

Elementary Particles Subject to an Energy Driven Fundamental Time Arrow

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Abstract

The Standard Model of elementary particles and forces has grown considering time neutral behaviour and a Lagrangian function with non-oriented energy quantities. Basing on an evaluation of shortcomings and trends of the Model and a recent new, dynamic interpretation of the principle of least action, to which the Lagrangian is exposed, this time neutral approach is challenged. Subject to an energy driven fundamental time arrow elementary particles and forces can be considered to be products of self-organization of energy, thus directly reflecting the proportionality of energy and mass. Non-active viruses, virions, are discussed to demonstrate that the generation and maintenance of lifeless self-organized mass particles is compatible with laws of nature. This example from biology also allows understanding relevant peculiarities of the elementary particle family: excessive number, repetitive building stones, different stability and properties, largely variable size, change of reactivity when exposed to different environments and to energy. Such a “dynamic” version of the Standard Model has the potential of much less conflict with experimental reality in quantum physics and cosmology. Before all, it explains gravity, which the Standard Model could not incorporate, as information on matter, which has to be dealt with, in addition to the description of elementary particles themselves for a complete quantum portrayal. This eliminates the conflict between quantum theory and cosmology, but questions the need for a space-time structure of the universe which is here claimed to be mostly controlled by this kind of fundamental information on matter (identified with gravitation). It is argued that exploring and adapting the Standard Model towards fundamental irreversibility rooted in a “dynamic” Lagrangian and an energy driven time arrow is a much more obvious, realistic and experimentally promising strategy, compared to the increasingly accessed abstract world of counterintuitive interpretations, of strings, additional dimensions or multiple universes.

Keywords

Standard Model, Least Action, Irreversibility, Dynamic Energy, Self-Organized Energy, Information

1. Introduction

The principle of least action plays a fundamental role in the derivation of physical laws and mechanisms. It is successfully applied in a wide range of fields ranging from dynamic motion to relativity theory and fundamental physical mechanisms of elementary particles. Action is derived as a time integral over a function, described by energy quantities, the Lagrangian function. Least action is then searched for via a mathematical procedure, the variational calculus. Even though the principle of least action has been in the focus of vivid discussions for three hundred years, up to recently nobody could reasonably explain why nature is applying the principle, nor what it means, and why scalar, time neutral energy quantities, used in the Lagrangian function, can yield and describe dynamic properties of matter.

In a recent publication [1], it was argued that infinitesimal sections of the least action integral have also to be able to minimize and this can only happen when the energy quantities in the Lagrangian function express such properties. They have to be dynamic and oriented; energy must have the property to decrease its presence per state. When this is considered then this means that the principle of least action is expressing a fundamental irreversibility in nature with an energy driven fundamental time arrow. This change of paradigm (which is not in contradiction to everyday experience), of course, should also be valid for elementary particles and their behaviour, which are presently treated as time neutral objects subject to time invertible physical laws. This was investigated in [1] with the result that essential paradoxes of quantum physics disappeared.

The presented approach investigates, what would be the consequences if elementary particle physics would be subject to fundamentally irreversible mechanisms.

The Gradually Grown Standard Model of Elementary Particles

On the basis of long term experience physics relies on the assumption that nature can be described by a limited number of fundamental laws which are expected to be fundamental and simple. The focus is on understanding the smallest building stones but includes the expectation to finally also get a reasonable understanding of the universe. The Standard Model of particles [2] [3] [4] and their interactions has grown over many decades involving increasingly sophisticated and energy intensive experiments combined with parallel theoretical approaches. It has seen the contribution of many famous scientists ranging from Rutherford, Dirac and Feynman to Weinberg, Salam and Higgs. Gradually the Standard

Model Lagrangian grew and became optimized. A mayor strategy consisted in respecting symmetry requirements basing on Noether's theorem (see [5]). It relates physical quantities like energy or momentum with geometrical properties, the invariance of action during symmetry transformations. Symmetry in translation, rotation and time relates to conservation of momentum, angular momentum and energy and dictates interactions. When, fifty years ago, the mass terms were found to violate symmetry properties the proposal by Higgs, Englert and Brout [6] [7] of a new field interacting with all others seemed to resolve the problem. It is well known that only recently a fast decaying particle with some of the expected properties was found in high energy experiments and earned a Nobel prize.

In spite of such apparent progress significant problems remain for the Standard Model. About 20 parameters, describing masses of particles or intensities of interactions cannot be predicted. They have to be measured. Then there are disturbingly large differences between the strength of forces found in nature (35 orders of magnitude between gravitation and strong nuclear forces, 13 orders of magnitude between weak nuclear and electromagnetic forces). For being building stones of matter also masses of elementary particles are quite different, reaching a difference of 14 orders of magnitude between electron-neutrino and top-quark and 5 - 6 orders of magnitude between electrons and Higgs boson. What is the reason for such large differences? Gravitation is not at all included in the Standard Model and quantum processes are incompatible with space-time of general relativity. There is also no explanation for dark matter, which is presently expected to account for 85 % of matter in the universe, nor for the dark energy which is assumed to be responsible for the acceleration of the expansion of the universe. What causes this repulsive force, which appears to act against gravitation in space? The discrepancies between some calculated values and experimentally obtained values, for example of the cosmological constant, which relates to the expected energy density in space, or for Higgs mass, are also extremely high. Finally, numerous phenomena exist around elementary particles, especially at higher energy conditions, which are not explained by the Standard Model at all.

In spite of quite significant successes the Standard Model in its present form is not satisfactory and is also logically problematic. As an escape, new research initiatives started looking for alternatives such as the Grand Unified Theories (GUT), String and Superstring Theories and extra dimensions including Multi-Universe approaches. But such efforts make the real understanding even much more complex and problematic, since non-intuitive elements, such as additional dimensions and parallel worlds are increasingly invoked, in addition to the already existing counter-intuitive properties of quantum systems. In addition, it is difficult to accept concepts of a field that "creates" mass, because it complicates the already bizarre four-dimensional space of General Relativity even more.

