A circular "basic space" as complement of space-time - an outcome of analogies between natural systems

Hans-Dieter Herrmann

January 8, 2022

Abstract

Natural systems are categorized according to their structural and dynamical similarities. A two-dimensional schema is proposed as a kind of "periodic table" of natural systems. Six of eight levels in this schema serve as sources of analogies, two levels are the targets of analogical reasoning.

The source domains are the atomic, molecular, macromolecular, microorganismic, organismic and socio-cultural systems and processes.

One of the target domains discussed in the article is the level of subatomic particles. The other target domain, not discussed in the article, could be the level of future supra-national systems.

Three types of processes are identified occurring in natural systems: conservation, modification and transformation. Modifications allow a reversible adaptation of a system to environmental influences by changing its internal state. The entirety of all internal states defines the "state space" of the system. Similarities of state spaces between systems of six levels are investigated. A dual-space picture of natural systems can be defined on six levels, the source domains of analogical reasoning.

On the subatomic level, space-time is identified as part of the state space of subatomic particles. However, space-time needs a completion by an additional state space in order to obtain a dual-space picture also for subatomic particles. A "basic space" is proposed, so that subatomic particles exist simultaneously in space-time and in basic space. The basic space is assumed to be a circular space, where masses and charges circulate force-free and generate "intrinsic" properties like the spin and the magnetic moment of particles.

A conjecture about the existence of hypothetical matter not detectable in space-time is derived. Such forms of matter could exist exclusively in basic space and represent the dark matter.

Contents

List of Figures

1 Introduction

Analogical arguments have been used by philosophers of all times since Aristotle and analogical reasoning is of philosophical and general interest also for contemporary sciences [64]. Analogies based on similarities between natural systems are used for instance in biology, where the function of an organism to fly can be realized by birds, bats and flying insects in developing analogical structures, the wings.

In a more abstract sense of similarity, one can compare the relationships between complex systems and its constituents. The organism as a whole consists of a big number of interacting cells, and each cell consists of a big number of interacting macromolecules. The question is whether there exist similarities in such whole - parts - relationships. We should ask this question not only in the field of biology and micro-biology, but much more general in all branches of science: physics, chemistry, biology and history of human communities.

The systems investigated by these sciences exist on very different levels of structural organization and represent the result of completely different phases of evolution. The intention to formulate similarities between these different levels seems to be presumptuous and somewhat weird.

Besides the whole - parts - relations, which exist on all levels and in all sciences, there are some systemic properties, which can be compared. The most important properties are the relative indivisibility of systems acting as "building stones" of more complex structures and the adaptability of complex structures to its environment.

The term "evolution" has not a unique meaning. Evolution was originally used for the development of living matter only, connected with the systematics of protozoans, plants and animals. This specific meaning of "evolution" is also widely used by contemporary authors [17][18][19][20][21][16]. Additionally, the development of galaxies, parts of the cosmos or of the universe as a whole can be designated as evolution. The same is true for the development of minerals and geological formations as well as for other parts of the unanimate world [3][6][7][8][9][10][27][37][41]. Also immaterial objects like the language show an evolution.

Philosophical questions concerning all stages of the development of matter need a general, wide and unique definition of the term "evolution". The self organization of matter could obey general rules. These common rules result eventually in a self-similarity of evolutionary steps and emerging structures on different levels of evolution. This could have consquences for different branches of science.

Investigations of this kind have been performed using mathematical methods, e.g. by comparison with the self-similarity of fractals [25], or by other methods describing self-organization and compexity [42][44][45]. The most general point of view is the combined investigation of the evolutionary development in living and nonliving systems [1][2][36][39][43].

The definition of evolution used in this article comprises the development of subatomic, atomic, molecular and macromolecular systems. The living world is also included, i.e, the development of viruses and bacteriae, of plants and animals as well as of human societies. Thus the term "natural system" is used with a very broad meaning in contrast to the different definitions of this term in history [46].

The term "development" means conservation processes (steady state), modification (e.g. adaptation to external influences) and transformation (e.g. synthesis or decomposition and decay) of a system.

This definition will be considered in more detail in the next section.

The term "evolution" defined this way implies a certain relation to the sciences, which investigate the different material systems. One can emphasize the "unity of science" or the "diversity of the sciences". Sometimes is the claim of a "unity of science" connected with a reduction of all sciences into one scientific branch. E.g. one could prefer a more physical or a more biological thinking and vocabulary. [34][35][38].

A reconciliation of the two interpretations of science, its unity or disunity, seems to be reasonable. We accept the diversity of the different branches of physics, chemistry, biology and human history. They use different methods and special languages for the presentation of their results. On the other hand, we recognize the philosophical effort to extract common rules, similarities and analogies beween the results of these sciences. This constitutes aspects of the unity of science. The unification of selected scientific results needs also a general language, which allows to formulate definitions and results applicable in physics, chemistry, biology and history simultaneously. Such languages have been developed in different branches of philosophy. [29][30][31][32][28]. Examples for such a language applicable to natural systems will be given in the next sections.

2 Periodization of the evolution and types of natural systems

Eight levels of evolution In a first step, we divide the evolution in the one of the non-living and the one of the living world, finding the emergence of life as the one and only step of development of matter. This exciting step was a main topic of research for decades and is far from complete understanding [4][26][12][13][14][15][40][16].

The differentiation in an evolution of non-living and of living matter is doubtless the most important periodization.

The next finer classification leads to four periods of evolution. The development of living matter is divided by the emergence of human beings in a period of biological development below and a period of sociocultural development in top of this event.

In a similar manner the development of non-living matter is divided by the emergence of chemically active atoms. This essential step separates the physical world of particles, nuclei and highly ionized ions from the world of chemical reactions between molecules and macro-molecules.

One has now four periods, separated by the emergence of the atom, of living matter and of the human being. Nevertheless, also four periods are not enough to identify the similarities of structures and processes, one needs an additional refinement of the classification. The author attempted to determine eight periods or levels of evolution and to find similarities between them [5].

A scheme with eight levels is given in fig. 1[1]).

Units as building stones The division of the evolution into levels is guided by the existence of special types of natural systems, see fig. 2.

Each of the eight levels of evolution is characterized by the existence of "building stones" of development, which are relatively indivisible. A human being, for instance, is the building stone for socio-cultural development in the history of mankind. Its organism can be destroyed, it may die and decay. But for the special class of processes, which are essential for the development of social systems, the human being (in combination with its successors) is indivisible, philosophically speaking an "atom". The same holds for atoms in chemistry, they are the indivisible building stones of chemical development. This is true despite the fact, that atoms can be completely ionized, its nucleus can be split. But this stops the chemical development and represents another type of process.

