these nonlinear quantum interactions compressed the overall molecular system resulting in a smaller gap between the HOMO and LUMO electron energy levels which allows

enhanced tunneling of photo excited electrons from the sensitizer squarine and (1,4bis(N,Ndimethylamino)naphthalene) to the pFA molecule resulting in its cleavage. The new fatty acid joins the existing minimal cell thus increasing it in size. After reaching some critical size, the minimal cell should divide (i.e. self-replicate) into two separate smaller minimal cells. [7]

Quantum Biology

Researchers have long suspected that something unusual is afoot in photosynthesis. Particles of light called photons, streaming down from the Sun; arrive randomly at the chlorophyll molecules and other light-absorbing 'antenna' pigments that cluster inside the cells of every leaf, and within every photosynthetic bacterium. But once the photons' energy is deposited, it doesn't stay random. Somehow, it gets channeled into a steady flow towards the cell's photosynthetic reaction centre, which can then use it at maximum efficiency to convert carbon dioxide into sugars. Quantum coherence in photosynthesis seems to be beneficial to the organisms using it. But did their ability to exploit quantum effects evolve through natural selection? Or is quantum coherence just an accidental side effect of the way certain molecules are structured? [6]

Quantum Consciousness

Extensive scientific investigation has found that a form of quantum coherence operates within living biological systems through what is known as biological excitations and biophoton emission. What this means is that metabolic energy is stored as a form of electromechanical and electromagnetic excitations. These coherent excitations are considered responsible for generating and maintaining long-range order via the transformation of energy and very weak electromagnetic signals. After nearly twenty years of experimental research, Fritz-Albert Popp put forward the hypothesis that biophotons are emitted from a coherent electrodynamics field within the living system.

What this means is that each living cell is giving off, or resonating, a biophoton field of coherent energy. If each cell is emitting this field, then the whole living system is, in effect, a resonating fielda ubiquitous nonlocal field. And since biophotons are the entities through which the living system communicates, there is near-instantaneous intercommunication throughout. And this, claims Popp, is the basis for coherent biological organization -- referred to as quantum coherence. This discovery led Popp to state that the capacity for evolution rests not on aggressive struggle and rivalry but on the capacity for communication and cooperation. In this sense the built-in capacity for species evolution is not based on the individual but rather living systems that are interlinked within a coherent whole: Living systems are thus neither the subjects alone, nor objects isolated, but both subjects and objects in a mutually communicating universe of meaning. . . . Just as the cells in an organism take on different tasks for the whole, different populations enfold information not only for themselves, but for all other organisms, expanding the consciousness of the whole, while at the same time becoming more and more aware of this collective consciousness.

Biophysicist Mae-Wan Ho describes how the living organism, including the human body, is coordinated throughout and is "coherent beyond our wildest dreams." It appears that every part of our body is "in communication with every other part through a dynamic, tunable, responsive, liquid crystalline medium that pervades the whole body, from organs and tissues to the interior of every cell."

What this tells us is that the medium of our bodies is a form of liquid crystal, an ideal transmitter of communication, resonance, and coherence. These relatively new developments in biophysics have discovered that all biological organisms are constituted of a liquid crystalline medium. Further, DNA is a liquid-crystal, lattice-type structure (which some refer to as a liquid crystal gel), whereby body cells are involved in a holographic instantaneous communication via the emitting of biophotons (a source based on light). This implies that all living biological organisms continuously emit radiations of light that form a field of coherence and communication. Moreover, biophysics has discovered that living organisms are permeated by quantum wave forms. [5]

Information – Entropy Theory of Physics

Viewing the confined gas where the statistical entropy not needs the information addition is not the only physical system. There are for example quantum mechanical systems where the information is a very important qualification. The perturbation theory needs higher order calculations in QED or QCD giving more information on the system as in the chess games happens, where the entropy is not enough to describe the state of the matter. The variation calculation of chess is the same as the perturbation calculation of physics to gain information, where the numbers of particles are small for statistical entropy to describe the system. The role of the Feynman graphs are the same as the chess variations of a given position that is the depth of the variations tree, the Information is the same as the order of the Feynman graphs giving the Information of the micro system. [9]

Information – Entropy Theory of Life

There is also connection between statistical physics and evolutionary biology, since the arrow of time is working in the biological evolution also.
The Fluctuation Theorem says that there is a probability that entropy will flow in a direction opposite to that dictated by the Second Law of Thermodynamics. In this case the Information is growing that

is the matter formulas are emerging from the chaos. So the Weak Interaction has two directions, samples for one direction is the Neutron decay, and Hydrogen fusion is the opposite direction. The living biological systems have also entropy lowering and information growing direction by building more complicated or entangled molecules, governed by the quantum mechanics and the general weak interaction. On the other hand there is the arrow of time; the entropy growing is lowering

the information by dissipating these entangled or otherwise connected biomolecules, aging the living systems.