Fact is, on the other hand, that everything in our environment is changing in one direction only. Fact is also that no experiment is known which shows inversion of time in a natural process without any additional change in the environment. It is consequently a reasonable intellectual experiment to tentatively assume, in contrast to traditional physics, that elementary particles are not time neutral and that physical laws support a fundamental energy driven time arrow, as recently suggested on the basis of a re-evaluation of the principle of least action and the suggestion of a “dynamic” quantum physics, which also yielded a new interpretation of gravitation (information on matter) [1] [8]. Such an approach, assuming irreversible fundamental properties of nature (which everyone can see in the environment), appears to be more reasonable than accepting counterintuitive mechanisms such as non-locality or particles popping out from nothing, or introducing additional dimensions to mathematically justify what we really do not understand in our natural world.

2. Results

2.1. The Standard Model Approach Subject to an Energy Driven Fundamental Time Arrow

The only important assumption towards irreversibility necessary is that energy, free energy, has the property to decrease its presence per state, a result recently derived via a dynamic interpretation of the principle of least action [1]. It is doing that also in the Lagrangian function and acts that way dynamically towards the principle of least action. It is expressing that nature is fundamentally irreversible and that energy is driving time in the form of a flow of action. The statement that free energy is decreasing its presence per state and approaching a minimum is entirely compatible with practical experience. When, for example, crystals of snowflakes are formed the physical chemical explanation is that this passive self-organization happens because free energy is thereby approaching a minimum. To assume, that such a behaviour of free energy is fundamental, and therefore also applicable to elementary particle physics (as for quantum physics [1]) is the only important new statement here. As visualized in **Figure 1**, which sketches a “dynamic” Standard Model, energy has thus the property to decrease its presence per state and is the reason for a fundamentally irreversible world (top).

What is the immediate consequence of an energy driven time arrow? It allows the distinction of a “before” and an “after” during energy conversion phenomena, which is crucial for highly nonlinear self-organization processes. We know that matter can self-organize. We see this in living organisms and inorganic processes. Life is the consequence of self-organization of matter and started as chemical evolution on our planet more than 3.5 billion years ago. Chemical feedback reactions created local order and molecular organization at the expense of overall entropy production. One simple example of an inorganic self-organization process is the Leidenfrost phenomenon, water poured over a

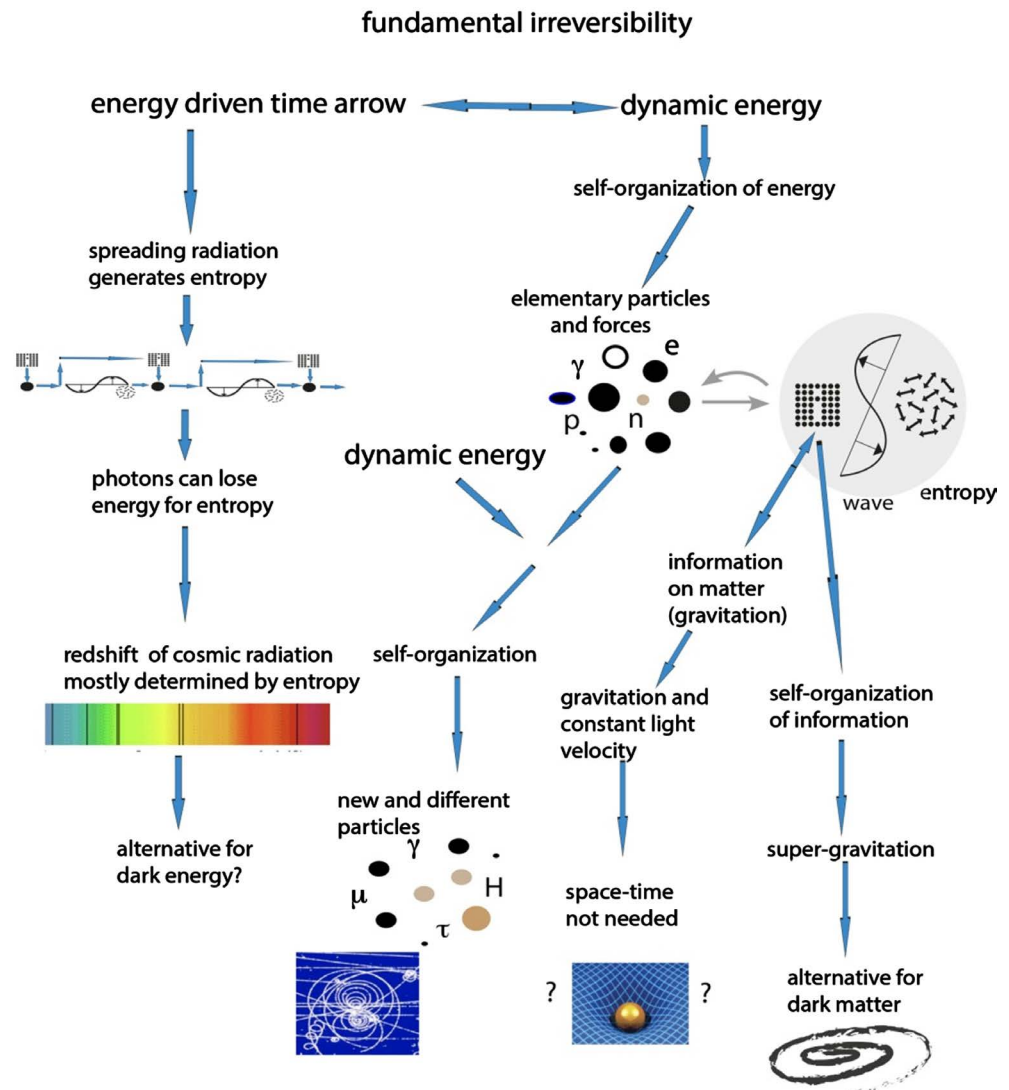


Figure 1. A flow-sheet explaining the adaptation of the Standard Model for elementary particles to a fundamentally irreversible nature. The right side explains how self-organized elementary particles, via the dynamic quantum state, which, besides of particle and wave, involves information on matter, allow different cosmological interpretations. In the lower centre it is shown how added energy yields new and different self-organized particles. On the left side it is shown that spreading light, subject to a dynamic quantum state, has to and can generate entropy, causing stellar redshift.

