frontiers in Physics

ORIGINAL RESEARCH
published: 12 September 2016
doi: 10.3389/fphy.2016.00040

Information and Temporality

Christian Flender *

Faculty of Economics and Behavioral Sciences, University of Freiburg, Freiburg, Germany

Being able to give reasons for what the world is and how it works is one of the defining characteristics of modernity. Mathematical reason and empirical observation brought science and engineering to unprecedented success. However, modernity has reached a post-state where an instrumental view of technology needs revision with reasonable arguments and evidence, i.e., without falling back to superstition and mysticism. Instrumentally, technology bears the potential to ease and to harm. Easing and harming can't be controlled like the initial development of technology is a controlled exercise for a specific, mostly easing purpose. Therefore, a revised understanding of information technology is proposed based upon mathematical concepts and intuitions as developed in quantum mechanics. Quantum mechanics offers unequaled opportunities because it raises foundational questions in a precise form. Beyond instrumentalism it enables to raise the question of essences as that what remains through time what it is. The essence of information technology is acausality. The time of acausality is temporality. Temporality is not a concept or a category. It is not epistemological. As an existential and thus more comprehensive and fundamental than a concept or a category temporality is ontological; it does not simply have ontic properties. Rather it exhibits general essences. Datability, significance, spannedness and openness are general essences of equiprimordial time (temporality).

Keywords: information, technology, temporality, acausality, quantum mechanics

OPEN ACCESS

Edited by:
Emmanuel E. Haven,
University of Leicester, UK

Reviewed by:
Ignazio Licata,
ISEM - Institute for Scientific Methodology, Italy
Paavo Pylkkanen,
University of Helsinki, Finland

***Correspondence:**
Christian Flender
mail@christian-flender.de

Specialty section:
This article was submitted to Interdisciplinary Physics, a section of the journal Frontiers in Physics

Received: *31 May 2016*
Accepted: *22 August 2016*
Published: *12 September 2016*

Citation:
Flender C (2016) Information and Temporality. Front. Phys. 4:40. doi: 10.3389/fphy.2016.00040

1. INTRODUCTION

In Plato's famous allegory of the cave chained prisoners only see shadows of things projected on the wall they are forced to look at. As one of their fellows is freed from the cave, he comes to see reality and returns to inform about what he experienced. Nobody believes his report. Plato's idealism stems from the presupposition that there are pure ideas apart from humanity (the cave) which only sees instances and appearances (shadows) of perfect shapes. The truth is judged according to perceptions and conceptions matching or corresponding to a perfect idea (*eidos*) which may never be attainable.

With the advent of modern science in the Sixteenth and Seventeenth century correspondence started to bear fruits again. Descartes was the first who assured himself of what things really are by claiming *cogito ergo sum* (I think, therefore I am) [1]. He pulled Plato's ideas to his cognitive faculty and made thinking and reasoning the ultimate means for determining being of the self[1]. His thoughts eluded doubt and became the subject-pole (*res cogitans*) as opposed to objects in the external world (*res extensa*). Correspondence was redefined as the relation between propositions uttered by the thinking ego and properties of things out there in the external world. The truth of the *res extensa* depended on its matching the *res cogitans*. Modern dualism was born.

With the rise of commercial information technology and the Internet in the second half of the last century dualism has been a fruitful engine for business innovation and economic prosperity. The template for digital information processing is social phenomena in the analog world.

Communication, coordination, cooperation and competition are metaphors employed for building information systems. Calculating machines, digital storages, and information highways facilitate and support human activities from the viewpoint of input-output relations and state transitions. Information is coded, transformed, stored, and transmitted at high speed over large distances. Symbol representation and manipulation are at the heart of computation and information exchange exercised by digital machines and human minds. Typical artifacts are algorithms and data structures. Brain-like sub-symbolic networks are trained to represent and simulate symbolic information and problem-solving abilities at a higher human-like level of reasoning. A huge amount of tools and services emerged to support social activities like manufacturing, information search, or relationship management. Such informational artifacts have become pervasive and ubiquitous and alter entrenched norms of social activities at an increasing level of speed and sophistication. Their utility and usability can be determined anthropologically. The way they are developed and used within a given cultural context partly determines their significance. With the advent of commercial online social networks in the late 1990s managing contacts was a major utility. Today, they serve millions of businesses to advertise their products and services. Essentially, informational artifacts are instrumental. Their inner-causality serves humanity as means to an end. Both human causation and inner-causal-functioning follow design principles: purposive ideas described in (in-) formal terms for the sake of computational and material instantiation and support.