Creating quantum technology

Another area of potential application is in quantum computing. The long-standing goal of the physicists and engineers working in this area is to manipulate data encoded in quantum bits (qubits) of information, such as the spin-up and spin-down states of an electron or of an atomic nucleus. Qubits can exist in both states at once, thus permitting the simultaneous exploration of all possible answers to the computation that they encode. In principle, this would give quantum computers the power to find the best solution far more quickly than today's computers can — but only if the qubits can maintain their coherence, without the noise of the surrounding environment, such as the jostling of neighboring atoms, destroying the synchrony of the waves. [6]

Quantum Entanglement

Measurements of physical properties such as position, momentum, spin, polarization, etc. performed on entangled particles are found to be appropriately correlated. For example, if a pair of particles is generated in such a way that their total spin is known to be zero, and one particle is found to have clockwise spin on a certain axis, then the spin of the other particle, measured on the same axis, will be found to be counterclockwise. Because of the nature of quantum measurement, however, this behavior gives rise to effects that can appear paradoxical: any measurement of a property of a particle can be seen as acting on that particle (e.g. by collapsing a number of superimposed states); and in the case of entangled particles, such action must be on the entangled system as a whole. It thus appears that one particle of an entangled pair "knows" what measurement has been performed on the other, and with what outcome, even though there is no known means for such information to be communicated between the particles, which at the time of measurement may be separated by arbitrarily large distances. [4]

The Bridge

The accelerating electrons explain not only the Maxwell Equations and the Special Relativity, but the Heisenberg Uncertainty Relation, the wave particle duality and the electron's spin also, building the bridge between the Classical and Quantum Theories. [1]

Accelerating charges

The moving charges are self maintain the electromagnetic field locally, causing their movement and this is the result of their acceleration under the force of this field. In the classical physics the charges will distributed along the electric current so that the electric potential lowering along the current, by linearly increasing the way they take every next time period because this accelerated motion. The same thing happens on the atomic scale giving a dp impulse difference and a dx way difference between the different part of the not point like particles.

Relativistic effect

Another bridge between the classical and quantum mechanics in the realm of relativity is that the charge distribution is lowering in the reference frame of the accelerating charges linearly: $ds/dt = at$ (time coordinate), but in the reference frame of the current it is parabolic: $s = a/2\ t^2$ (geometric coordinate).

Heisenberg Uncertainty Relation

In the atomic scale the Heisenberg uncertainty relation gives the same result, since the moving electron in the atom accelerating in the electric field of the proton, causing a charge distribution on delta x position difference and with a delta p momentum difference such a way that they product is about the half Planck reduced constant. For the proton this delta x much less in the nucleon, than in the orbit of the electron in the atom, the delta p is much higher because of the greater proton mass.

This means that the electron and proton are not point like particles, but has a real charge distribution.

Wave – Particle Duality

The accelerating electrons explains the wave – particle duality of the electrons and photons, since the elementary charges are distributed on delta x position with delta p impulse and creating a wave packet of the electron. The photon gives the electromagnetic particle of the mediating force of the electrons electromagnetic field with the same distribution of wavelengths.

Atomic model

The constantly accelerating electron in the Hydrogen atom is moving on the equipotential line of the proton and it's kinetic and potential energy will be constant. Its energy will change only when it is changing its way to another equipotential line with another value of potential energy or getting free with enough kinetic energy. This means that the Rutherford-Bohr atomic model is right and only that changing acceleration of the electric charge causes radiation, not the steady acceleration. The steady acceleration of the charges only creates a centric parabolic steady electric field around the charge, the magnetic field. This gives the magnetic moment of the atoms, summing up the proton and electron magnetic moments caused by their circular motions and spins.