hot plate forming water droplets moving erratically around. Another example is a vortex in a water flow or a hurricane. Matter is related to mass, and mass to energy. From this it can be mathematically derived that also energy can self-organize [8]. How could this practically happen? Energy moving along time in its drive to decrease its presence per state could interact with energy, which did not yet do that, in a kind of feedback reaction. Such feedback steps can yield self-organization. This capacity of self-organization towards matter is indicated in **Figure 1** (top right). What is the consequence of self-organization of energy? This is obvious. It must be the spectrum of elementary particles with their different properties. An immediate consequence is that mass, self-organized en-

ergy, must be proportional to energy. In the cgs system of unities this proportionality between energy and mass can be written down in the form (E = energy, m = mass):

$$E(\text{cm}^2\text{gs}^{-2}) \sim m(g) \quad (1)$$

It is seen that the required proportionality constant has the unity of a squared velocity: cm^2/s^2 . It is well known that in Einstein's formula, derived from the theory of relativity, this is the square of light velocity with $c \approx 3 \cdot 10^{10}$ cm/s (exact value: 29,979,245,800 cm/s). Here in (1), when matter is assumed to be the consequence of self-organization, the nature of the proportionality should be more complex, involving quantities such as feedback parameters, rate constants and activation energies. Because the need for a four-dimensional space time is questioned (see arguments further below) it is interesting here to point out that the famous formula of Einstein for the equivalence of energy and mass was apparently not obtained via logic reasoning. It was already presupposed in the derivation of the result and did not require relativistic considerations [9], which is important here. It can be obtained from classical considerations only [10]. In addition, it has been shown that the same formula had been published two years earlier than by Einstein by the Italian geologist Olinto de Pretto, who derived it from considerations on the transformation of natural radioactive elements [11]. Relation (1) shows that the energy-mass equivalence is already the immediate consequence of self-organization of energy and thus receives a trivial, rational explanation, which also accounts for the nature of nuclear reactions.

It is consequently logic to assume that the spectrum of 61 presently know elementary particles and interactions are products of energy self-organization (Figure 1). Further below it will be attempted to learn more about properties of elementary particles, which can be derived from fundamental irreversibility and self-organization. Here, at first the particle-wave duality, a fundamental property of matter, first discovered by Louis de Broglie, should be considered. In contrast to conventional time neutral quantum physics, which assumes a parallel existence of both phenomena, which are activated according to the experimental situation, self-organized energy subject to a fundamental time arrow has to be dealt with differently. As explained in [1] energy, self-organized as a particle, attempts to decrease and minimize its presence per state by spreading into space while decreasing its presence per state. This generates the wave form of elementary particles, which however also involves entropy generation because of the dilution of energy into space. Therefore, and in order to warrant reversibility of the particle-wave quantum state, the wave form is activated while providing information (on energy and matter) for the re-conversion of the wave into the particle (a kind of Maxwell demon, which supplies information for the reverse reaction). This is visualized in Figure 1 on the right side. The particle-wave dualism, the quantum state, here is an alternating process assisted by information for the back-conversion of the wave into the particle (Figure 1, right side). This information also aims at decreasing the presence of energy per (quantum-) state.

The quality of this information, the patterns and restrictions imposed by nature, will evidently have an impact on structure and properties of elementary particles (see below).

It was shown [1] that this essential detail, the need to consider information on matter involved, besides of describing the matter itself, makes quantum processes rationally understandable. In fact, the information on the particle-wave state was the missing “information” which seemingly made quantum processes counter-intuitive and irrational in conventional theory. This was shown by logically explaining quantization, the double slit experiment and quantum correlation [1] as well as other quantum phenomena [12] within the “dynamic” quantum approach.

The need to invoke information on matter for the explanation of the particle-wave duality first appeared to be a challenge, because information involves energy and should be experimentally detectable. Then it became clear that the information on matter, around matter, is nothing else than the phenomenon of gravitation [8] [12]. It is information that generates the phenomenon of gravitation by implementing a decrease of energy per state (which causes attraction only, but not repulsion). While in the General Theory of Relativity a curved space is guiding a satellite on an orbit around a planet, it is information (via gravitation) imposing a path of least action, functioning like a remote control of a guided object, which acts in a world controlled by an energy driven time arrow. Since gravitation plays not only an important role on nanoscale, but also on cosmological level, it can, on the basis of such a concept, obviously be concluded that our universe is largely controlled by information and may also have started by information. Our universe appears to function entirely different from the Big Bang scenario, which is characterized by massive entropy formation during the initial explosion, a bizarre expansion of empty space, and an end in total darkness [8] [12].

These considerations show that the strange phenomenon of gravitation, which cannot be accommodated at all within the Standard Model, thus finds a natural explanation within the “dynamic”, energy driven model. Exactly speaking it is not a force but information, which implements a decrease of energy per state. This actually happens, when gravitation is active, and thus explains gravitational forces.

But there arises also an additional opportunity for fundamental physics: since information is related to energy, since it depends on it, and since energy can self-organize, also information on matter can self-organize in certain conditions in a universe which is subject to an energy driven fundamental time arrow. What means self-organized information? It leads to a feedback-driven generation of local order in information and for this it has to consume energy from outside. Like in the elaborate molecular organization of self-organized living beings one is dealing with a higher hierarchy of organization, compared to simple non-organized environments or information activities. Self-organized information activities in our brain has all properties permitting to identify it with con-

sciousness and human spirit [12]. What capability has then self-organization of “information on matter”, which is active in the dynamic quantum state and was identified with gravitation? It should still deal with the drive to decrease energy per state, but within a higher hierarchy of information handling and thus with much more capacity and impact. The energy for such a much more intensified handling of gravitation (of information), a super-gravitation must come from an external energy source, since we are dealing with a self-organized process. But, compared to dark matter, and its expected gravitation, needed for explaining super-gravitation in present theories, it is energy (not gravitation) from matter explaining self-organized super-gravitation here.

