The initial patterns of Big History and Evolution

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The origins of the world's fundamentals and the basic similarities of the matter

The study of the first 200-300 million years of our Universe after the Big Bang in the context of evolution is of great interest.

In that very period many evolutionary laws and patterns were formed.

The basis of our world's integrity originated just in those dark ages.

The origins of the world's fundamentals and the basic similarities of the matter

- In the first hundreds of thousand years we observe the emergence of the basic elements of the world's structure and some of its universal characteristics (such as self-organization, self-preservation, regulation, and pursuance of complexity).
- At this stage of the world evolution, more than in any other period, one can distinguish the phase transition from one state of matter to another.
- We can formulate a number of general evolutionary ideas and patterns which were manifested in that period. Some of them will be presented in our paper.

Phase transitions after the Big Bang

As a result of heating and the hot Big Bang, temperatures reached tremendous levels, and the emerging particles obtained huge energy.

Due to great expansion, the temperature and pressure in the Universe rapidly decreased.

In the very first second of the early Universe a number of important phase transitions occurred and some significant properties of matter emerged.

Phase transitions after the Big Bang

Epoch and physical processes	Time period after the start of the Universe	Temperature
Hot Big Bang and origin of the matter	10^{-36} s	10^{32}– 10^{29} K
Creation of baryon excess	10^{-35} s	10^{29} K
Electroweak phase transition	10^{-10} s	10^{17}–10^{16} K
Appearance of protons and neutrons	10^{-4} s	10^{12}–10^{13} K
Initial nucleosynthesis (synthesis of nuclei)	The 1st second – 5-15 minute	10^{9}–10^{10} K

Phase transitions after the Big Bang

Then we can speak about

- **transition of matter into hot plasma state (after 5–15 minutes)**
- **condensation of dark matter (a. 80 thousand years after the Big Bang)**
- **emergence of atoms or the *hydrogen recombination* (*a.* 240–270 thousand years)**

The law of potential characteristics of systems

The potential properties of many systems appear only in specific environments.

- Emerging features of forms, systems and matter are generally realized within some extreme environments (super pressure, hyper density, or, on the contrary, very law pressure, ultrahigh or near zero temperatures etc.) as well as within extra-long processes.
- As a result, absolutely new conditions emerge or the former ones are manifested in a different way.
- The same is true for the higher evolutionary levels. The hyper mutation environment leads to new genetics; specific environmental challenges – to new solutions in biology and sociology; societies with low population density or under high population pressure act in absolutely different ways; different institutions, relations ,and forms develop there as well.

Chaos, order, and bifurcations from the theoretical perspective

- The destruction of a structure brings chaos; the so-called bifurcation states emerge when a system comes close to collapse or to establishing a new order (the so called order from chaos).

Chaotic or revolutionary periods of evolution are described in Complexity Studies

- The system can rise or fall to a higher or lower attractor, respectively, i.e. choose one or another pattern of new order.

- This theory, originally developed for certain chemical reactions, is appropriate for many processes including some social ones.

Chaos, order, and bifurcations after the Big Bang

This theory to a certain degree fits the purposes of the hot Big Bang theory and cosmology in general.

We have a state of chaos, caused by rapid expansion and huge energy.

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Some order is gradually formed via self-organization.

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First bifurcation such as the formation of different types of matter (dark and baryonic matter) occurred in the first milliseconds after the BB.

Emergence of the primary pattern of evolutionary structuring

Structuring is one of the pivotal evolutionary processes almost at all phases and levels.

The **formation of nucleus** is the basic structure of evolution.

The **emergence of atomic nucleus** is the first step in structuring (nuclei consist of protons and neutrons, which, in turn, consist of quarks).

- Nuclei are the main elements of the atomic structure formed in the epoch of nucleosynthesis which started in a second after the Big Bang and was over within 5-15 minutes.
- The nuclear structure, emerging during the first seconds and minutes of evolution, was widely reproduced later. Nuclei are present in stars, planets, galaxies and their clusters; in a modified way the nuclear-based structure occurs in the “core – periphery” model within global political systems.

Emergence of the primary pattern of evolutionary structuring

Emerging atoms also marked the formation of the most essential pattern of evolutionary structuring.

- Approximately 240-270 thousand years after the Big Bang, the temperature in the Universe fell to 3500-3000 K.
- This promoted the integration of positively charged nuclei with negatively charged electrons.
- Electrically neutral atoms of hydrogen emerged.
- That was the **epoch of hydrogen recombination**.

Emergence of the primary pattern of evolutionary structuring

For the first time in Big History a fundamentally new structure of matter (atoms) had emerged.

- **In structural terms, atoms principally differ from atomic nuclei since two opposite forces merge here – the atomic nuclei and electrons – and develop a spatial structure of a new type.**
- **This initial pattern of classical discrete system structure (of a nucleus surrounded by grouped peripheral elements interacting with the nucleus), is permanently reproduced.**

Emergence of the primary pattern of evolutionary structuring

Why does this very structural pattern develop?

- It is efficient and cost-effective (in terms of minimal/optimal energy consumption and other expenses).
- Efficiency is a criterion which defines the formation and directs interaction of many structures and almost every object (from a photon to a state).
- Nucleus is a concentration of energy and resources.
- Predominance of the centre and centripetal forces (or their parity with centrifugal forces) give the ground for a rather strong and stable structure, allowing some systems to exist for a long time.