[1]The figures 1, 2 and 4 are translations from a publication of the author on Analogies between Natural Systems on eight Levels of Evoluion (in German, [5])

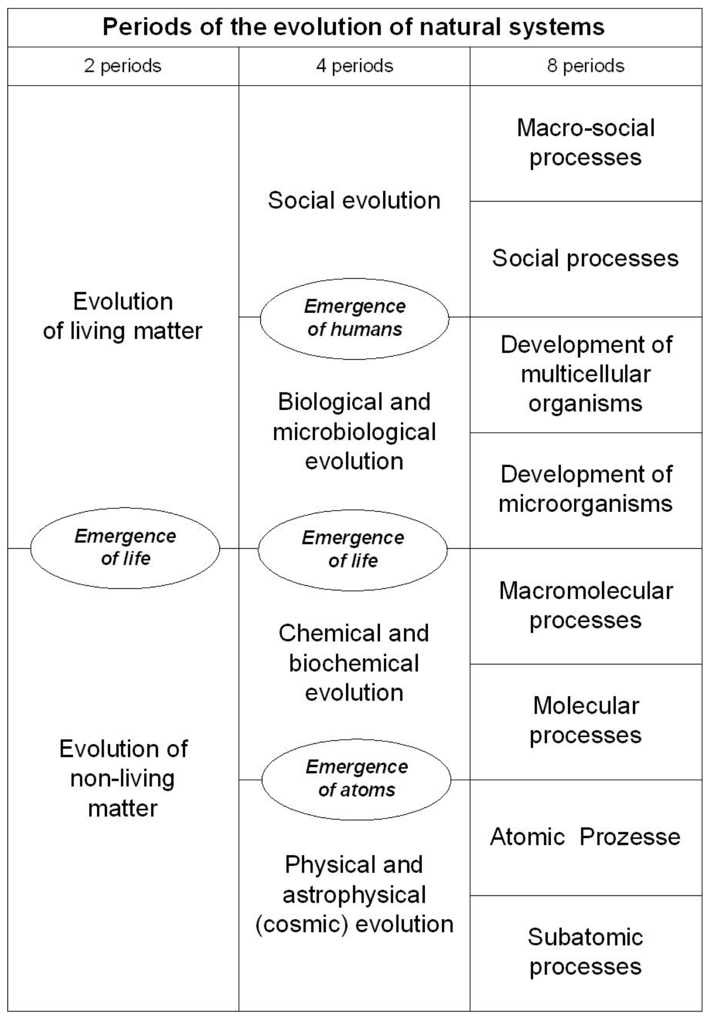

Figure 1: Historical periods and organizational levels of the evolution of natural systems

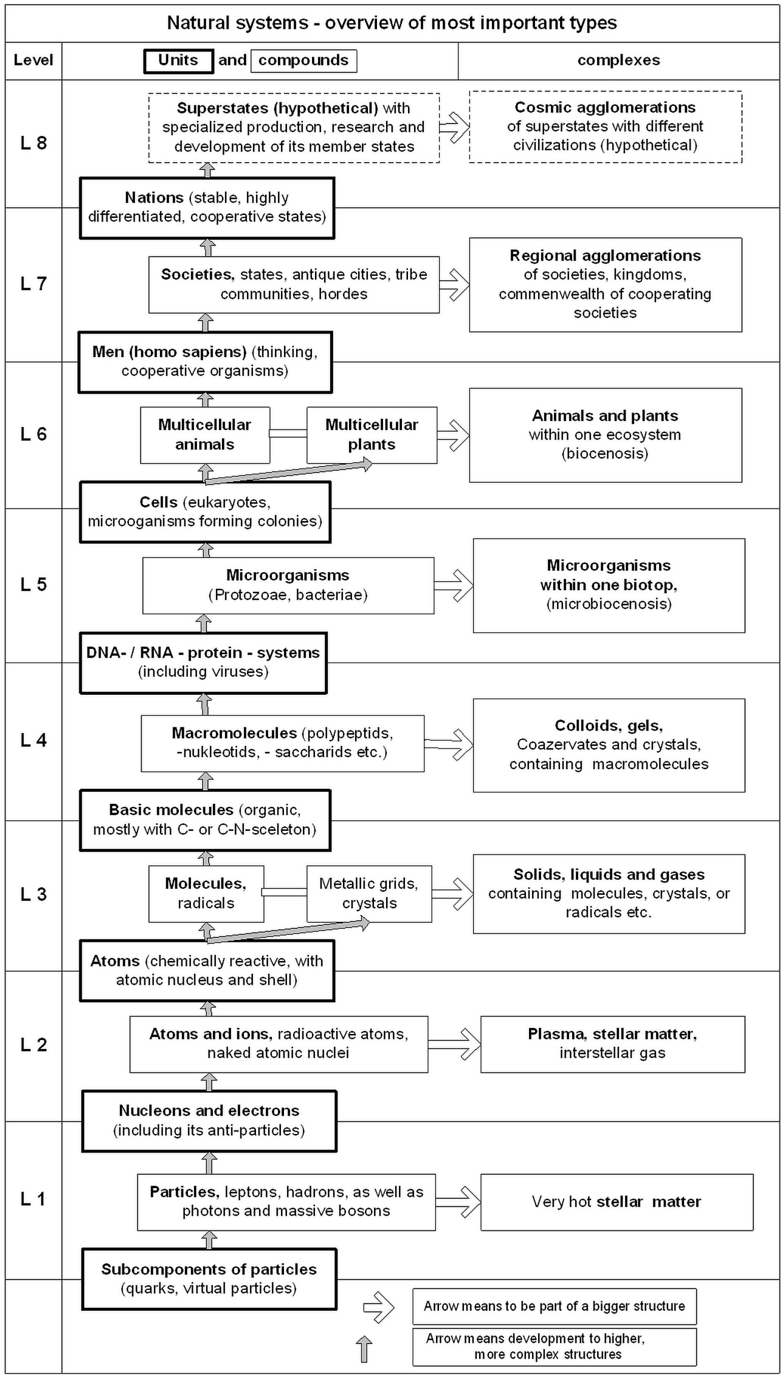

Figure 2: Types of natural systems in a "periodic table". The "units" mark the transition from level L(n) to L(n+1). Compounds of the level L(n), ready for transition, become building stones (units) of the level L(n+1).

The units are building stones of a relative indivisibility, that means they are indivisible only with respect to a certain type of processes.

Compounds as carrier of the evolution Two or more units form structures of different complexity, whose development is the essential content of the evolution at this level. These carriers of evolution are named “compounds”. Thus, for instance, tribe communities of Stone Age, antique city states or modern nations are compounds of the level L(7), with the human being as unit. Molecules and radicals are compounds of level L(3), with chemical atoms as units, and so on. The numbering of levels used here is explained in fig. 2. A schematic view of the structural relations at level n, i.e. the whole - parts - relations, is given in fig. 3.

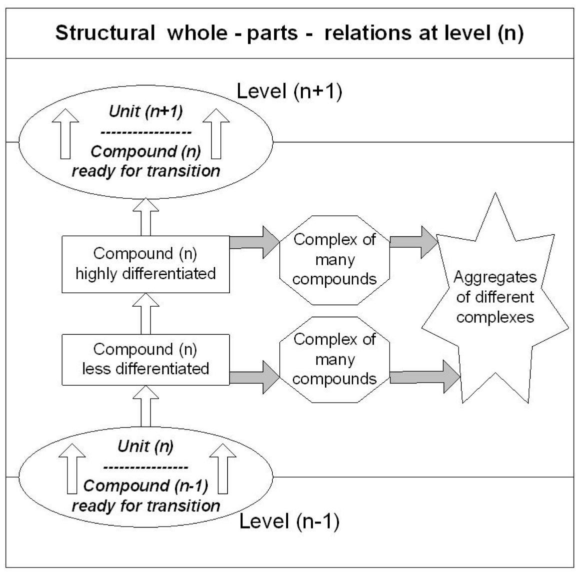

Figure 3: Structural relations between natural systems on level (n). Evolutionary development occurs in vertical direction, compounds with a higher complexity emerge. The development in horizontal direction leads to quantitative growth and spatiotemporal expansion of complexes.