It is evident, that such super-gravitation (arising from information on matter) could explain the supposed effect of dark matter, as seen in the rotation behaviour of galaxies or in gravitational lensing and calculated to make up 85% of the universe mass. A much higher gravitation would persist in such super-gravitation areas, but there would be no need for a search for matter, producing ordinary gravitation. Mass provides much more nuclear than gravitational energy so that the source of such mass which could provide the energy for self-organized gravitation would be inconspicuous in space. There would be no need for searching for new invisible particles that contribute to dark matter via their mass. Such reasoning would basically neutralize another crucial problem of the Standard Model, that of dark matter (compare **Figure 1**, right side).

The classical Standard Model has the additional problem that quantum effects are not compatible with General Relativity. It should be recalled that Einstein, faced with the unexplained phenomena of an always constant light velocity, of gravitation, and of inertia, proposed that empty space can do the job. This resulted in the complex mathematical structure of 4-dimensional space-time described in the General Theory of Relativity. The here proposed alternative of an irreversible particle physics based on an energy driven fundamental time arrow opens a surprising alternative. Gravitation turned out to be information on matter. Particles are constantly reassembled from waves via this information. Exactly for this reason an always constant light intensity, independent of the relative motion of light source and object, is evident. This works like sending digital information to airplanes. The nature of information transmitted will be independent of the plane’s flight direction and speed [8]. Similarly, a photon reassembled from information (compare drawing in **Figure 1**, centre) will implement an identical constant light velocity, independent of the relative velocities of light source and detection system. Inertia can easily be explained as well. It arises when there is a counteraction against the energy’s drive to decrease its presence per state. Ernst Mach was right in speculating that gravitation from all the universe is involved in inertia. Since gravitation, inertia and constant light velocity are that way explained, this leads to the surprising conclusion that in an irreversible universe there is no necessity to postulate a 4-dimensional space-time. Gravitation, inertia and constant light velocity are associated with information

(on matter) and do not need additional explanations. As a consequence, there is no need any more to make quantum phenomena compatible with a (superfluous) four-dimensional space-time. Another drawback of the conventional Standard Model seems to be eliminated, but there is a need to explain additional phenomena attributed to relativity: the increase of mass at high velocity and the corresponding change of frequency of a photon interacting with a gravitational field. The explanation given here is that kinetic energy and gravitational energy respectively is incorporated into self-organized energy (mass, $h\nu/c^2$ for a photon) or released from it, when velocity or gravitation is decreasing. This superposition and incorporation of external energy into self-organized energy systems is an experienced fact and regularly observed with self-organized natural phenomena. A hurricane grows from environmental energy, a plant from (solar) radiation, an animal from chemical energy (food) and an oscillating chemical reaction from addition of an energy supplying chemical. Why should particles, when self-organized from energy, not be able to harvest energy supplied in kinetic or gravitational form?

Let us return to these elementary particles. There are 6 types of quarks (up, down, charm, strange, top, bottom) and 6 types of leptons (electron, electron neutrino, muon, muon neutrino, tau, tau neutrino) respectively, as well as force mediators (gauge bosons: photons, gluons, W and Z bosons). Their properties have been and are studied in accelerators, which expose the particles to high energy. What does this mean for self-organized particles? It simply means that also the added energy gets involved and is included in a thus modified self-organization pattern. Resonances are observed and different new particle constellations may result from collisions. As just mentioned, the mass increase, observed when particles are accelerated to near light velocity, is simply showing the conversion of kinetic energy into mass. When a particle collision occurs then the energy is bound to reorganize producing new self-organized particles and energy. Time-oriented mechanisms can much better explain the observed mechanisms and products from high energy collision experiments than time-neutral ones, as considered today. The Standard Model at high energy conditions is known to become very complicated and much less transparent. Experimentally, many short-lived resonances are observed. The grown Standard Model cannot easily deal with some of them and lacks robustness.

Here also a few words should be said on forces, electrical, magnetic and nuclear ones. Since, within the proposed fundamental time arrow, energy is understood to decrease its presence per state, the self-organized products, elementary particles with their special qualities, including forces, should also be subject to such properties and reflect it via their self-organized characteristic mechanisms. This implies that elementary forces, apart from gravitation (explained before to represent and implement information on matter) are also aiming at decreasing energy per state. They are self-organized specialized properties of energy within matter with the additional ability to decrease energy per state. This is actually

true. Electrical, magnetic and nuclear attraction decrease, through their action, the presence of energy per state. This emphasizes the function of elementary particles, as well as force carriers, as self-organized systems which activate these forces while supporting the energy driven time arrow, aiming at decreasing energy per state.

The classical Standard Model has also a problem with dark energy, a repulsive driving force, deduced from the estimated cosmological constant. The latter is deduced from a slight curvature in the plot of stellar and galactic redshifts versus the estimated distance of the light emitting objects. When dealing with a fundamentally irreversible world one has to take the fact serious that radiation spreading out in space generates entropy. It loses capacity to do work. The entropy formula, a logarithmic dependence on the ratio of reached volume of dilution to starting volume, for radiation spreading out into space (originally obtained by Wien and referred to him by Einstein) is the same as for a gas spreading out in space. It is from the comparison of these two identical expressions that Einstein, in 1905, deduced that radiation can be considered as particles [13], later called photons (G.N. Lewis, 1926). A gas of a certain temperature and pressure expanding into space loses working ability by decreasing its pressure and by cooling down (Joule-Thomson-effect). Energy is, of course, not lost, but working ability is decreased as expressed by the mentioned entropy formula (the entropy change times the temperature yields the not any more available energy). And an expanding radiation field is subject to the same entropy change. Since for very large distances the logarithmic function goes towards infinity, all radiation energy expanded into space should finally get degraded to non useful (finely divided up, chaotic) energy. When rearranging the logarithmic entropy formula ((relation (2), V = volume, x = distance), this means that for very large distances x the entropy ΔS , and, with $T\Delta S$ the not any more available energy, will approximately increase linearly with the distance from the light source:

