

Physics source for intelligence

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Abstract

In physics, Energy is the fundamental component of the Cosmos, integral to all processes and changes. Evolution, through trial and error, must adhere to the restrictions of the “Energy Conservation Principle,” just like all other processes in space-time. The development of both nonintelligent and intelligent structures is driven by Energy changes, and the “Uncertainty Principle.” Nonintelligent structures lack ad hoc planning. Through an extensive evolutionary process of trial and error, intelligent structures emerged from nonintelligent ones, gaining capabilities for advanced Energy exertion control, increasing Energy storage capabilities, ad hoc planning, and bypassing the “Least Action Principle.”

Article

1. Preliminaries

There are several definitions of intelligence. They usually relate to fields like psychology, cultural studies, and cognitive science. They do not incorporate the application of physics principles as their facilitators.

In this article, I will provide the missing physics base.

Fundamental physics principles:

Energy always conforms to the “Uniformity of Physics Laws in the Universe Principle” (**Each physics law is the same throughout the Cosmos**) and the “Energy Conservation Principle” (**Energy is conserved in a closed system.**) (1)

Nobody has ever found a deviation from these principles on Earth, the solar system, or in distant galaxies. (2)

2. Energy, uncertainty, and trial and error evolution

In physics, Energy is everything: Energy represents both the substance of the Cosmos and the ability to cause changes in the Cosmos.

In the form of a principle:

The Completeness Principle:

Energy and nothing but Energy exists in the Cosmos.

Therefore, all processes and their influences in space-time are Energy changes. Thus, Energy and its applications in space-time must be the basis for intelligence.

After research, I found that in this article, I should concentrate on the three factors concerning Energy that influence intelligence and nonintelligence: Energy exertion control, Energy storage, and ad hoc planning (of Energy exertion).

All processes in space-time follow the Uncertainty Principle: **"Each process in space-time has ingrained Uncertainty."** Practically, it means we cannot foresee precisely all quantities of processes in space-time. (This is not a reflection of our inability to observe all possible quantities to the utmost accuracy but a reflection that there is true Uncertainty in all processes in space-time.)

"Luminous Energy" is the Energy that relates to elementary particles and their influence on space-time. **"Hidden Energy"** is Dark Matter. As a consequence of the "Uncertainty Principle," all luminous and hidden Energy processes have some randomness. In particular, all elementary particles have ingrained Uncertainty. (1)

Both nonintelligent and intelligent structures (which will be defined later) result from the trial and error evolution processes, which are processes in space-time that create structures. The created structures endure if they can cope with their environment. (If not, they perish.)

Trial and error evolution introduces random structure changes (randomness source is the uncertainty-related Energy in elementary particles.) If the change contributes to the structure's existence, it will keep existing longer than without the change. More significantly, Trial and error evolution introduces random changes in the structures' hereditary systems (if existing.) If these changes contribute to the descendants' existence, the number of species members will increase over time.

If the change is bad for existence, the structure will not remain for long (its owner will perish.) **Note:** This description is a simplistic view of a complex process but represents its most basic and essential qualities.

Going forward, I will abbreviate trial and error evolution to "**TAE**E."

Aside: Highly evolved intelligent structures can change hereditary systems or create new species, including AGI, by design rather than by "natural" random changes. As the creators of these actions result from previous TAE E (trial and error evolution) processes, the artificial manipulation of genetic materials and the creation of new species still fall under TAE E as part of the chain of TAE E processes.

To understand intelligence, I followed the TAE E path that led to intelligence creation.

3. Nonintelligent structures

Structures Definition:

Structures are distinct entities emerging from binding one or more elementary particles to one or more elementary particles, which remain for a period.

First-Level Nonintelligent Structures Definition:

First-level nonintelligent structures are structures that immediately exert Energy received from external sources. They cannot control the Energy exertion, cannot store Energy, and cannot plan.

In this article, I will start discussing TAE E after the creation of elementary particles. (I will discuss their creation in another article.) Elementary particles do not have internal structures, but they cannot control their Energy exertion, store Energy, or plan – therefore, I will also classify them as first-level nonintelligent structures.