Compounds organize themselves in structures of higher order, in figs. 2 and 3 named “complexes”. Complexes may be organized in structural hierarchies of their own, but this will not be dealt with in this article. The focus of this article is on the compounds and their structural and dynamical similarities.

The differentiation of the evoluion in levels (see fig. 2) is mainly determined by the existence of the units. Units are the result of transition processes. They emerge from the next deeper level by the development of compounds with a high degree of stability and functional differentiation. The emergence of such "compounds ready for transition" plays the key role in all periods of evolution.

Each transition generates a new kind of "atoms" called units. The units become the constituents or "atoms" of the compounds on the next higher structural level.

Atomistic and holistic description of compounds The special role of units on each level does not provide an argument for a "universal atomism". Each level has its own interconnection between atomistic and holistic interpretations. Moreover, the term "atomism" has specific definitions in different branches of science, and misinterpretations are likely if this term is used without explanation.

In the *social sciences*, the term "social atom" is defined in a very restricted manner [59]. Only the soldiers in a medieval army, the workers in a coal mine of the 19. century or the slaves rowing an ancient ship could be considered as "social atoms" according to this definition. In general, the human being as constituent of a social community needs a holistic interpretation, it can be defined only considering its interaction with other humans, its communication, cooperation and functional differentiation.

In the *biological sciences* of plants and animals, the cell theory describes the cells of plants and animals from two viewpoints. Cells are the autonomous self-consistent smallest living entities of an organism as well as interacting parts with a specialized function within this organism. The biological atomism of the cell theory has to be complemented by a biological holism describing tissues, organs and the organism as a whole [58].

In *micro-biology*, eucariotic and procariotic cells like protozoes, bacteriae and archaea represent the compounds. The macromolecules of the DNA capable of self-replication and the RNA which controls protein synthesis within the microorganisms are interpreted as the units on this level. The atomistic aspect is dominant in abiotic states of microorganisms, when the macromolecules are nearly without biological activity (without metabolic, catalytic or replicatory activity). During normal living activities, the macromolecules are involved in a multitude of interactions and only a holistic interpretation is able to depict a living microorganism.

In *macro-molecular chemistry*, the different forms of RNA and DNA together with the proteins coded by RNA - macromolecules represent the compounds. Nucleotides and triplets of nucleotids, the codons, as well as single amino acids, sugars and phosphate molecules represent the units. The alphabet of the genetic code and the amino acids viewed as a static ensemble of building stones provide the basis of an atomistic interpretation [60]. However, the characteristics of life are encymatic controlled processes of synthesis and decomposition of macromolecules and only a holistic description is adequate for such processes.

In *molecular chemistry*, the atomism has been developed as an ingredient of modern science [61]. Mendeleev´s periodic table in its current form shows the systematics of the chemical atoms. However, also in chemistry are holistic interpretations necessary. A C-atom in a benzene ring can be described only by considering the covalent bonding between all the C-atoms in the ring. The metallic bonding characterizes the atoms in a metal, and so on. The chemical atomism has to be complemented by a "chemical holism", too.

In physics, the discussion has to be organized in two parts, concerning the atomic and the subatomic level.

Physics at the atomic level investigates atoms, ions and naked nuclei as compounds. The constituents of all compounds are protons and neutrons in the nucleus and electrons in the shell, if the compound has a shell at all. Protons, neutrons and electrons are the stable, relative indivisible building stones, the units. The whole - parts - relation between compounds and units allows to formulate an atomism at this level. It has to be complemented by holistic considerations, because nucleons as well as electrons in an atom or an ion are spin correlated and structured in energetically different shells; a single nucleon or an electron cannot be characterized without a description of its energetic and spin state.

Physics at the subatomic level presents the most complicated situation.

Leptons and quarks are considered to be point-like; this is demonstrated experimentally by scattering experiments with electrons down to a distance of $\backsim 10^{-18}$ m. Theories assuming an extension in space-time have to assume extremely small dimensions. Moreover, the search for a compositeness of leptons and quarks was not successful [33],[62]. That means, they appear as "elementary" particles. The experimental limits for eventual existing but not yet detected constituents amount to very high energies of more than $\backsim$10 TeV. Thus the energy of the "constituents" of particles would exceed the energy of the whole particle by more than three orders of magnitude. Even if we accept, that leptons and quarks are point-like and elementary, fundamental problems remain[2]).

The particles may appear as corpuscles in a detector or in case of a collision, but they seem to propagate in space-time following a "matter wave". This can be described mathematically by a quantum-mechanical wave function or a wave packet [57]. However, no carrier of the wave, no field or medium could be found experimentally performing a wavy movement. It is not clear, which kind of reality describes a wave function, a wave packet or a superposition of different wave functions. Several interpretations of quantum mechanics exist [63][48][49][50][51][52][53][54] [55], but the ontological problem of the wave function is under discussion for about 90 years [47][56].

A whole - parts relation like on the social, organismic, microorganismic, macromolecular, molecular and atomic level (the six "source levels" of our analogical thinking) seems to be **excluded** on the subatomic level (the "target level" of analogical arguments). This is probably true if we look for constituents of particles like leptons and quarks **in space-time**. A possibility to go beyond space-time will be discussed in the next section.

We can state, summarizing the possibilities of atomistic and holistic interpretations of compounds, that both viewpoints complement each other.

---

[2]Problems connected with "intrinsic" properties of point-like particles like spin or magnetic dipole moment are not mentioned, because they are not of primary importance for the discussion of the eventual compositeness of the particles.

Atomism in general does not provide a complete description of the whole-parts relations between compounds and the units constituting them. It is restricted to a certain type of processes considering the parts as autonomous building stones. Nevertheless, atomistic theories are a useful approximative method to describe evolutionary developments.

Holistic considerations, which consider also the processes concerning the whole, will be discussed in the next section.

3 The state space of compounds

Types of processes Different types of processes preserve the current structure of a compound or result in structural changes of different extent. In general, processes of conservation, modification and transformation can be observed in compounds.

Conservation designates processes, which guarantee stability in a steady state of the system. Conservation processes are characterized by an internal equilibrium between contradictory forces like attraction and repulsion, bonding and anti-bonding. The mechanism of these forces depends on the level of evolution. Some kind of material, energetic and informational exchange between the units of a compound represent usually the conservation processes.

Modification processes comprise the adaptation of the compounds to alterations in its external or internal environment. Modification processes are reversible excitations, without changing the structure of the compound fundamentally. A modification process generates transitions between different conservation processes, i.e. between different states of internal equilibrium of the compound.

Transformation is the term for severe alterations, for the synthesis of new structures as well as for the destruction or decay of the old ones. Transformations are the engine of the evolutionary development.

The region of adaptation The modification processes should not initiate a transformation of the compound. This condition is fulfilled, if the modification does not exceed certain limits. These limits define the "adaptation region" of the compound. The totality of equilibrium states within the adaptation region spans the "state space" of the compound. A state space emerges simultaneously with the compounds on a certain level of evolution. No state space can be defined without the relation to the existence of compounds and their behavior, the different states of their existence.

