

Comment on “The Information as Absolute Concept and Basic Physics”

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The attempt by Sergey V. Shevchenko and Vladimir V. Tokarevsky to regard information as fundamental for physics addresses an important question. However, the historical and conceptual presentation of the relation of this approach to Carl Friedrich v. Weizsäcker’s program requires substantial clarification.

The authors explicitly refer to v. Weizsäcker’s Ur hypothesis and correctly emphasize his idea that binary quantum alternatives may provide a fundamental basis for physics. What is largely missing, however, is the subsequent development of this program.

Already several decades ago, the Ur-alternative approach was developed far beyond the general statement that information is fundamental. Binary quantum alternatives were treated within a concrete quantum-theoretical and group-theoretical framework. In particular, the relation between the two-dimensional Hilbert space of a binary quantum alternative, its symmetry group $SU(2)$, and the structure of three-dimensional space was investigated in detail. A corresponding quantum field theory of binary alternatives was formulated by Görnitz and v. Weizsäcker [1], and Görnitz, Graudenz and v. Weizsäcker [2]

This point is particularly relevant because the present paper itself refers to v. Weizsäcker’s Ur hypothesis as one of the fundamental starting points of its model and associates the binary structure of the Urs with the three-dimensionality of physical space. However, the decisive mathematical content of this connection is not merely that an Ur represents a binary logic. An Ur is a **quantum** alternative. Its state space is a two-dimensional complex Hilbert space, and its symmetry structure leads to $SU(2)$, whose group manifold has the structure of the three-dimensional sphere S^3 .

Thus, the relation between fundamental quantum information and three-dimensional space does not require the prior introduction of a spatial lattice. Rather, spatial structure can emerge from the mathematical structure of quantum information itself.

This marks an essential difference from the approach proposed in the present paper. Shevchenko and Tokarevsky introduce a dense Planck-scale lattice of fundamental logical elements (FLEs), with spatial dimensions, a Planck length and a Planck time assigned to these elements. These are additional physical assumptions. In the informational approach developed from v. Weizsäcker’s program, by contrast, the aim has been precisely to reduce

the number of such additional assumptions and to derive as much physical structure as possible from quantum theory itself.

There is also a fundamental conceptual distinction concerning the meaning of “information”. It is not sufficient for a physical theory simply to postulate that reality consists of “informational patterns”. One has to specify what kind of information is meant, what its mathematical state space is, which transformations act on it, and how known physical structures can emerge from it.

This problem led to a further development of the Ur program. Ordinary information is relational: it is information about something and, in general, relative to a particular system, question, or observer. Such a concept cannot without further assumptions serve as the ultimate foundation of physical reality.

For this reason, the concept of **absolute and abstract quantum information** was introduced. Its elementary units are no longer understood as answers to a question posed by an observer. Their ultimate reference is the cosmos as a whole. In the later formulation these elementary units are referred to as **Abstract Quantum Information units (AQIs)**.

This development changes the role assigned to information fundamentally. Information is no longer an additional description of an independently existing material reality. Rather, abstract quantum information is taken as the fundamental physical entity from which spatial, energetic and material structures have to be understood. The program did not stop with the emergence of spatial structure. The question whether particle structures can be obtained from quantum information was explicitly investigated. In *Quantum Particles from Quantum Information* [3], the transition from fundamental quantum information to particle-like structures was addressed. The subsequent work with Schomäcker, *The Structures of Interactions - How to Explain the Gauge Groups $U(1)$, $SU(2)$ and $SU(3)$* [4], extended this program to the symmetries of the fundamental interactions. The aim was to show how the gauge groups occurring in particle physics can be related to structures already inherent in the quantum-informational foundation rather than simply being added as independent fundamental assumptions. This is important for assessing the novelty claimed by the present paper. Long before the present “Information as Absolute” model, the informational program originating with v. Weizsäcker had therefore progressed through the sequence:

binary quantum alternatives → quantum information → spatial structure →
particle structures → symmetries of interactions

The decisive question is consequently not whether “everything is information”. Such a statement by itself remains primarily ontological. The physically relevant question is whether the mathematical structure of fundamental quantum information permits known properties of the physical world to be derived.

The distinction has recently been stated particularly explicitly in the framework of **abstract quantum information**. In the BioSystems paper *Quantum information as the scientific basis*

for the explanation of human consciousness and its evolution [5], AQIs are treated as the fundamental entities underlying physical reality. Although that paper is concerned primarily with the physical foundations required for an understanding of consciousness, its underlying ontological point is directly relevant here: quantum information is not regarded merely as information possessed by an observer about matter. Rather, matter itself is understood as a manifestation of quantum information.

This also clarifies why the adjective **abstract** is important. At the fundamental level the quantum information must not presuppose already existing material objects that carry the information. Otherwise, information could not serve as the foundation from which matter is to be explained.