$$\Delta S \sim \log \frac{V}{V_0} \sim \log x^3 \sim \log x \sim x \quad (2)$$

This rough approximation yields exactly the linear dependence of the redshift on distance of light emitting objects in space up to a distance of 1500 Mpc (half of the presently monitored universe) [8]. However, historically grown quantum physics is based on time neutrality, and since a photon travels at light speed, no time, needed for generating entropy, should pass on it according to the Theory of Relativity. In absence of a collision or an interaction with a gravitation field an emitted photon cannot lose energy. The well-known presently favoured interpretation for starlight is therefore not considering free energy loss mediated by entropy generation. It is attributing the actually observed redshift mainly to a supposed inflation, an expansion of empty space (cosmological redshift). The question, how a space with nothing in it can expand, is not answered, neither the question where the superfluous radiation energy (the portion reduced by the redshift) is going. The main reason, why entropy generation is not considered in

this process seems to be that quantum physics simply does not show a way how to do it. A photon, once it left a light source can only change its energy by interaction with matter or gravitation. It cannot do it in empty, homogeneous space. A time neutral particle physics and quantum physics can simply not reasonably explain irreversible phenomena. For present cosmology, a stretching of empty space was therefore the only mathematical way out, with the consequence, that the most distant galaxies already seem to approach light velocity.

When, however, nature is assumed to be subject to a fundamental energy driven time arrow, and a “dynamic” quantum physics is implemented [1], photons should and can respect thermodynamics [8]. When expanding and propagating into space, when photons are already moving free in space, they still can lose free energy via the involvement of information on matter and emission of low-energy (microwave) photons. The tool, which is allowing that is gravitation (information), present both around a photon and in space, around the travelling photon. The proposed mechanisms involved will, of course, have to be explored and studied in greater detail. The challenge is complex. There are, for example, factors which could locally, around cosmic objects, affect entropy generation by expanding radiation. Light could, for example, only have been radiated into a small sector of space or the local temperature, local fields or other parameters could be different. Fact is that consideration of entropy loss for spreading radiation would shape a quite different universe and relativize and question the presently highlighted challenges of dark energy and dark matter.

These brief comments support the argument, that the present concept of a dramatically expanding universe can be wrong. One should not describe an exploding universe, with outer galaxies estimated to approach the speed of light, by assuming time neutral particles and laws as well as ignoring essential thermodynamic experience. One should approach the universe with its elementary particles as a fundamentally irreversible system.

2.2. Stable and Unstable Self-Organized Elementary Particles?

After arguing that elementary particles represent self-organized matter it is necessary to forward additional evidence. Why are there so many elementary particles? Why are quarks (in protons, neutrons) and leptons (electron) indivisible? Why are some particles (e.g. electrons, protons) highly stable and others (free neutrons) quite unstable. Protons and neutrons consist of three quarks each (two up-quarks, one down-quark and two down-quarks and one up quark respectively). But there are additional quark types. Why? Strangely, individual quarks are also not detected freely. The up-and down-quarks and the electron would be sufficient to build matter. Why are there so many additional particles (61 in all up to now)? Does nature, within its self-organization activities, offer a reasonable example, which would support the claim that elementary particles could indeed be considered to be self-organized energy equivalent to matter (**Figure 1**)? There could be the argument that self-organized systems should be

active in matter and energy exchange like living systems and not just existing like protons and electrons. Are there self-organized biological particles which could be compared with the proposed self-organized elementary particles?

A look at virions in biology, viruses outside energy supplying biological cells can give us a fascinating and convincing example, which **Figure 2** will help us to better understand. It is well known that viruses are infectious particles, which replicate only inside living cells [14]. Outside cells they cannot be considered living organisms, because they do not show any metabolic activity, no energy exchange and no reproduction. They are just structured particles, originating from self-organization. In most electron microscopic reproductions of viruses one is actually looking at the inactive virion form which is generated and released during self-organization activity of viruses within a living biological cell. Important here is that biological self-organization of matter can yield particles, which are not living, in the sense of biological life, and get only involved in modifications and transformations when exposed to energy and appropriate matter. This is exactly what one needs as an example when considering elementary particles as self-organized energy. Virions are self-organized particles which are not living but share, as we will see, many properties with elementary particles. And before all, virions (and their active counterpart in form of a virus, which turns over energy and matter) are not a rare phenomenon, but the most abundant biological species on earth. Nothing within the biosphere of the earth is, with estimated 10^{31} particles, so abundant as virions, even though they may, because of their small size, only account for approximately 5% of the world's biomass. Comparing elementary particles, suggested to arise from self-organization of energy, with virions, arising from self-organization of matter, therefore means comparing two very present and relevant natural phenomena. The aim is to show that, when formation of virions is possible through self-organization from matter, then formation of elementary particles from energy is also possible, since matter is mathematically related to mass and mass to energy.

A virion, in fact, is only a closed shell of proteins (capsid), protecting nucleic acid (DNA or RNA), which has the potential to self-replicate after getting access to energy when entering a host cell. It may be enveloped or devoid of a cell envelope. In this way virions have an infrastructure of specific components like protons or neutrons (with their up- and down-quarks) in elementary particles. In virions the geometry of the capsid structure is very elegant, often icosahedral, spherical or rod-shaped (**Figure 2**). Sizes range from 17 nm (Porcine circovirus, via 30 nm (Poliovirus) to 500 nm (Mimivirus) and 1500 nm (Pithovirus). There is a size variation among virions in the order of magnitude of 100, which is quite large. Also mass ratios among elementary particles are very large. The proton-electron mass ratio is 1836. The neutron is only slightly less heavy (99.86%) than a proton. Virions only become active when, in living cells, they get access to energy for metabolic activity. This is similar to elementary particles, which may also react and transmute, when exposed to energy. Virions also differ greatly in stability.