Working with the definition of abstract state spaces, configuration spaces or phase spaces is a common practice in many branches of science. Such a definition makes sense, for example, when transitions between states can be treated as "movement in the state space" more clearly or mathematically more simply than without this concept. Interactions between different compounds can be interpreted as collisions in its state space.

Each "point" in the state space corresponds to a state, i.e. a certain level of bonding and anti-bonding within the compound. The compound has always to exist in some state, it therefore necessarily exists at one point in its state space.

If we consider a complex of several compounds instead of one compound, so it is no longer point-like in the state space, because in general not all compounds are in the same state. One can say that a complex has a certain "extension" in the state space of the compounds. The bigger the aggregate of compexes, the more space is occupied in the state space of the compounds.

The units, on the other hand, cannot exist in any of the equilibrium states of the compounds, they are "non-existent" in their state space (strictly speaking, units are non-existent in the upper state space of compounds, see the next section).

Examples for state spaces on different levels of evolution are given in fig. 4.

4 The dual-space existence of compounds

Compounds on the level L(n) have a dual nature, represented by properties belonging in part to the state space S(n) of level L(n) as well as partially to the state space S(n-1) of level L(n-1). This is a result of the fact, that an internal equilibrium of compounds is not only dependent on the interaction of the units as building stones of the compound. A certain state of the compounds is also influenced by the equilibrium within the units, their internal interaction. The units hand down their properties to the compounds, and with them their state space.

Compounds show “spatial duality”, i.e. they have a dual nature with respect to their state spaces. This will be shown in some more detail.

The spatial duality of social communities Social communities of human beings like antique cities or modern states represent the compounds at the level L(7). In such communities the humankind shows a differentiated and highly specialized material and intellectual production. The human beings develop education, science, arts and different forms of communication using languages and pictures. This has to be considered as an "upper space" $S_U(7)$ of existence of the communities, which cannot be achieved to the same extent by societies of animals.

At the other hand, the same communities need safe spaces to live and to reproduce, they need food, drinking water and other prerequisites of life. They can suffer from endemic illnesses. This is called the "lower space" $S_L(7)$ of existence, which is similar to the state space of hords of animals. Animals like other multi-cellular organisms are the compounds at the level L(6). That means, social communities of human beings show a dual existence: At level L(7) as well as at level L(6).

The existence of social communities in its lower space is preserved also if movements in its upper space are reduced or nearly absent (e.g. during complete

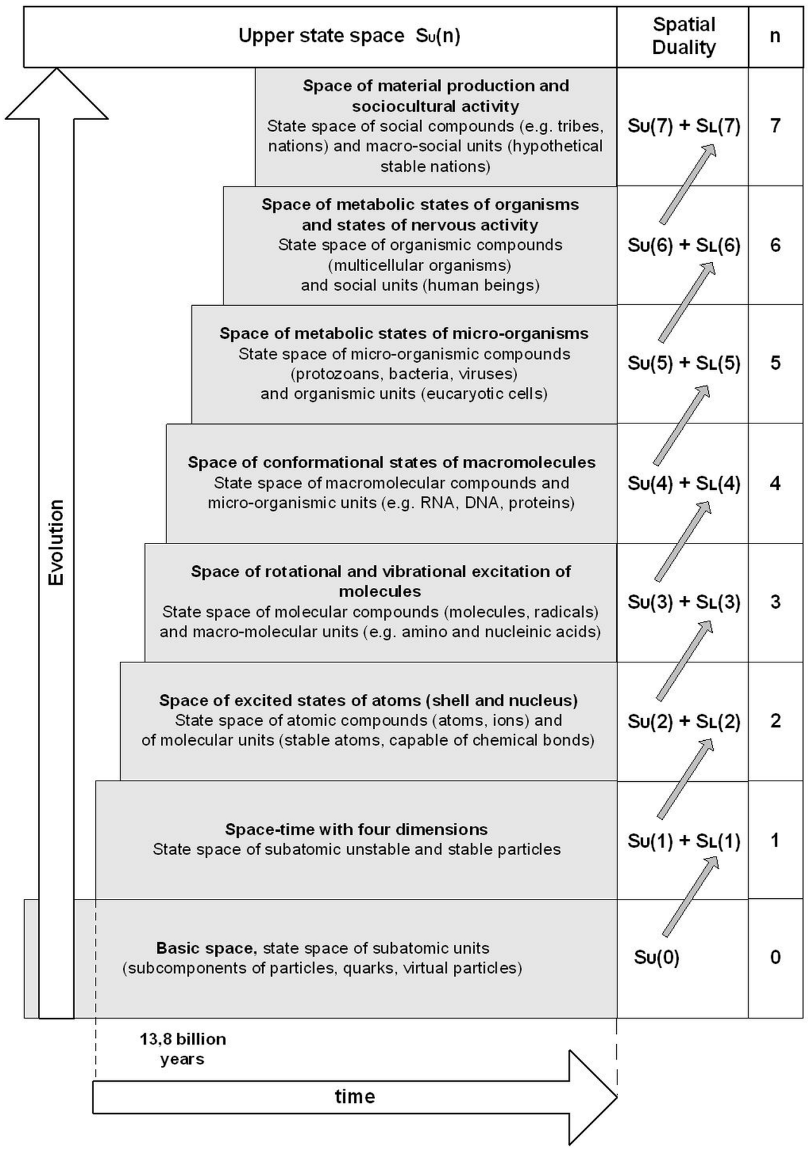

Figure 4: State spaces at different levels of evolution. The upper space emerging at each level completes the lower space inherited from the next deeper level. The simultaneous existence in an upper and a lower space constitute the "spatial duality" of compounds.

lockdown in a pandemic stuation). The lower space is spanned by the minimum or "static" properties of the community.

The spatial duality of organisms Multi-cellular organisms of plants and animals represent the compounds at level L(6). Organisms develop signal transfer between specialized cell groups. This can be realized by nervous, hormonal, chemical or other types of communication. By this way, the organism generates a coordinated reaction to its environment including other organisms. These properties span the "upper space" $S_U(6)$ of an animal or plant.

At the other hand, the same organisms need a temperature range, an energy source and a chemical environment (water within a certain pH-range, ion content, eventually oxygen content et cetera). The organisms have to supply certain conditions of life for its cells. This represents the "lower space" $S_L(6)$ of organisms, it is similar to the needs of single-cell organisms, the compounds of level L(5). In many cases, the reproduction cycle of a multi-cellular organism contains a stadium of a "single cell" existence, the zygote. That means, multi-cellular organisms show a dual existence: At the levels L(6) and L(5).

The existence of organisms in its lower space is preserved also if movements in its upper space are reduced or completely absent (e.g. during sleep or unconsciousness). The lower space is spanned by the minimum or "static" properties of an organism.

The spatial duality of micro-organisms and viruses Micro-organisms like protozoans, bacteria and viruses represent the compounds of level L(5). A virus exists near the borderline between nonliving and living matter. If a virus was able to occupy the infrastructure of a host cell, it develops metabolism and shows different functions like the interaction with the immune system of its host. These are characteristics of the level L(5) and span the "upper space" $S_U(5)$ of a virus or another micro-organism.

At the other hand, a virus behaves like an ensemble of macromolecules. An amount of identical isolated viruses may be crystallized and chemically or with X-ray spectrography characterized like other macromolecules, which are the units of a virus. The macromolecular properties of a virus constitute its "lower space" $S_L(5)$. This state space of a virus is similar to the state space of a macromolecule, a compound at level L(4). Thus viruses are the most prominent example of systems with dual properties, which belong in part to level L(5) (animate matter) and in part to level L(4) (nonanimate matter).