The TAE E process first created elementary particles. Then, TAE E created "**Non-Replicating Structures**": First, the elementary particles (in TAE E processes) created compound particles, then in parallel (after the creation of enough compound particles,) compound particles (in TAE E processes) created atoms, and then in parallel, atoms (in TAE E processes) created molecules. All the processes described above require Energy exertion, which is the Energy associated with the elementary particles' charges. In these processes, there is no control of Energy exertion, no Energy storage, and no ad-hoc planning. Therefore, they are all first-level nonintelligent structures. (1)

From close to the end of Earth's oceans' creation, lasting 200-300 million years, a giant step in TAE E emerged: transformed (by evolution,) non-replicating structures (like molecules) started to copy themselves, forming "**Simple Replicating Structures**" (which are first-level nonintelligent structures). Scientists suggest it occurred near hydrothermal vents in the ocean. To gauge the intensity of TAE E interactions, I calculated that in this time frame, near a single

hydrothermal vent (within 40 cubic meters around it), there would be $8.45 \cdot 10^{58}$ interactions between seawater molecules, minerals, and other non-replicating structures close to the hydrothermal vent. There are currently more than 500 hydrothermal fields in the oceans, each consisting of hydrothermal vents. Their areas range from a few square meters to several square kilometers. There were many more hydrothermal fields right after the ocean's creation; since then, the Earth's crust has been very active and hot. For 1,000 hydrothermal fields with an average of 100 hydrothermal vents, the number of interactions increases to $8.45 \cdot 10^{63}$ within the mentioned period - a staggering number representing the TAEE processes' very high intensity. (3)

Processes in space-time always obey the "Energy Conservation Principle." From observations, we know that processes tend to be in states with the lowest possible potential Energy states, which leads to the following:

Macroscopically, in a state where the Hamiltonian does not depend explicitly on time, the processes obey the "Least Action Principle" (**A Universe part path has minimal Action for stationary start and endpoints**), which embodies the "Energy Conservation Principle." (Because in a system where the Hamiltonian does not change with respect to time, the total Energy does not change.) (4)

Mathematically, if the action $S = \int_{t_1}^{t_2} L dt$, where L is the system Lagrangian, then the "Least Action Principle" means $\delta S = 0$ with fixed start and end points.

Without change in the Hamiltonian with respect to time, space-time movement always follows infinitesimal progress increments according to the "Least Action Principle." This situation represents a lack of internal control over Energy exertion. (Atoms do not decide when to exert Energy.)

All first-level nonintelligent structures (elementary particles, non-replicating structures, and simple replicating structures) follow the "Least Action Principle."

Second-Level Nonintelligent Structures Definition:

Second-level nonintelligent structures are structures that can exert Energy from external and internal Energy sources. They can store Energy. They cannot plan ad hoc.

The following discussion relates to second-level nonintelligent structures (Note: dates of evolutionary results' appearances vary significantly between different scientists. The dates are less important than the order in which the TAEE results appear. I only mention the end results and not the less important (for the article) intermediary evolutionary stages):

Since the appearance of simple replicating structures, several hundreds of millions of years of TAEE passed until about 3.5-3.8 billion years ago, when a giant step in TAEE emerged: the first cells (**Prokaryotes**) appeared. They could exert Energy and store Energy but could not plan ad hoc. (5)

Almost from their start, prokaryotes have been able to react to changes in their environment in simple ways, such as chemotaxis and phototaxis. That means they have some control over Energy exertion, but they do not plan ad hoc - their reaction is part of their genetics.

Remark: These reactions are less complex than instincts. (6)

1.6-2.1 billion years ago, a more advanced cell type appeared – a cell with a nucleus (**Eukaryotes**). All eukaryotes have reaction types similar to those of prokaryotes. (7)

It took another ~400-800 million years for another major advancement in TAE: the appearance of the first multicellular structures from eukaryotes. Some of these multicellular structures developed instincts (named “**Instinctual Multicellular Structures**”) while others did not (named “**Noninstinctual Multicellular Structures**”). Instinct Definition: **An instinct is a fixed complex pattern of behavior in response to certain stimuli. It is inborn and occurs without prior experience or training.** (8)

Remark: in this article, whenever I refer to instinctual multicellular structures, I refer to those that do not plan ad hoc. **Aside:** Some multicellular structures are composed of prokaryotes, but they are simple and not worth mentioning in a separate description in the context of this article. They fit all that I attribute to second-level nonintelligent structures.

Note: Prokaryotes, eukaryotes, noninstinctual and instinctual multicellular structures are second-level nonintelligent structures because they do not plan ad hoc.

Discussion: Prokaryotes, eukaryotes, noninstinctual and instinctual multicellular structures, have some control over their Energy exertion in the sense that they exert Energy in response to some change in their neighborhood, but it is not an ad hoc planned action. It is a genetically inherent behavior. Because they react in a predetermined way that is never optimized for the very specific state they face, their Energy exertion is not optimal. Their Hamiltonian depends on time, and thus, they do not follow the "Least Action Principle."