The Relativistic Bridge

Commonly accepted idea that the relativistic effect on the particle physics it is the fermions' spin - another unresolved problem in the classical concepts. If the electric charges can move only with accelerated motions in the self maintaining electromagnetic field, once upon a time they would reach the velocity of the electromagnetic field. The resolution of this problem is the spinning

particle, constantly accelerating and not reaching the velocity of light because the acceleration is radial. One origin of the Quantum Physics is the Planck Distribution Law of the electromagnetic oscillators, giving equal intensity for 2 different wavelengths on any temperature. Any of these two wavelengths will give equal intensity diffraction patterns, building different asymmetric constructions, for example proton - electron structures (atoms), molecules, etc. Since the particles are centers of diffraction patterns they also have particle – wave duality as the electromagnetic waves have. [2]

The weak interaction

The weak interaction transforms an electric charge in the diffraction pattern from one side to the other side, causing an electric dipole momentum change, which violates the CP and time reversal symmetry. The Electroweak Interaction shows that the Weak Interaction is basically electromagnetic in nature. The arrow of time shows the entropy grows by changing the temperature dependent diffraction patterns of the electromagnetic oscillators.

Another important issue of the quark model is when one quark changes its flavor such that a linear oscillation transforms into plane oscillation or vice versa, changing the charge value with 1 or -1. This kind of change in the oscillation mode requires not only parity change, but also charge and time changes (CPT symmetry) resulting a right handed anti-neutrino or a left handed neutrino.

The right handed anti-neutrino and the left handed neutrino exist only because changing back the quark flavor could happen only in reverse, because they are different geometrical constructions, the u is 2 dimensional and positively charged and the d is 1 dimensional and negatively charged. It needs also a time reversal, because anti particle (anti neutrino) is involved.

The neutrino is a 1/2spin creator particle to make equal the spins of the weak interaction, for example neutron decay to 2 fermions, every particle is fermions with ½ spin. The weak interaction changes the entropy since more or less particles will give more or less freedom of movement. The entropy change is a result of temperature change and breaks the equality of oscillator diffraction intensity of the Maxwell–Boltzmann statistics. This way it changes the time coordinate measure and
makes possible a different time dilation as of the special relativity.

The limit of the velocity of particles as the speed of light appropriate only for electrical charged particles, since the accelerated charges are self maintaining locally the accelerating electric force. The neutrinos are CP symmetry breaking particles compensated by time in the CPT symmetry, that is the time coordinate not works as in the electromagnetic interactions, consequently the speed of neutrinos is not limited by the speed of light.

The weak interaction T-asymmetry is in conjunction with the T-asymmetry of the second law of thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes the
weak interaction, for example the Hydrogen fusion.

Probably because it is a spin creating movement changing linear oscillation to 2 dimensional oscillation by changing d to u quark and creating anti neutrino going back in time relative to the proton and electron created from the neutron, it seems that the anti neutrino fastest then the velocity of the photons created also in this weak interaction?

A quark flavor changing shows that it is a reflection changes movement and the CP- and T-symmetry breaking!!! This flavor changing oscillation could prove that it could be also on higher level such as atoms, molecules, probably big biological significant molecules and responsible on the aging of the life.
Important to mention that the weak interaction is always contains particles and antiparticles, where the neutrinos (antineutrinos) present the opposite side. It means by Feynman's interpretation that these particles present the backward time and probably because this they seem to move faster than the speed of light in the reference frame of the other side.

Finally since the weak interaction is an electric dipole change with ½ spin creating; it is limited by the velocity of the electromagnetic wave, so the neutrino's velocity cannot exceed the velocity of light.

The General Weak Interaction

The Weak Interactions T-asymmetry is in conjunction with the T-asymmetry of the Second Law of Thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes for example the Hydrogen fusion. The arrow of time by the Second Law of Thermodynamics shows the increasing entropy and decreasing information by the Weak Interaction, changing the temperature dependent diffraction patterns. A good example of this is the neutron decay, creating more particles with less known information about them.
The neutrino oscillation of the Weak Interaction shows that it is a general electric dipole change and it is possible to any other temperature dependent entropy and information changing diffraction pattern of atoms, molecules and even complicated biological living structures. We can generalize the weak interaction on all of the decaying matter constructions, even on the biological too. This gives the limited lifetime for the biological constructions also by the arrow of time. There should be a new research space of the Quantum Information Science the 'general neutrino oscillation' for the greater then subatomic matter structures as an electric dipole change. There is also connection between statistical physics and evolutionary biology, since the arrow of time is working in the biological evolution also.
The Fluctuation Theorem says that there is a probability that entropy will flow in a direction opposite to that dictated by the Second Law of Thermodynamics. In this case the Information is growing that is the matter formulas are emerging from the chaos. So the Weak Interaction has two directions, samples for one direction is the Neutron decay, and Hydrogen fusion is the opposite direction.

Fermions and Bosons

The fermions are the diffraction patterns of the bosons such a way that they are both sides of the same thing.