The existence of microorganisms and viruses in its lower space is preserved also if movements in its upper space are reduced or absent (e.g. in states of low or nearly absent metabolic activity). The lower space is spanned by its minimum or "static" properties.

The spatial duality of macromolecules Macromolecules like polypeptides, RNA or DNA represent the compounds of level L(4). They are usually folded in three dimensions, this conformation results in a differentiation and specialization of single molecules, the units which constitute the macromolecule. The molecules of a polypeptide e.g. can be located at the surface, in holes or in the interior of the macromolecule. These variants of the (eventually biochemically active) conformations span the "upper space" $S_U(4)$ of the macromolecule. The sequence of the nucleotides G, U, A and C determines the structure of a DNA macromolecule. Its state space is defined by the totality of spiral-like or flat foldings of the chain of molecules.

At the other hand, a macromolecule in any conformation has to react to external influences like high temperature or acidic content. Similar to the reaction of single molecules, the macromolecule may change its state of vibration and rotation. This are movements in its "lower space" $S_L(4)$.The state space of molecular vibrations and rotations belongs to the level L(3), where molecules represent the compounds. In general, macromolecules show a dual existence, at the levels L(4) and L(3).

The existence of macromolecules in its lower space is preserved also if movements in its upper space are reduced or absent (e.g. frozen biochemical activity and stopped changes of conformation at low temperatures). The lower space is spanned by the minimum or "static" properties of a macromolecule.

The spatial duality of molecules and radicals Molecules like amino acids, sugars or water and radicals of such molecules represent the compounds of the level L(3), atoms with its capabilities to undergo chemical bonds are the units of that level. Molecules have a certain spectrum of rotational and vibrational states, the characteristics of L(3). This variety of states spans the "upper space" $S_U(3)$ of molecules.

At the other hand, molecules may behave as parts of a gas, like single atoms. In such cases these molecules and radicals behave like systems of the level L(2), they move in its "lower space" $S_L(3)$. The dual nature of molecules e.g. in a cosmic gaseous nebula is caused by the fact, that they show the newly emerged properties of level 3 (rotation, vibration) and also the "old" properties of level 2 (excitation in the electronic orbitals, emission of light with a characteristic spectrum, ionization). These "old" properties of molecules are inherited from its constituents, the atoms.

The existence of molecules and radicals in its lower space is preserved also if movements in its upper space are reduced or absent (e.g. in the ground state where rotations and vibrations are zero or nearly zero). The lower space is spanned by the minimum or "static" properties of a molecule.

The spatial duality of atoms and ions Atoms, ions and naked nuclei represent the compounds of the level L(2). Protons, neutrons, electrons and photons are the units of that level. The excitation of the atomic shell and even of the nucleus are the characteristics of that level, these excitation states span the "upper space" $S_U(2)$ of atoms and ions.

At the other hand, atoms, ions and naked nuclei in a plasma may react like free particles. They change the direction of its translational movement and exchange kinetic energy during collisions with other particles, the space-time at level L(1) is their "lower space" $S_L(2)$. The existence of atoms and ions is spatially dual: They populate the state space of excitations of shell and nucleus on the level L(2) as well as the Minkowski space-time on the level L(1).

The existence of atoms and ions in its lower space is preserved also if movements in its upper space are reduced or absent (e.g. in the ground state of shell and nucleus, where no excitations occur). The lower space is spanned by the minimum or "static" properties of atoms or ions.

The spatial duality of leptons, hadrons and photons Leptons, hadrons and photons represent the compounds of the level L(1). Their dynamical behaviour in space-time according to the Dirac equation and the Maxwell equations has to be interpreted as a movement in its "upper space" $S_U(1)$. Some properties of the particles cannot be explained by such movements, especially their spin. There exist mathematical descriptions, but no classical correlates, no ontological explanation of spin and magnetic dipole moment.

Particles and photons have no "lower space", $S_L(1)$ is missing. Really, the necessity to assume vacuum expectation values and the existence of virtual particles show, that something has to be added to the Minkowski space-time. Also the "intrinsic" character of the spin of point-like particles and photons shows a certain incompleteness of the usual picture of particles and photons.

In analogy to other levels we conclude, that the existence of particles in its lower space should be preserved also if movements in its upper space are reduced or absent, e.g. if they are more or less "at rest" in space-time. An approximation to such a state of "rest" is possible by an appropriate choice of a system of reference, at least for massive particles. The preserved properties of such particles "at rest" are "rest"-mass (derived from its invariant energy), spin and charge in case of charged particles. Photons and neutrinos do not fit perfectly in this picture, they need additional discussion. But in all cases, a lower space $S_L(1)$ is missing.

5 The introduction of the basic space

We can conclude, that the dual existence of compounds at level L(n) in an upper state space $S_U(n)$ and a lower state space $S_L(n)$ is a general property found on the six levels L(2) to L(7). By analogical reasoning, this "spatial duality" should also exist on the level L(1).

We introduce the "basic space" as $S_L(1)$ in order to complete the dual character of leptons, hadrons and photons in analogy to the dual character of compounds at the other levels[3]). Subatomic matter, especially fermions could exist as point-like particles in space-time and simultaneously as extended objects in

[3] The assumption of a "basic space" as the state space of subatomic particles and its possible role in the early phases of the universe was introduced in a book on the "Analogies between Natural Systems on eight Levels of Evolution", p. 164 (in German, [5])

basic space. Early forms of matter could possibly exist in basic space only, not detectable as particle or wave in space-time. This proposal would have consequences for the particle models, for the nature of dark matter and for different cosmological problems.

Dual-space particle models with compositeness Within the Standard Model of particles, all leptons and quarks are considered to be elementary particles without compositeness. The introduction of the proposed basic space would change the situation.

Any model of leptons, quarks and photons with spatial duality would consist of two partner models: the usual model in space-time, e.g. describing an elementary point-like lepton or fermion, and the basic space model, e.g. representing a composited lepton or fermion as an extended object. The intrinsic properties of particles like spin and magnetic dipole moment can be described naturally in basic space, if it is defined as a circular space.

Such models with spatial duality will be discussed in a separate article[4]).

The connection of structure and state space The upper state space is connected with the structure of the compound. There is, in general, no abstract state space, no "empty" space, independent of the structure which generates the different states. This is especially true for such periods of evolution, when compounds of higher levels do not exist at all. In a hot plasma, no molecules can be formed. But if a corresponding cooling occurs, at first two or three atoms couple and build a molecule which performs rotations and vibrations. The state space of these rotational and vibrational states emerges with the first molecules. It does not exist in a hot plasma without molecules.

The upper state space emerges only together with the structure of the compound, whose states are the defining items of the space. The state space is structure-connected.

Interactions between systems at level L(n) and level L(n-1) If matter is ready for the transition to the next evolutionary level L(n), then the different newly developed compounds will interact, undergoing modifications and also transformations. But additionally, the "old" interaction, belonging to the next deeper level L(n-1) of the evolution, will continue. The structures of the level L(n-1) cannot populate the Level L(n), but they are effective by interaction with structures of level L(n).