Engineering as problem-solving reduces technology to a means; technology is instrumental. In contrast, science is dedicated to find out about what nature and technology is—its essence (*Wesen*)—including the essence of utility and problem-solving. The essence of technology is neither simply anthropological nor merely instrumental [5, 6]. The essence of something is its enduring as presence[2]. It is temporal and goes beyond meaning in the sense of a correspondence between an idea or formal description and its material instantiation and computational enactment. Engineering builds upon science and science makes use of technological artifacts. Science wants to know what things really are. It wants to know essences as that what remains through time what it is.

From a foundational and scientific point of view it is reasonable to question instrumental conceptions of information technology. However, nothing is gained if we play off utility against foundation. Both applied research and basic science are legitimate. In the history of science the latter was often a precursor of the former. Who expected that after the discovery of the quantum in 1900 transistors and micro-electronics would enable mobile access to global and personalized services as we find them today?

In the early Twenty-first century we stand at the brink of a fourth industrial revolution [9]. After mechanical production with power from steam and water in the late Eighteenth century, electricity and mass production a 100 years later, and production automation through information technology in the second half of last century, today, cyber-physical systems such as augmented reality appliances, Industry 4.0, autonomous cars, and the Internet of Things mark the cornerstone of a next revolution. Interpreting data truthfully is a key competence in this context. They call it the cognitive era. When it comes to explain how the cognitive and the embodied, the mechanical and the enlivened, humans and machines, actually correlate and interact with each other interdisciplinary approaches involving disciplines such as engineering and philosophy appear as first-class candidates to clarify the very nature of what it means to make sense of the world both from an applied and foundational point of view.

However, up to this day we still lack a sound and coherent understanding of what it means to be a conscious, autonomous, freedom-loving, situated and culturally-embedded individual. There are many debates about whether a computing machine one day will be able to turn into a conscious being like a human [10]. Of course, this depends on our definition of consciousness. For a panpsychist even a dead stone or a river is somehow enlivened. Another extreme demarcates certain pathological observations of people having lost control of their autonomy. Is it possible for a human to turn into a deterministic machine totally controlled from outside? These and many other questions will increasingly pop up the more we advance and extend our industry and culture with information technology.

What is information? Many answers to this question are spatial. They refer to a location. For instance, a dialectic approach may distinguish information from matter and energy and locate it in the human mind or a storage device such as the front page of a newspaper or the magnetic tape of a hard disk drive. But even for matter and energy it is far from clear and settled if and where they are located. Think of non-local correlations in quantum physics. For two classically correlated observables usually a change of property A (e.g., acceleration) causes property B (e.g., position) to change[3]. The time it takes for A to have

[1] Descartes' ontological mind-matter dualism stems from his understanding of God as *ens perfectissimum*. This being is substantial, i.e., self-sustaining; it needs nothing else than itself. He took this understanding of being as substance and applied it to thinking and the world, i.e., *ens creatum*. There is an infinite difference between the creator and its creations; however, human beings are as self-sustaining as their creator. More precisely, the *res cogitans* (ego) and the *res extensa* (world) are substances. Ego and world are ontological in the sense of substantial. Like Kant at a later point in time he acknowledged that these self-sustaining things are not knowable how they are in-themselves. Therefore, value predicaments are necessary. However, he like the scholastics and the ancient Greeks presupposed substances as self-sustaining things nevertheless. Heidegger was the first who questioned this presupposition of being as substance and came up with a new ontology (I call it Twenty-first century ontology [2] because it will be our current millennium and century that Heidegger's ontology will be understood properly) for which the essence of being is not infinite like God or finite like ego and world. The essence of being is temporality. Temporality temporalizing itself is not self-sustaining though remaining and resting-in-itself. There is no infinite difference between temporality and human beings like Descartes' ontology presupposed. If you want God is through and with us. See §20 (The Fundaments of the Ontological Definition of the "World") in Heidegger [3, 4].