Emergence of the primary pattern of evolutionary structuring

The lack of a nucleus in a structure impedes evolution

- **The structure of the dark matter is unknown, but almost certainly it is acaryotic.**
- **A prokaryotic cell lacks a nucleus and thus, is unable to evolve.**
- **Societies without cores can hardly surpass the stage of acephalous tribes.**
- **Perhaps, the pattern of choosing a candidate for a more complex transformation is reproduced at all levels of evolution: the nuclear structures gain an evolutionary advantage, while acaryotic ones evolve ineffectively.**

Emergence of the primary pattern of evolutionary structuring

Emergence of nuclei of heavy elements and of the evolutionary pattern of complex structure formed from basic elements

- **The emergence of nuclei of heavy elements is a more recent process. The consequence of nuclear formation (at first of the light nuclei and much laterof the heavy ones) is similar to the formation, first, of single-cell and then of multi-cell animals; as well as to the formation of complex societies from primitive.**
- **In all cases, the basic elements transform into the elements with a more complex structure.**
- **The most primitive units form the bulk; while the more complicated structures are less frequently formed.**

Predecessors of the evolutionary leading pattern

Within evolution the evolutionary leading forms and structures often have predecessors which to some extent prepare environment for their emergence.

- **The first atom-like structures were helium ions (and before them – lithium ions), which had emerged much earlier than hydrogen atoms, about 17 thousand years after the Big Bang. But they were scarce and unable to change the nature of plasma of photons, electrons, and protons.**
- **Having in mind the ratio between dark and light matter, we can say that the former precedes the latter in concentration , thus, playing the role of its analogue and predecessor.**

Predecessors of the evolutionary leading pattern

- It also reminds some levels of structuring within clusters of single-cell animals, while colonies of single-cell animals to a degree are analogues to many-celled organisms.

- This situation also illustrates the evolutionary law of sufficient diversity: the emergence of an important form (type) needs a certain diversity of forms.

Flexibility

Flexibility significantly increases opportunities for developing and realization of potential properties as well as provides alternative paths for evolution.

- **Even at the early stages of development of the Universe there revealed such a fundamental feature of nature and evolution as flexibility, which is the formation of several types (alternatives) of the same pattern, element, structure etc.**
- **For example, in the very first minutes there were formed hydrogen isotopes (deuterium and tritium) along with helium isotopes.**

Structuring and de-structuring as evolutionary strategies

At all levels we can find a balance between the high- and low-structured groups.

- **Elementary particles consolidate or exist autonomously.**
- **Stars exist in galaxies or in small groups.**
- **Single-celled animals can live alone or in organized colonies.**
- **Many-celled animals live separately, or in independent families and groups.**
- **Hunters, gatherers and primitive farmers can live separately or join together.**

Structuring and de-structuring as evolutionary strategies

What is common for the amalgamations and splitting processes in micro world, cosmic macro world and in biological and social realms? This is predetermined by the following factors:

- **the level of available energy (resources)**
- **the balance between gains and losses from amalgamation**
- **the scale of uniting or splitting force which creates initial clusters as a core for the structure to be formed.**

On the role of the dark matter

- After the nucleosynthesis had finished, the matter remained in the state of hot plasma of electrons, photons, and protons where also atomic nuclei and the dark-matter elements would “boil” for a while.
- About 80 thousand years after the Big Bang, the decreasing pressure reduced radiation and dark matter could start to condense.
- The fact that it was just the dark matter that started to cluster much earlier than the light one played an important role in the formation of galaxies.
- The period preceding the formation of hydrogen atom can be considered the period of gravitational predominance of the dark matter.

Dark matter and evolutionary laws

This is one of the first evolutionary examples when minor, even tiny differences can grow into huge ones.

- **During the epoch of dominating dark matter, the fluctuations would become larger and the opportunities of micro-scale manifestations of fluctuations would already start forming, in other words, there emerged the germs of heterogeneity which would later play an important role in the formation of the large-scale clusters of matter: protogalaxies, galaxy clusters etc.**
- **Later we can observe this in every case of divergence and differentiation (in the divergence of populations and species, of languages and cultures, of political movements etc.).**

Dark matter and evolutionary laws

The common law of development and evolution consists in the following: **any process always proceeds with some inconsistencies, fluctuations, abruptness etc. which are the germs and starting points of subsequent transformations** (in some cases – of the evolutionary important ones).

- The changing structure at the micro-world level (i.e. the formation of atoms) finally led to a large-scale structuring of the Universe.
- One can find analogues at other evolutionary levels: mutations in genes can dramatically change flora and fauna over a certain period of time.
- An ideology capturing masses can both change situation in an individual society and launch some dramatic changes in the whole World-System (as it happened in the early seventh century in Arabia after the emergence of Islam).

On the role of ‘seed grains’ in evolution

Within evolution it frequently happens that elements which are foreign for the basic mass may become the primary nucleus of a process.

- **Within the primary chaos, atoms and molecules emerged forming gas masses which gradually clustered into giant clouds.**
- **The “seed grains” of the dark matter, which had much earlier consolidated into clusters, contributed to the concentration of the light matter.**
- **After the radiation pressure had dropped as a result of hydrogen recombination, the light (baryonic) matter falls in potential holes prepared for it by the dark matter.**
- **The formation of ethnos or states is often launched by an element of different ethnicity.**

In the initial periods the laws always manifest themselves in a peculiar way

The transition to a qualitatively new state is always a rather large-scale and complicated phase transition with the following peculiarities:

1. **The transition occurs under peculiar and rarely emerging conditions.**
2. **Sometimes such a transition can proceed only under conditions of complicated bifurcation.**
3. **There should emerge peculiar environments where the known laws can manifest themselves in an unusual way.**
4. **During the formative phases certain alternative laws can operate (alternative Physics, Chemistry, Biology or Sociology).**

THANK YOU FOR YOUR ATTENTION!