Biological examples are the plants and animals at level L(6), which human beings, organized in social communities of L(7), use to breed for food. If animals are used in agriculture, they belong with their upper space $S_U^{agriculure}(6)$ to the lower space $S_L(7)$ of the social communities (food production). One can write symbolically $S_U^{agriculture}(6) \subset S_L(7)$

[4]An article titled "Composite leptons and quarks in an inaccessible circular space" is submitted to the "European Journal of Physics Plus" for review.

Bacteria with its lower space $S_L(5)$ are able to take advantage of protein molecules and even pieces of DNA in their environment, belonging to level L(4). One can write symbolically $S_U(4) \leftrightarrow S_L(5)$.

A physical example are the atoms of a hot gas, which interact with photons and electrons in the environment. Additional examples are given in fig. 5.

6 Hypothetical matter existing exclusively in basic space

One can speculate, that isolated subcomponents of particles exist exclusively in basic space, not as partner of a particle with spatial duality. This would require to assume a level L(0). At this level the state space $S(0)$ would be populated by hypothetical primitive types of matter not capable to manifest themselves in space-time. A division in an upper and a lower space would be inappropriate on this level. Matter on this level represents the lower termination of the vertical whole-parts chain.

The cosmic inflation and the emergence of space-time Let us discuss the conjecture, that certain forms of matter exist in basic space, without the ability to appear in space-time. Then in the early universe, all matter and all energy could be located in the basic space $S(0)$. Instead of a singularity in space-time, which contains all the matter with infinite density in the moment of the "big bang", a wide distribution of non-particle, non-photon matter could have existed in basic space. Instead of an inflationary expansion, starting from the singularity in space-time, a large number of transitions of structures in basic space to point particles and photons in space-time could have taken place, with presumably nearly the same effect as with the cosmological "inflation".

Each transition would generate a particle or a photon surrounded by an insular piece of space-time $S_U(1)$, with its proper time as time axis. Only a large number of such newly generated insular pieces would result in the development of a general space-time. The "old" states of circulating matter in basic space are preserved by the transition of the corresponding state spaces: $S(0) \Rightarrow S_L(1)$.

This seems to be very speculative, and is not tested by observations and subsequent calculations. In particular it should be shown, whether the cosmic background radiation is in accordance with this possibility.

The presumption that space-time emerges in connection with the structure of particles was expressed by different authors [22][23].

Remarkably, the research on quantum gravity goes in the direction of a non-spatiotemporal theory, [24]. "It turns out that space-time is absent at the most fundamental level and emerges only in an appropriate limit" [23]. This possibly would allow to develop a variant of quantum gravity on a level "below" space-time, historically "before" the emergence of space-time.

Level		Interaction of systems at L(n) with systems at L(n-1)
L 8	Supra-national level	Extrapolation into the future: When stable supranational organizations emerge, they will interact with single social communities which do not take part in supranational cooperation (e.g. space activities)
L 7	Social level	Social communities interact with animals and plants (hunting, plant collecting, farming and breeding). Plants and animals do not appear in the upper state space of social communities (science, literature etc.)
L 6	Organismic level	Multicellular organisms interact with bacteria, protozoans or viruses in their surroundings. These micro-organisms do not appear in the upper state space of plants and animals (nervous, hormonal, gastrointestinal states etc.)
L 5	Micro-organismic level	Bacteria, protozoans or viruses interact with macromolecules in its environment. Isolated macromolecules do not appear in the upper state space of micro-organisms (metabolic states).
L 4	Macro-molecular level	Macromolecules (polymers) interact with amino acids, sugars, phosphoric acid and other monomers in its environment. The monomer molecules do not appear in the upper state space of macromolecules (conformation, i.e. folding in three dimensions)
L 3	Molecular level	Molecules and fractions of it (radicals) interact with free atoms and ions. Single atoms or ions do not appear in the upper state space of molecules (rotational and vibrational states)
L 2	Atomic level	Atoms and atomic nuclei interact via mechanical and photonic energy exchange with particles of the surrounding hot plasma. Single particles or photons from the plasma do not appear in the upper state space of atoms and ions (excitation states of the shell or the nucleus)
L 1	Subatomic level	Particles interact with virtual subcomponents or via gravitation with the surrounding dark matter. Subcomponents of the dark matter do not appear in the upper state space of particles and photons (they cannot exist as corpuscle or wave in space-time)

Figure 5: Interaction of systems at level n with systems at level n-1. Isolated systems at the lower level n-1 can not be localized in the upper state space of systems at the higher level n. This could eventually represent a model for the hidden character of dark matter.

Dark matter and gravity Dark matter could be a consequence of the existence of matter, which is not able to appear in space-time. Nevertheless, such forms of matter could interact with matter in space-time by means of gravitational interaction. This would be a model explanation for the dark matter and for the fact, that no candidate could be found which represents the content of dark matter in space-time.

This conjecture would require, that gravitational mass as a source of gravity is present already on the level L(0).

If this interpretation of dark matter could be demonstrated to be correct (in the sense of correctness, that this idea would become the part of a consistent theory), then the gravitational effect seen in the movement of galaxies would be the only sign of its existence forever. Then dark matter would populate the basic space, not space-time, and the search for candidates in space-time could be stopped.

The search for a "theory of everything" would also be questionable. At the one hand gravitation would represent the main characteristics of matter in the state spaces $S_U(0) \Rightarrow S_L(1)$. At the other hand, the electromagnetic, weak and strong interactions would represent the characteristics of the higher level state spaces $S_U(1) \Rightarrow S_L(2)$. The question is then, whether it would be natural or unnatural to unify all the interactions. A "theory of everything" does possibly not exist, if the conjecture discussed here meets reality.

Limits of human perception - a thought experiment One can speculate about the reason, why the human being up to now was not able to identify all the types of matter in the universe and to recognize all the peculiarities of the quantum world. Eventually a thought experiment could help, which transforms the problem from the subatomic level L(1) to the molecular level L(3).

We consider microscopic insects with sensors for the infrared frequencies emitted by vibrating and rotating molecules in the environment. These insects are able to perform rotational-vibrational spectroscopy and to identify all the molecules like O_2, H_2O, CO_2 etc. in their state space by its characteristic frequencies. But they have no possibilities to directly recognize single atoms or ions, they can not observe their position, velocities and electronic spectra. However, the insects can measure the density of the atmosphere, where they live. This measured density is much higher than the value expected from the density of molecules, which they recognize. The insects conclude, that there is some invisible, "dark" matter.

These insects have extreme difficulties to interpret large-scale transitions of matter from a hot plasma to a cooler gaseous phase, whereby suddenly a huge number of molecules appears in their accessible space of rotational-vibrational frequencies. Probably the insects have the impression of an "inflation" of newly emerging molecules.

The insects do not recognize such parts of nature, which exclusively exist "below" their state space. The insects have no knowledge of the ability of single atoms, to emerge suddenly in their state space by coupling to molecules.

Now we have to transform the results of the thought experiment from the molecular level L 3 down to the target level L 1.

We assume for a moment, that the human being has some kind of partial cognitive blindness concerning systems existing exclusively in basic space. The current description of the big bang and of the subsequent cosmic inflation could eventually be the consequence of a cognitive handicap; as well as our long lasting difficulties to interpret the quantum effects.

The circular nature of the basic space does eventually not match with our cognitive equipment.