A further problem with Planck-scale fundamental logical elements

There is an additional physical difficulty with identifying the fundamental informational elements with Planck-scale structures.

The authors assume that the fundamental logical elements (FLEs) have a size given by the Planck length, that their elementary change takes place within a Planck time, and that an elementary binary change corresponds to a change of physical action of order $\hbar$. If these Planck-scale quantities are intended merely as parameters of a mathematical description, this does not by itself identify a physical elementary object.

If, however, the FLEs are intended as real physical structures, an important problem arises.

$$E \sim \hbar / t_P = E_P$$

$$m = E / c^2 \sim m_P = \sqrt{\hbar c / G} \approx 2.2 \times 10^{-5} \text{ g}$$

The point should be formulated carefully. This does not mean that “one qubit has a mass of 10^{-5} g ”. Rather, if an elementary binary physical process is assumed to involve an action of order $\hbar$ within one Planck time, then its characteristic energy scale is of order the Planck energy, with a corresponding mass equivalent of approximately $2.2 \times 10^{-5} \text{ g}$. This is about 10^{19} proton masses.

Thus, if a Planck-scale “bit” or FLE is interpreted as a real physical elementary structure rather than merely as part of a mathematical discretization, the alleged simplest informational unit is associated with an extraordinarily high energy scale and hence with a physically highly nontrivial structure. In this sense, the attempt to begin with the physically simplest entity would instead begin with one of the most extreme structures conceivable in physics.

This illustrates a fundamental difference from the AQI approach. An AQI is defined by the mathematically simplest nontrivial quantum structure: a two-dimensional complex Hilbert space. Its physical energy is not fixed at the Planck energy. Since an AQI is related to the cosmos as a whole, its minimal characteristic energy is associated with the largest available

wavelength or, equivalently, with the cosmic time scale. Thus, mathematical simplicity is not identified with spatial localization at the smallest conceivable length.

This distinction is essential. **The smallest conceivable spatial scale need not represent the simplest conceivable physical structure.** On the contrary, extreme localization requires extreme energy. The attempt to make a fundamental informational unit Planck-sized therefore introduces precisely the physical complexity that a fundamental informational approach should seek to derive rather than presuppose.

The Protyposis approach starts from the opposite direction. AQIs are taken to be the mathematically simplest quantum structures, initially without a specific semantic meaning and without presupposing localization in an already existing physical space. Their state space is $\mathcal{C}^2$. Spatial structures, localization, energy, particles and interactions are then to be obtained from increasingly complex states and combinations of these elementary quantum structures.

This approach and its physical consequences are summarized in the booklet *Protyposis - an introduction: Consciousness and Matter from Quantum Information* [6], which is freely accessible online.

Conclusion

The difference between the two approaches is therefore deeper than a question of terminology.

The “Information as Absolute” model begins by postulating informational elements embedded in a highly structured Planck-scale physical framework: a dimensional space, a lattice, a fundamental length, a fundamental time and rules for the dynamics of its elements. If these elements are taken as physically real, their Planck-scale characterization additionally associates an elementary binary process with an extreme energy scale rather than with the physically simplest conceivable structure.

The Ur/Protyposis/AQI program proceeds in the opposite direction. It starts with the mathematically simplest nontrivial quantum structure and asks how space, localization, energy, particles and interactions can emerge from combinations of such structures.

This difference can be summarized succinctly:

The task is not to describe an already structured physical world as information, but to explain how physical structure can emerge from quantum information.

Consequently, the statement that information is fundamental is not new. More importantly, the attempt to transform this philosophical idea into a mathematically formulated physical theory had already progressed considerably before the “Information as Absolute” concept was proposed in 2007.

This historical point is especially important because the present paper explicitly invokes v. Weizsäcker's Ur hypothesis. The development from the Urs to the quantum field theory of binary alternatives, and subsequently to Protyposis and abstract quantum information, is not a minor extension of the original idea. It addresses precisely the central problem that any informational foundation of physics has to solve: **How can physical structure emerge from information without presupposing that structure in the definition of the fundamental informational elements themselves?**

Any contemporary proposal for an informational foundation of physics that explicitly invokes v. Weizsäcker's Ur hypothesis should therefore discuss this earlier development and demonstrate clearly what is conceptually and physically new in comparison with it.

Without such a discussion, the paper gives an incomplete picture both of the historical development and of the present state of informational approaches to fundamental physics. This omission is particularly significant because precisely those problems that the present paper seeks to address - the emergence of three-dimensional space, particle structures and the symmetries of fundamental interactions from quantum information - had already been treated within the further development of v. Weizsäcker's program long before the formulation of the "Information as Absolute" concept.

References

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