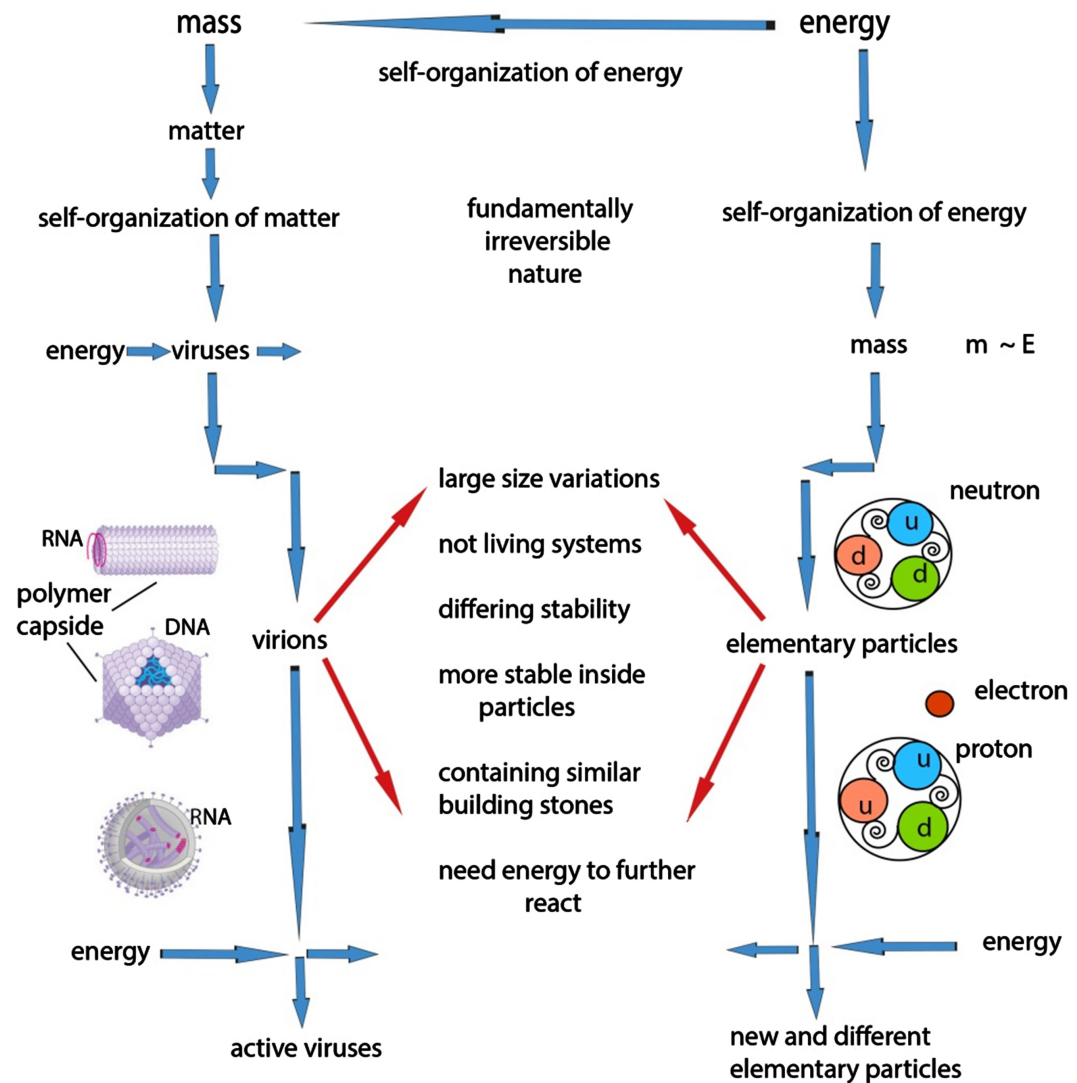


Figure 2. Scheme showing the similarity between self-organized virions (inactiv viruses) and of elementary particles, proposed to arise from self-organization of energy. The virions shown to the left are from Tobacco mosaic virus (top), Adenovirus (centre) and Influenza virus (bottom). They contain RNA or DNA strands respectively which are enclosed in a capsid consisting of self-organized capsomere polymers. To the right neutron and proton are depicted with their corresponding quarks, besides of an electron.

These differences are often correlated with the means, by which viruses are able to infect a new host. Also elementary particles differ significantly in stability. Interestingly, a neutron is stable within the nucleus of an atom with not too high proton number, but it is unstable outside a nucleus (lifetime 880.2 s). A similar situation is found in inactive viruses (virions). The well studied Tobacco mosaic virus (compare **Figure 2**, left, virion at top), for example, a 300 nm times 18 nm sized rod, contains RNA, which is much more unstable than DNA and quite easily hydrolyses, decomposes. When outside a tobacco plant, in its virion state, the self-organized structure of this virus nevertheless tolerates 50°C and survives 50 years. The environment within the virion capsule makes the difference. DNA and RNA are contained in virions, but are not virions themselves. Quarks are

contained in protons and neutrons, but are not seen as free elementary particles.

These remarkable similarities between (non living) virions and (non living) elementary particles are sketched and compared in **Figure 2**. They support the suggestion that elementary particles are just self-organization products of energy. This requires an energy driven fundamental time arrow. Such an interpretation also explains why there are much more elementary particles than needed as building stones for the material world. It also clarifies why there are large variations in size and stability. Such properties are also found in virions. Last not least there is an obvious explanation why access to external energy allows a reshuffle of composition and reactivity. But one also learns why quantitative conclusions are so complicated to achieve in context to self-organization and why complications rise with energy from outside, when it gets involved. Nobody probably tried yet to describe the large family of possible virions mathematically. The historically grown Standard Model tries to do it with elementary particles.

The example of virions demonstrates that the proposed mechanism of self-organization for elementary particles is allowed by natural laws. This can even be mathematically evidenced, since matter (from which virions are derived through self-organization) is related to mass and mass to energy. Energy, consequently, can get involved in a similar self-organization process, generating elementary particles, which are equally not living systems.

An additional (psychological) support for the plausibility of the proposed self-organization model of elementary particles is the fact that such a process of self-organization is already tacitly presupposed in the established and widely accepted Big Bang scenario for the creation of the universe (which is questioned in this paper because of the not adequately considered entropy mediated redshift of spreading starlight): within the first second and after inflation of space the initial Big Bang energy creates quarks, gluons, electrons and muons. Protons and neutrons are formed and react within the first 1000 s. This is definitively self-organization of energy, which, however, cannot arise from time-neutral laws but requires a fundamentally irreversible, feedback mediated, energy driven world. Time-neutral fundamental laws cannot create time neutral particles as, strictly speaking, Big bang theory tacitly assumes today in an attempt to explain the existence of matter.