7 Conclusions

This article deals with structural and dynamical similarities between natural systems, including nonliving and living matter. The natural systems are categorized in eight levels according to their organizational complexity and their evolutionary development. Building stones called "units" and more complex structures called "compounds" are defined on each level and filed in a kind of "periodic table" of natural systems. Compounds show adaptation to impacts from the environment by a reversible change of its structural configuration. The entirety of such states defines the "state space" of the compound.

The state space is divided in an upper and a lower space. In the upper space only processes on a single organizational level occur and the units appear as indivisible “atoms”. In the lower space also processes on the next deeper level are present and the units act as composited systems. In general the compounds exist simultaneously in its upper and its lower state space, this property is designated as “spatial duality”. Examples are given in the article for the spatial duality of compounds on several levels, the source domain of analogical arguments. The conclusion concerns the subatomic level, the target domain of the analogy.

Space-time appears as the upper space of subatomic particles (leptons and hadrons like proton, neutron and unstable particles, photons). The lower space of these particles is missing by analogical reasoning. This becomes obvious when properties like the "intrinsic spin" or the magnetic moment of point-like particles cannot be described within a space-time ontology[5]).

The definition of a “basic space” is proposed to fill this gap, i.e. to represent the lower state space of subatomic particles. The basic space is located “below” space-time according to the structural organization and historically “before” space-time. The general consequences of this proposal are outlined in the article. A full discussion would need to develop a particle model with spatial duality, which is beyond the scope of this article.

The proposed introduction of a basic space raises physical as well as philosophical questions about the nature of dark matter and the cosmic inflation. The

[5] The mathematical representation of the spin in the Dirac theory and the Feynman diagrams used in calculations of QED (Quantum Electro-Dynamics) are useful theories without an ontologic explanation in space-time.

role of gravity in a period of the evolution "before" the emergence of space-time represents one of the most fundamental problems.

Whole-parts relations have been found on each level in two dimensions. In the vertical dimension, which is directed to the next higher level, compounds represent the wholes and units represent the parts. The horizontal dimension is determined by the formation of a hierarchy of systems with the expansion and an ever increasing number of compounds. These "complexes" and higher aggregated systems represent the wholes, compounds represent the parts.

8 Declarations

No funds, grants, or other support was received.

The author has no relevant financial or non-financial interests to disclose.

References

[1] Chambers J., Mitton J., From Dust to Life: The Origin and Evolution of Our Solar System, Princeton University Press, ISBN 978-0-691-14522-8 (2017)

[2] Oschmann, Wolfgang: Evolution der Erde, Haupt-Verlag, ISBN 978-3-8252-4401-9 (2016)

[3] Rosing, M. On the evolution of minerals. Nature 456, 456–458 (2008). https://doi.org/10.1038/456456a

[4] Rasmussen S, Constantinescu A, Svaneborg C. Generating minimal living systems from non-living materials and increasing their evolutionary abilities. Philos Trans R Soc Lond B Biol Sci. 2016; 371 (1701): 20150440.

[5] Herrmann, Hans-Dieter: Vom Elektron zum Superstaat - Analogien zwischen natürlichen Systemen auf acht Ebenen der Evolution; Berlin: Pro Business 2016, ISBN 978-3-86460-608-3

[6] Shvartsev, S.L. Evolution in nonliving matter: Nature, mechanisms, complication, and self-organization. Her. Russ. Acad. Sci. 87, 518–526 (2017).

[7] Altwegg, K. et al.: 67P/Churyumov-Gerasimenko, a Jupiter Family Comet with a High D/H Ratio. In: Science 347, 1261952, 2015

[8] Bardley, J. P. et al.: Detection of Solar Wind-Produced Water in Irradiated Rims on Silicate Minerals. In: Proceedings of the National Academy of Sciences USA 111, S. 1732-1735, 2014

[9] Hsieh, H. H. et al.: A Population of Comets in the Main Asteroid Belt. In: Science, 312, p. 561-563, 2006

[10] Mottl, M. J. et al.: Water and Astrobiology. In: Chemie der Erde 67, p. 253-282, 2007

[11] Gesteland, R. F. et al. (Ed.): The RNA World. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, 3. ed. 2006

[12] Hazen, R. M.: Genesis: The Scientific Quest for Life's Origins. Joseph Henry Press, Washington 2005

[13] Nielsen, P. E.: Ein neues Molekül des Lebens? In: Spektrum der Wissenschaft 10/2009, p. 42-49

[14] Shapiro, R.: Ein einfacher Ursprung des Lebens. In: Spektrum der Wissenschaft 11/2007, p. 64-72

[15] Szostak, J. et al.: Synthesizing Life. In: Nature 409, p. 387- 390, 2001

[16] Cox, C. J. et al.: The Archaebacterial Origin of Eukaryotes. In: Proceedings of the National Academy of Sciences 105, p. 20356-20361, 2008

[17] Koonin, E. V.: The Origin and Early Evolution of Eukaryotes in the Light of Phylogenomics. In: Genome Biology 11, 209, 2010

[18] Lane, N., Martin, W.: The Energetics of Genome Complexity. In: Nature 467, p. 929-934, 2010

[19] Müller, M. et al.: Biochemistry and Evolution of Anaerobic Energy Metabolism in Eukaryotes. In: Microbiology and Molecular Biology Reviews 76, p. 444-495, 2012

[20] Rocher, C., Letellier, T.: Influence of Mitochondrial DNA Level on Cellular Energy Metabolism: Implications for Mitochondrial Diseases. In: Journal of Bioenergetics and Biomembranes 40, p. 59-67, 2008

[21] Spang, A. et al.: Complex Archaea That Bridge the Gap Between Prokaryotes and Eukaryotes. In: Nature 521, p. 173-179, 2015

[22] Żenczykowski, P., Quarks, Hadrons, and Emergent Spacetime, Foundations of Science (2019) 24:287–305, https://doi.org/10.1007/s10699-018-9562-2

[23] Kiefer C., Space, Time, Matter in Quantum Gravity, arXiv:2004.03174v1 [gr-qc] 7 Apr 2020

[24] Wüthrich C., The emergence of space and time, arXiv:1804.02184v1 [physics.hist-ph] 6 Apr 2018

[25] Kurakin A., The self-organizing fractal theory as a universal discovery method: the phenomenon of life, Theoretical Biology and Medical Modelling 2011, 8:4, http://www.tbiomed.com/content/8/1/4

[26] Salazar-Ciudad, I., Evolution in Biological and Non-biological Systems: The Origins of Life, Biol Theory (2013) 7:26–37, DOI 10.1007/s13752-012-0066-y

[27] Krylov, M. V. , Evolutionary Commonality of Nonliving Nature and Living Organisms, ISSN 1019-3316, Herald of the Russian Academy of Sciences, 2017, Vol. 87, No. 3, pp. 249–255. © Pleiades Publishing, Ltd., 2017., Original Russian Text © M.V. Krylov, 2017, published in Vestnik Rossiiskoi Akademii Nauk, 2017, Vol. 87, No. 5, pp. 441–448

[28] Canavotto, I., Alessandro Giordani, A., An Extensional Mereology for Structured Entities, Erkenntnis(2020), https://doi.org/10.1007/s10670-020-00305-5

[29] Tsai, Hc., Varzi, A.C. Atoms, Gunk, and the Limits of 'Composition'. Erkenn 81, 231–235 (2016). https://doi.org/10.1007/s10670-015-9736-z

[30] Cotnoir, A. J., ABELIAN MEREOLOGY, Logic and Logical Philosophy (2015), DOI: 10.12775/LLP.2015.006

[31] Mormann, Thomas. "On the Mereological Structure of Complex States of Affairs." Synthese, vol. 187, no. 2, 2012, pp. 403–418. JSTOR, www.jstor.org/stable/41681583.