Note: Non-optimal Energy use may render the structure that used it lack sufficient Energy to protect itself in future activities. However, the fact that second-level nonintelligent structures exist for a long time and exert Energy less efficiently than they would have had they followed the "Least Action Principle" suggests that they have an evolutionary advantage over first-level nonintelligent structures. Indeed, their triggered behavior gives them an existential advantage in cases when a swift genetically preprogrammed response that bypasses the "Least Action Principle" is preferred for existence to reactions that are not planned in any way.

4. Intelligent structures

The success of instinctual structures that do not plan ad hoc (despite their deficiencies) "led" TAE to "exploit" the deviation from the "Least Action Principle" and add more control over Energy exertion, enhance Energy storage capabilities, use Energy from internal and external sources, and add ad hoc planning (all through random changes.)

Intelligent Structures Definition:

Intelligent structures are structures that can control their Energy exertion, use internal and external Energy sources, store Energy, and plan ad hoc.

The intelligent structure comprises several substructures: those related to observation, ad hoc analysis of observation results, decision-making based on the current or past analysis, and controlled Energy exertion following these decisions. These substructures are complicated. As an example, there are grosso modo $1.36 \cdot 10^{26}$ atoms in a Homo Sapiens brain.

Intelligence is the TAE effort to achieve future existence by ad hoc planned design rather than ensuring current existence without conscious consideration of the future.

Intelligent structures utilize processes that ignore the "Least Action Principle" by controlling their Energy exertion: controlling the output quantity, timing, and intensity of their choosing based on the ad hoc planning of their making. Of course, they must follow the "Energy Conservation Principle," which sets a boundary for Energy exertion, and they cannot escape the influences of the "Uncertainty Principle."

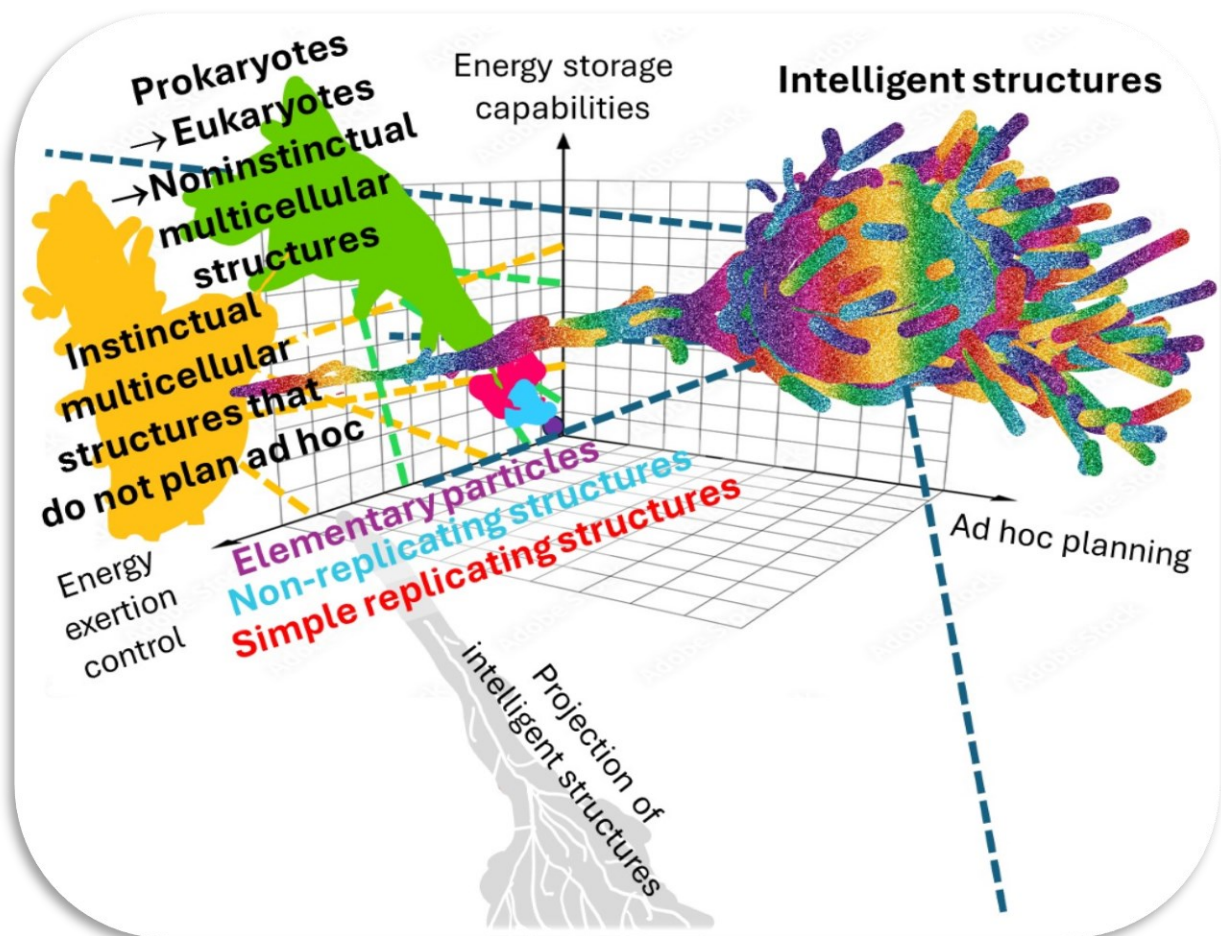
Note: The TAE created intelligent structures that produce "free will thinking" – thoughts that do not have to produce the same results every time under the same conditions (This is a result of uncertainty-related Energy.) This quality is why genuine new ideas can emerge!