[2] Gumbrecht [7] uses the term presence to signify effects fusing with meaning. Noë [8] refers to presence in the context of sensor-motor activity. Both ground the intellect in the physical and socio-cultural world, the place where essences are to be found [2].

[3] This is not to say that A is necessary and sufficient for B to change.

an effect on B is constrained by the speed of light. A and B are spatially localized whereas a change of A exerts a force leading to a change of B. Non-local correlations between observables (e.g., spin of photons) are faster than light and thus instantaneous. A and B change at two (even far distant) places at the same time without a local force between them. In other words, A and B are at two spatially separated locations simultaneously. Their relation is acausal.

Again what is information? Some scientists claim information is matter and energy. All information about matter and energy is encoded in their respective wave function. But where is the wave function of my information about the latest stock market news? In my head or in the weekly magazine I read to gather information about the stock exchange? If information is non-local the relevant news about the shareholder value of a particular company may be distributed among both physical devices, my brain and the magazine, and thus it may be localized at two places simultaneously.

Besides the many problems a reductive view on information raises, it is hard to deny the experience of information being something extra-physical. It resides over, above or beyond the material. The development of information technology starts with an abstract idea—let's say a diagram of the main classes and their relationships of an object-oriented software application to be developed—and ends with the implementation of a prototype ready to run and be presented at the customer's in-house hardware infrastructure. The software and its design are essentially separated from its implementation and hardware. But what about the users, how do they relate and interact with the software and its interfaces? While using a smart phone, can we clearly separate the device from its user? Do we transfer information from our minds into the database of a software application and vice versa? Is there a correspondence between information in the mind and information stored on a physical device? Is the essence of information a correspondence between thinking and the external world (*adaequatio intellectus et rei*)? What is the essence of information technology: software, hardware, interface design, or usability as experienced?

In this article I'll argue that the essence of information technology is temporality. Temporality is the time of acausality. Acausality is introduced by means of the mathematical apparatus of quantum mechanics (QM) [11] and takes into account the current state of what natural science revealed to be form and matter and how humans actually come to know what form and matter is.

The paper proceeds as follows. In the next section anthropology and instrumentalism demarcate the starting point for a discussion of information technology. Causality is revealed as a unity of four causes including an anthropological dimension which philosophy has taught for centuries [5, 6]. In Section 3 quantum concepts are presented in light of causality as a precise acausal means for revealing the essence of information technology. Section 4 argues that temporality is the time of acausality and temporalizes information technology ecstatically and horizontally [3, 4]. Finally, Section 5 concludes the paper.