Van Der Waals force

Named after the Dutch scientist Johannes Diderik van der Waals – who first proposed it in 1873 to explain the behaviour of gases – it is a very weak force that only becomes relevant when atoms and molecules are very close together. Fluctuations in the electronic cloud of an atom mean that it will have an instantaneous dipole moment. This can induce a dipole moment in a nearby atom, the result being an attractive dipole–dipole interaction.

Electromagnetic inertia and mass

Electromagnetic Induction

Since the magnetic induction creates a negative electric field as a result of the changing acceleration, it works as an electromagnetic inertia, causing an electromagnetic mass. [1]

Relativistic change of mass

The increasing mass of the electric charges the result of the increasing inductive electric force acting against the accelerating force. The decreasing mass of the decreasing acceleration is the result of the inductive electric force acting against the decreasing force. This is the relativistic mass change explanation, especially importantly explaining the mass reduction in case of velocity decrease.

The frequency dependence of mass

Since $E = h\nu$ and $E = mc^2$, $m = h\nu / c^2$ that is the m depends only on the ν frequency. It means that the mass of the proton and electron are electromagnetic and the result of the electromagnetic induction, caused by the changing acceleration of the spinning and moving charge! It could be that the m_o inertial mass is the result of the spin, since this is the only accelerating motion of the electric charge. Since the accelerating motion has different frequency for the electron in the atom and the proton, they masses are different, also as the wavelengths on both sides of the diffraction pattern, giving equal intensity of radiation.

Electron – Proton mass rate

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! Also since the particles are diffraction patterns they have some closeness to each other – can be seen as a gravitational force. [2]

There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

Gravity from the point of view of quantum physics

The Gravitational force

The gravitational attractive force is basically a magnetic force.

The same electric charges can attract one another by the magnetic force if they are moving parallel in the same direction. Since the electrically neutral matter is composed of negative and positive charges they need 2 photons to mediate this attractive force, one per charges. The Bing Bang caused parallel moving of the matter gives this magnetic force, experienced as gravitational force.

Since graviton is a tensor field, it has spin = 2, could be 2 photons with spin = 1 together.

You can think about photons as virtual electron – positron pairs, obtaining the necessary virtual mass for gravity.

The mass as seen before a result of the diffraction, for example the proton – electron mass rate Mp=1840 Me. In order to move one of these diffraction maximum (electron or proton) we need to intervene into the diffraction pattern with a force appropriate to the intensity of this diffraction maximum, means its intensity or mass.

The Big Bang caused acceleration created radial currents of the matter, and since the matter is composed of negative and positive charges, these currents are creating magnetic field and attracting forces between the parallel moving electric currents. This is the gravitational force experienced by the matter, and also the mass is result of the electromagnetic forces between the charged particles. The positive and negative charged currents attracts each other or by the magnetic forces or by the much stronger electrostatic forces!?

The gravitational force attracting the matter, causing concentration of the matter in a small space and leaving much space with low matter concentration: dark matter and energy.
There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

The Higgs boson

By March 2013, the particle had been proven to behave, interact and decay in many of the expected ways predicted by the Standard Model, and was also tentatively confirmed to have + parity and zero spin, two fundamental criteria of a Higgs boson, making it also the first known scalar particle to be discovered in nature, although a number of other properties were not fully

proven and some partial results do not yet precisely match those expected; in some cases data is also still awaited or being analyzed.

Since the Higgs boson is necessary to the W and Z bosons, the dipole change of the Weak interaction and the change in the magnetic effect caused gravitation must be conducted. The Wien law is also important to explain the Weak interaction, since it describes the T_{max} change and the diffraction patterns change. [2]

Higgs mechanism and Quantum Gravity

The magnetic induction creates a negative electric field, causing an electromagnetic inertia. Probably it is the mysterious Higgs field giving mass to the charged particles? We can think about the photon as an electron-positron pair, they have mass. The neutral particles are built from negative and positive charges, for example the neutron, decaying to proton and electron. The wave – particle duality makes sure that the particles are oscillating and creating magnetic induction as an inertial mass, explaining also the relativistic mass change. Higher frequency creates stronger magnetic induction, smaller frequency results lesser magnetic induction. It seems to me that the magnetic induction is the secret of the Higgs field.

In particle physics, the Higgs mechanism is a kind of mass generation mechanism, a process that gives mass to elementary particles. According to this theory, particles gain mass by interacting with the Higgs field that permeates all space. More precisely, the Higgs mechanism endows gauge bosons in a gauge theory with mass through absorption of Nambu–Goldstone bosons arising in spontaneous symmetry breaking.