If elementary particles can be created via self-organization, this should also be possible for the elements in the periodic system, which involve a larger degree of local order. Today a synthesis of elements, besides of hydrogen and helium, which are expected to arise during the very early Big Bang, is only considered possible in exploding stars, which appeared to provide the adequate environment for element synthesis up to atom number 28 (Nickel). Heavier elements are expected to require supernovae explosions for synthesis [15]. Self-organization processes are able to build up local order, which is needed for element synthesis, at the expense of entropy generation at much more modest conditions. A fundamentally irreversible, energy driven nature should allow that in a straight for-

ward way in much less extreme environments, when appropriate feedback-conditions are present for nuclear reactions.

3. Discussion

3.1. Time-Neutral versus “Dynamic” Standard Model

The Standard Model, as it grew historically and is dealt with now, assumes that elementary particles and their properties just exist in a time neutral world. Basing on measured and adjusted parameters, on symmetry considerations and experimental trials a working model of function and interactions has been constructed over decades. The historic understanding is that the principle of least action to which the Standard Model Lagrangian is applied leads to the correct description of reality, even though the meaning of the principle of least action remained unclear. In contrast, the here adopted approach is based on a dynamic interpretation of the principle of least action [1], which recognizes in it the action of a fundamental, energy driven time arrow.

Accomplishments, expectations, but also shortcomings and difficulties of the Standard Model were discussed to justify the here presented idea of a new, “dynamic” Standard Model subject to such a fundamentally irreversible, energy driven time arrow.

The here sketched dynamic, irreversible version of the Standard Model sees elementary particles as temporarily or long-term stabilized self-organized intermediates of energy dissipation into not any more useful entropic energy, occurring in a fundamentally irreversible world. The mechanisms can be understood similarly as the well known self-organization of matter (to which energy is related). Self-organization in biological structures are omnipresent. But also dynamic self-organization patterns in inorganic environments are frequent. They range from structures of nanoparticles to water whirls, characteristic cloud formations, hurricanes and galaxy structures and are an important part of nature as well. Since matter is physically and mathematically related to energy, also energy should consequently have the property to self-organize. The here developed interpretation of elementary particles as self-organized energy is therefore a reasonable approach intended for better understanding their origin and behaviour. The example of virions, inactive viruses, shows that laws of nature are tolerating elementary particles as non-living self-organized systems. It also shows that significant peculiarities of the elementary particle family ranging from large size and stability variations to energetic behaviour can be readily understood qualitatively (Figure 2). A very remarkable result also is that it seems to make counter-intuitive and abstract mathematical explanations, which have been and are increasingly infiltrating the time-neutral Standard Model, unnecessary.

For the “irreversible” Standard Model the explanation for the existence of the observed elementary particle family as well as their properties and interactions results to be very different. They are not elements of a set of adjusted building stones for matter, but just happen to partially function that way. More and more

particles and resonances are to be expected under more extreme natural and experimental conditions. The interpretation and function of self-organized particles is highly different within the “dynamic” model. An example is the explanation of mass. It is not any more an abstract Higgs field which is generating the mass (for example by interacting with quarks), but mass is just self-organized energy (like a whirl generated and sustained in a stream of water). This is a very simple and logical explanation of mass, which in addition readily explains the proportionality between energy and mass and its ability to convert into the mass of other particles and to exchange energy with the environment. Interestingly such a dynamic understanding of mass formation is not in contradiction to what is anyway assumed for the generation of elementary particles from energy during the “first seconds” of the presently widely accepted Big Bang scenario. They just form from energy. However, such a mechanism should not be deduced from a time-neutral theory, which again highlights inconsistencies in established world models. They assume a time neutral fundamental nature but make very daring statements on highly dynamic and irreversible phenomena.

3.2. Some Science-Philosophical Considerations

How reasonable is it, nevertheless, to challenge a seemingly very successful, established theory, which was developed over decades to its present form, the grown Standard Model of elementary particles? There are after all approximately 16 Nobel Prize winning discoveries associated with the formalism of the Standard Model.

According to science philosopher and science critic Paul Feyerabend, who was teaching at the University of California in Berkeley, science is typically not functioning via a systematic procedure for the setup of hypotheses and their falsification via independent facts [16]. Rather he considers its procedure a “non ordered, quite political process, in which the authority of facts is essentially based on their being a constitutive part of a world model, which succeeded to establish itself as a natural reality. Besides of a methodical observation and collection of information, rhetoric, induction and counter-induction are relevant for scientific progress. The success of a theory could therefore be essentially man-made and would then not necessarily reflect the truth. When it was decided to stick to some ideas the result is the survival of these ideas. A theory turns into an ideology”.

The world model here is the Standard Model and induction means making a generalization from a set of specific observations. In contrast, counter-induction means the acceptance of a hypothesis which contradicts facts. It is claimed here that the assumption of time neutrality in fundamental natural phenomena means counter-induction. There is no experimental evidence which is supporting such a claimed fundamental time neutrality in nature. Demonstrating such a time neutrality, by the way, would mean a “falsification” of the here advanced explanation of elementary particles as products of self-organization of energy. As

long as this falsification is not experimentally demonstrated the here advanced proposal of a “dynamic” Standard Model is to be handled as a new theory (Popper, [17]).

A time-neutral nature, which is rejected here, is a convention, which may go back to Isaac Newton and his occupation with the laws of motion. A later consequence of such a “counter-induction” is the assumption of the time neutral equivalence of particle and wave. Energetically they should not be equivalent, because spreading out energy should be associated with entropy formation. As shown in [1] a consequence of such a timeless equivalence are quantum phenomena, perceived as counterintuitive. The always constant light velocity, gravitation and inertia became, within Relativity Theory, explainable via a mathematically constructed four-dimensional space-time, again on the basis of a time-neutral nature. The inability of spreading out time neutral photons in dealing with entropy required the postulation of an expanding “empty space” of the universe (inflation theory). In efforts to improve it, the obviously still present deficiencies of the grown time-neutral Standard Model appear to attract even more abstract mathematical approaches such as Additional Dimensions, String and Superstring Theories [18], Super Symmetry or GUT, Grand Unified Theories [19]. It is concluded that the concept of time neutrality (here recognized as counter-induction) has conducted elementary particle physics into more and more counterintuitive and abstract theories.