Aside: Does a thought that does not result in an action constitute a part of the planning phase? No, it is the outcome of a planning phase.

Question: Can performing the ad hoc planning phase pose new threats to the intelligent structure?

Yes. Suppose the Energy exerted by the intelligent structure on ad hoc planning before execution is very high. In that case, it may lack the Energy to protect itself from current or future existence-threatening events. Or if the forecasting phase (before action) takes too much time, then too many new existence-threatening situations can occur.

Figure 1 Schematics of intelligence development through TAE



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In Figure 1, the components are not scaled in size, exact relative position on axes, and time of appearance.

All the nonintelligent structures reside in the Energy exertion control and the Energy storage capabilities plane: Elementary particles appear as a purple circle (should be a dot) at the origin of the axes. The non-replicating structures (containing compound particles, atoms, and non-replicating molecules) in light blue emanate from the elementary particles. The simple replicating structures in red emanate from the non-replicating structures. A group of three: the prokaryotes - emanating from the simple replicating structures; the eukaryotes - emanating from the prokaryotes, and the noninstinctual multicellular structures - emerging from the eukaryotes - all three are in a shade of green (I combined these three types into one to avoid visual clutter.) The instinctual multicellular structures that do not plan ad hoc in a shade of yellow emerge from the eukaryotes. All of the nonintelligent structures have changing surfaces and appendages to demonstrate TAEE.

The intelligent structures are colorful - emanating from instinctual multicellular structures that do not plan ad hoc. They are all over the three axes (including the ad hoc planning axis) with multiple appendages demonstrating their flourishing TAEE many turns.

Alternative definition:

An Intelligent Structure Definition:

An intelligent structure is a structure that tries to foresee the future and exerts Energy in a controlled manner according to its ad hoc forecasts to achieve its goals - following the “Energy Conservation Principle” and the “Uncertainty Principle,” but not the “Least Action Principle.”

Aside: Life on Earth shows signs of intelligence much sooner than some scientists believe.

5. Intelligence levels

Intelligent structures levels definitions:

1. First-level intelligent structure is an intelligent structure that can observe its non-local surroundings, analyze ad hoc the results of the observations, plan ad hoc its activities according to the observational results, and exert Energy (act) in a controlled way according to its plan.
2. Second-level intelligent structure is a structure with all the qualities of a first-level intelligent structure that can record observational results and analysis, extract them, and convey them to other structures.
3. Third-level intelligent structure is a structure with all the qualities of a second-level intelligent structure with one or more of the following abilities: the ability to use knowledge from internal and external sources, learn, create knowledge, and invent new things that do not necessarily pertain to immediate required action.

Note: The “Uniformity of Physics Laws in the Universe Principle” ensures that intelligence development everywhere in the Cosmos will follow the same principles discussed here.

6. Conclusions

TAAE created processes that do not follow the "Least Action Principle" from processes that always follow it.

Intelligent structures always follow the "Energy Conservation Principle" and the "Uncertainty Principle" and allow for actions that are accumulatively **better** for future existence than other options.

As the best existential strategy (yet,) intelligence will appear anywhere it can in the Universe.

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