The simplest implementation of the mechanism adds an extra Higgs field to the gauge theory. The spontaneous symmetry breaking of the underlying local symmetry triggers conversion of components of this Higgs field to Goldstone bosons which interact with (at least some of) the other fields in the theory, so as to produce mass terms for (at least some of) the gauge bosons. This mechanism may also leave behind elementary scalar (spin-0) particles, known as Higgs bosons.

In the Standard Model, the phrase "Higgs mechanism" refers specifically to the generation of masses for the $W^{\pm}$, and Z weak gauge bosons through electroweak symmetry breaking. The Large Hadron Collider at CERN announced results consistent with the Higgs particle on July 4, 2012 but stressed that further testing is needed to confirm the Standard Model.

What is the Spin?

So we know already that the new particle has spin zero or spin two and we could tell which one if we could detect the polarizations of the photons produced. Unfortunately this is difficult and neither ATLAS nor CMS are able to measure polarizations. The only direct and sure way to confirm that the particle is indeed a scalar is to plot the angular distribution of the photons in the rest frame of the centre of mass. A spin zero particles like the Higgs carries no directional information away from the original collision so the distribution will be even in all directions. This test will be possible when a much larger number of events have been observed. In the mean time we can settle for less certain indirect indicators.

The Graviton

In physics, the graviton is a hypothetical elementary particle that mediates the force of gravitation in the framework of quantum field theory. If it exists, the graviton is expected to be massless (because the gravitational force appears to have unlimited range) and must be a spin-2 boson. The spin follows from the fact that the source of gravitation is the stress-energy tensor, a second-rank tensor (compared to electromagnetism's spin-1 photon, the source of which is the four-current, a first-rank tensor). Additionally, it can be shown that any massless spin-2 field would give rise to a force indistinguishable from gravitation, because a massless spin-2 field must couple to (interact with) the stress-energy tensor in the same way that the gravitational field does. This result suggests that, if a massless spin-2 particle is discovered, it must be the graviton, so that the only experimental verification needed for the graviton may simply be the discovery of a massless spin-2 particle. [3]

Conclusions

A more efficient body, and specifically more efficient muscles will take longer to generate entropy. As such, the team says, it should be possible to determine entropy of the masseter muscles under laboratory conditions by recording precise energy measurements of the tissue while a person chews and so provide an estimate of lifespan based on likely quantities of food they eat each day through their lives. [10]

There is also connection between statistical physics and evolutionary biology, since the arrow of time is working in the biological evolution also.

Prentiss, who runs an experimental biophysics lab at Harvard, says England's theory could be tested by comparing cells with different mutations and looking for a correlation between the amount of energy the cells dissipate and their replication rates. [8]

Exists experimental evidence for quantum-coherent is used for more efficient light-harvesting in plant photosynthesis. Quantum entanglement exists in supramolecules determining the sense of smell and in the brain neurons microtubules due to quantum vibrations.

In the work presented here, we started to design and quantum mechanical investigations of the molecular logical devices which are useful for construction of nano medicine biorobots against the molecular diseases such a cancer tumors, and against the new kinds of synthesized microorganisms and nano guns. [7]

One of the most important conclusions is that the electric charges are moving in an accelerated way and even if their velocity is constant, they have an intrinsic acceleration anyway, the so called spin, since they need at least an intrinsic acceleration to make possible they movement . The accelerated charges self-maintaining potential shows the locality of the relativity, working on the quantum level also. [1]

The bridge between the classical and quantum theory is based on this intrinsic acceleration of the spin, explaining also the Heisenberg Uncertainty Principle. The particle – wave duality of the electric charges and the photon makes certain that they are both sides of the same thing. The Secret of Quantum Entanglement that the particles are diffraction patterns of the electromagnetic waves and this way their quantum states every time is the result of the quantum state of the intermediate electromagnetic waves. [2]

These relatively new developments in biophysics have discovered that all biological organisms are constituted of a liquid crystalline medium. Further, DNA is a liquid-crystal, lattice-type structure (which some refer to as a liquid crystal gel), whereby body cells are involved in a holographic

instantaneous communication via the emitting of biophotons (a source based on light). This implies that all living biological organisms continuously emit radiations of light that form a field of coherence and communication. Moreover, biophysics has discovered that living organisms are permeated by quantum wave forms. [5]
Basing the gravitational force on the accelerating Universe caused magnetic force and the Planck Distribution Law of the electromagnetic waves caused diffraction gives us the basis to build a Unified Theory of the physical interactions also.

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