[32] Keet, C.M., Artale A., Representing and Reasoning over a Taxonomy of Part-Whole Relations, Applied Ontology (2007) 1 1, IOS Press

[33] Zyla P.A. et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2020), 92. Searches for Quark and Lepton Compositeness, Revised 2019 by K. Hikasa, M. Tanabashi, K. Terashi, N. Varelas

[34] Vagelli, M., Loison, L., Diez, I.M., Thinking Crossroads: from Scientific Pluralism to Pluralist History of Science, Introduction, Journal for General Philosophy of Science (2021) 52:87–95, https://doi.org/10.1007/s10838-020-09550-2

[35] Auffray, C., Noble, D., Nottale, L., Turner, P., Progress in integrative systems biology, physiology and medicine: towards a scale-relative biology, Eur. Phys. J. A (2020) 56:88, https://doi.org/10.1140/epja/s10050-020-00090-3

[36] Rice, C., Smart, J., Interdisciplinary modeling: a case study of evolutionary economics, Biol Philos (2011) 26:655–675, DOI 10.1007/s10539-011-9274-2

[37] Greben, J.M., The Role of Energy Conservation and Vacuum Energy in the Evolution of the Universe, Found Sci (2010) 15:153–176, DOI 10.1007/s10699-010-9172-0

[38] Rowbottom, D.P., Models in Biology and Physics: What's the Difference?, Found Sci (2009) 14:281–294, DOI 10.1007/s10699-009-9160-4

[39] Dennis, L., Gray R.W., Kauffman, L.H., Brender, J., et al., A FRAMEWORK LINKING NON-LIVING AND LIVING SYSTEMS, Classification of Persistence, Survival and Evolution Transitions, DOI: 10.1007/s10699-008-9154-7, Available at http://www.springerlink.com/content/1233-1821, "Foundations of Science" 14, page #s to be assigned, 2009

[40] Baianu, I.C., Æ R. Brown Æ J. F. Glazebrook, Categorical Ontology of Complex Spacetime Structures: The Emergence of Life and Human Consciousness, Axiomathes (2007) 17:223–352, DOI 10.1007/s10516-007-9011-2

[41] Geiss, J., Gloeckler, G., Evolution of Matter in the Universe, The Solar System and Beyond: Ten Years of ISSI (2015)

[42] Suh, N.P., On functional periodicity as the basis for long-term stability of engineered and natural systems and its relationship to physical laws, Research in Engineering Design (2004) 15: 72–75, DOI 10.1007/s00163-003-0045-1

[43] LINDAHL, P.A., STEPWISE EVOLUTION OF NONLIVING TO LIVING CHEMICAL SYSTEMS, Origins of Life and Evolution of the Biosphere 34: 371–389, 2004.

[44] Simms, J.R., SYSTEMS SCIENCE FUNDAMENTAL PRINCIPLES, Understanding Complexity. Edited by Ragsdell and Wilby., Kluwer Academic/Plenum Publishers. New York. 2001

[45] Gigch,J. P. van, The System Approach: Applied System Theory, chapter 3 in System Design Modeling and Metamodeling, © Springer Science+Business Media New York 1991

[46] O'HARA, R.J., Representations of the Natural System in the Nineteenth Century, Biology and Philosophy 6" 255-274, 1991.

[47] Egg, M., Quantum ontology without speculation, European Journal for Philosophy of Science (2021) 11: 32; https://doi.org/10.1007/s13194-020-00346-1

[48] Goldstein, Sheldon, "Bohmian Mechanics", The Stanford Encyclopedia of Philosophy (Fall 2021 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/fall2021/entries/qm-bohm/

[49] Ghirardi, Giancarlo and Angelo Bassi, "Collapse Theories", The Stanford Encyclopedia of Philosophy (Summer 2020 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/sum2020/entries/qm-collapse/

[50] Allori, Valia, Sheldon Goldstein, Roderich Tumulka, and Nino Zanghi, 2008, "On the Common Structure of Bohmian Mechanics and the Ghirardi-Rimini-Weber Theory: Dedicated to GianCarlo Ghirardi on the Occasion of His 70th Birthday", The British Journal for the Philosophy of Science, 59(3): 353–389. doi:10.1093/bjps/axn012

[51] Faye, Jan, "Copenhagen Interpretation of Quantum Mechanics", The Stanford Encyclopedia of Philosophy (Winter 2019 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/win2019/entries/qm-copenhagen/

[52] Barrett, Jeffrey, "Everett's Relative-State Formulation of Quantum Mechanics", The Stanford Encyclopedia of Philosophy (Winter 2018 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/win2018/entries/qm-everett/

[53] Vaidman, Lev, "Many-Worlds Interpretation of Quantum Mechanics", The Stanford Encyclopedia of Philosophy (Fall 2021 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/fall2021/entries/qm-manyworlds/

[54] Laudisa, Federico and Carlo Rovelli, "Relational Quantum Mechanics", The Stanford Encyclopedia of Philosophy (Winter 2021 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/win2021/entries/qm-relational/

[55] Bacciagaluppi, Guido, "The Role of Decoherence in Quantum Mechanics", The Stanford Encyclopedia of Philosophy (Fall 2020 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/fall2020/entries/qm-decoherence/

[56] Myrvold, Wayne, "Philosophical Issues in Quantum Theory", The Stanford Encyclopedia of Philosophy (Fall 2018 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/fall2018/entries/qt-issues/

[57] Ismael, Jenann, "Quantum Mechanics", The Stanford Encyclopedia of Philosophy (Fall 2021 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/fall2021/entries/qm/

[58] Nicholson, Daniel J., Biological atomism and cell theory, Studies in History and Philosophy of Biological and Biomedical Sciences 41 (2010) 202–211

[59] Esfeld, M., Atomism and Holism: Philosophical Aspects, published in James D. Wright (ed.): International encyclopedia of the social and behavioral sciences, Amsterdam: Elsevier 2015, Volume 2, pp. 131–135).

[60] Koonin, Eugene V., Artem S. Novozhilov, Origin and evolution of the genetic code: the universal enigma, IUBMB Life. 2009 Feb; 61(2): 99–111. , doi: 10.1002/iub.146

[61] Weisberg, Michael, Paul Needham, and Robin Hendry, "Philosophy of Chemistry", The Stanford Encyclopedia of Philosophy (Spring 2019 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/spr2019/entries/chemistry/

[62] H1 Collaboration, C.Adloff, et al., Search for Compositeness, Leptoquarks and Large Extra Dimensions in eq Contact Interactions at HERA, DESY 00-027 ISSN 0418-9833, February 2000, arXiv:hep-ex/0003002v2 (hep-ex)

[63] Wolchover, N., What Is a Particle?, Quanta magazine, November 12, 2020

[64] Bartha, Paul, "Analogy and Analogical Reasoning", The Stanford Encyclopedia of Philosophy (Spring 2019 Edition), Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/spr2019/entries/reasoning-analogy/