A much more reasonable and simple approach, suggested here, instead of incorporating increasingly abstract and counterintuitive mathematical models, would be to go a step back in sophistication and to switch to the concept of a fundamentally irreversible world subject to an energy driven time arrow and to explore a “dynamic” Standard Model within. As outlined above the promise of such an acceptance of simple observable reality (irreversibility in nature) is that irrational concepts and theories could be avoided and new horizons for interpretations could be opened, which promise to be closer to reality and human intuition.

3.3. An Energy Driven, Dynamic Standard Model

By introducing a fundamental, energy driven time arrow the problem of understanding elementary particles can be approached in a very different and logic way. They do not just happen to be building stones of matter, but are temporarily or long-term stabilized intermediates of energy conversion. Main problems of the historically grown Standard Model, such as those arising from too many adjustable variables, from non-convincing building stone properties (e.g. why so many particles), from missing deducible information (e.g. on gravitation), and from unexplained phenomena (e.g. resonances in high energy experiments) appear to be avoided. A basically simpler and more rational model for the existence, structure and behaviour of elementary particles appears to result, a model, which also outlines where reality may be too complex for realistic theory. Mass is self-organized energy. Gravitation is information on matter around elementary

particles, which also explains the always constant light velocity, two essential factors for the differently conceived relativity theory. The fact that gravitation and constant light velocity do not need additional explanations makes the assumption of a counter-intuitive four-dimensional space unnecessary. Gravitation can self-organize to super-gravitation and does not require dark matter. Spreading light, via a “dynamic” quantum understanding, can account for entropy losses of photons and eliminates the need to imagine an exploding universe as well as dark energy. The wide spectrum of elementary particles with the surprisingly large differences in size, lifetime and properties is compared with that of inactive viruses, virions, which are characterized by similar patterns of self-organized existence. It is realized that main characteristic properties of the elementary particle family (existence as self-organized non-living systems, large number of members, large variations in size and stability, patterns of interaction with energy, composition of smaller and partially identical building elements) are similar. This comparison proves that such a model for understanding elementary particles as self-organized energy is compatible with natural laws. Nature tolerates this kind of mechanisms and phenomena. Matter, which is self-organized in virions, is mathematically related to mass and to energy. Energy, subject to an energy driven fundamental time arrow should be able to sustain a similar particle family, elementary particles.

3.4. Challenges towards an “Irreversible” Standard Model

In order to introduce irreversibility and a fundamental energy driven time arrow into the Standard Model the energy quantities in the Lagrangian function have to become time oriented and dynamic. This is a paradigm change and the most essential modification. But there are additional challenges to be handled. One consequence for irreversible quantum phenomena is the necessity to deal with information as a fundamental attribute of matter. It is helpful here to spend a few words on the nature of this “information on matter”, which is mediating the conversion of the wave aspect of matter into the particle aspect of matter (compare **Figure 1**, right). Since this information on matter with its property to decrease the energy’s presence per state can be identified with gravitation it provides the link between the quantum world and the universe. Consequently, it also exerts a significant role in determining the dynamics of the universe. Within the Standard Model there is no consideration of information. Today, within our present age of information, we realize how powerful information can be for technology. And this is all based on natural laws. Why should nature herself not take advantage of the huge potential of information and information technology, when they are compatible with her laws. The fundamentally irreversible energy driven time arrow has to consider information in a crucial quantum mechanism, the particle-wave duality, and this occurs in a quite logical way. When nature applies this information on matter to materialize particles, some well defined natural characteristic properties of this information, a blueprint or laws for tailoring and handling this information, will define characteristic features of the

particle family. Here, on the level of information handling, already recognized properties of elementary particles and forces within the time-neutral Standard Model, like the relation between symmetry and conservation (as described by Noether's theorem) may be enforced. At this level insight and experience gained for the time neutral Standard Model may be very helpful and could contribute to the development and functioning of an improved and theoretically well supported "dynamic" Standard Model. In addition, valuable insight may be gained on how information handling works in nature. Such knowledge and some trust in an irreversible nature, as we see it around us, may give access to a very different concept of elementary particles and the universe.

4. Conclusions

Adopting a fundamental energy driven time arrow for mechanisms in nature allows for the first time to understand the general importance of the principle of least action [1] and also its apparent teleological function (why does a stone rolling down a hill know where to go?). Free energy is not time neutral but aiming at decreasing its presence per state and generating action, which determines the flow of time (which here is not an illusion). As a consequence, the Standard Model of elementary particles has to be understood and treated as dynamic. The most remarkable result is, that such a quite small and reasonable change (irreversibility can be seen in all natural processes) has dramatic consequences for understanding nature and the universe:

- the quite large and heterogeneous family of elementary particles is the product of self-organization;
- particle matter is proportional to energy and can accordingly be modified, exchanged and subdivided;
- information on matter is involved in the particle-wave dualism;
- this information is gravitation (which the Standard Model could not consider);
- the same information accounts for a constant velocity of light and entropy turnover during its expansion;
- a four-dimensional space-time is not needed and entropy generation explains most stellar redshift;
- information (gravitation) can self-organize, produces super-gravitation and controls the universe.

A quite conspicuous finding is that the transition to a fundamentally irreversible world seems to make counterintuitive and mathematically abstract physical theories superfluous. Especially important is the identified role of information on matter. It helps understanding quantum phenomena rationally [1], explains the strange properties of gravitation, accounts for the always constant light velocity and characterizes a universe, which is largely dominated by information. This should give something to think about. Information plays no fundamental role in conventional physics and the grown Standard Model of ele-

mentary particles up to now. Was nature not ingenious enough to involve and apply information technology, which humans now develop basing on nature's laws? Or has physical science to abandon the concept of a time-neutral nature where time has to be considered an illusion (opinion also shared by A. Einstein)? The here presented analysis is an initiative towards abandoning this paradigm of fundamental time-neutrality in nature and to predetermine a working strategy towards fundamental irreversibility.

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