2. ANTHROPOLOGY AND INSTRUMENTALISM

We use information technology in manifold ways. Take browsers as an example. Through browsers we access web pages, fill out forms, view statistics, retrieve search results, or leave traces. Our active engagement with browsers partly determines utility and results we get out of the web. With our decisions and actions, clicks and hand movements, we cause browsers to perform a variety of tasks serving our purposes. In antiquity thinkers already knew about causation and causality for which effects were partly determined by a performer (*causa efficiens*). The browser is a window through which we trigger calculations and visualizations. The results we retrieve are not fully determined by this triggering. A search algorithm implemented on a server we are connected with takes our queries as input, interprets our request, and processes results according to its causal-functioning. This causal-functioning is formally described by an engineer (*causa efficiens*) in terms of a counting and calculating procedure instructed to determine a ranked list of web pages most relevant to our query (*causa formalis*). However, a formal search procedure like the famous page-rank algorithm is not sufficient for the essence of searching the web. Its materialization and instantiation on a physical machine is required (*causa materialis*). Like the calculating human mind is indebted to its physical realization—body, arms, hands, fingers, pen, and paper—a search procedure is caused by its material correlate. Moreover, the instantiated and materialized algorithm follows certain rules and these rules were designed to guarantee an end (*telos*)—the search result—with respect to degrees of freedom (*causa finalis*). Also an end is a cause for which means were developed and implemented. Together, these four causes make up the essence of causality. Anthropologically, this essence encompasses the *causa efficiens* in terms of an engineer who designed and implemented browser and search algorithm and an end-user who formulates and puts queries in order to retrieve results. The former is the original performer who adopts the perspective of the latter. All four causes make up instrumentalism. Together with performers who trigger design, implementation and usage an instrumental and anthropological conception of information technology stands.

Philosophy has taught these four causes for centuries [5, 6]. It becomes clear that the essence of searching the web is neither a general idea or form (*eidos*) of a search algorithm and the data structures it operates upon formalized as means to an end. Nor is it its physical implementation and readiness to be used. Essentially, at the heart of instrumentalism causality is anthropological too with the performers (engineer and user) being an integral part of technology.

In antiquity *techne* was not simply a technological artifact like a browser or a search procedure. *Techne* was a way of revealing truth (*aletheia*). Revealing was more than a craft. It also meant knowing (*episteme*)—the working of the mind—and artistic work like poetry. Poetic work stems from *poiesis* and means revealing in the sense of bringing-forth or disclosing. The essence of technology is revealing as it shows itself in the world. This self-revealing encompasses but stands in sharp contrast to a correspondence theory of truth (*adaequatio intellectus*

et rei). Correspondence starts with a proposition—a linguistic expression—which is either true or false. Truth and falsity is decided by referring to an object which either fulfills the proposition or fails to do so. For instance, the proposition `Plato was a genius` refers to the philosopher Plato who either was a genius or not. Plato himself would have reduced this proposition to a form or general essence—the proposition as *eidos*—from which truth or falsity would have emanated. He would have reduced his uniqueness and situatedness to an abstract idea. In contrast *techne* as revealing and poetic production brings-forth possibilities for action and affordances to act as remaining and resting-in-themselves. Possibilities and affordances of material (*hyle*), form (*eidos*) and purpose (*telos*) reveal themselves into unconcealment (*aletheia*). This revealing bears a concealing (*letheia*), i.e., a revealing that hides itself, for instance by means of context-annihilating propositions or ideas. The key of *techne* as revealing is to re-contextualize the hidden or concealed toward the essence of technology. Quantum mechanics provides the acausal means to do so.

3. QUANTUM MECHANICS AND INFORMATION TECHNOLOGY

Quantum mechanics is increasingly applied to areas outside of physics [11]. This has made it possible to investigate quantum-like effects in domains such as computer science, economics, and psychology. Since the discovery of the quantum in the beginning of the last century, physics has raised questions far beyond what has been traditionally conceived as physical. Determinism, reductionism and physical realism are usually concepts in philosophy. With the advent of quantum theory they became entangled not only with physics but a lot of other disciplines and even popular science. Today, with the success and economic significance of information technology, a large number of disciplines related to information exist side by side. Many of them claim to be an applied science. Institutions offering information-related research and education may wish to clarify their subject matter with respect to current scientific progress and questions related to *techne*.

This section gives credit to the current state of what natural science revealed to be form and matter and it takes into account how humans actually come to know what form and matter is. It shows that there are physical forms or shapes for which there is no cause in the sense of causality discussed in the previous section. Acausality (technology) reveals the essence of physical forms (information). Acausality has its own time, a primordial time (temporality) that temporalizes itself.

What makes formalisms of quantum mechanics interesting is that they can't fully abstract from the material world. Pure mathematics is neither required to put its formal statements to empirical test[4]. Nor does it derive necessarily its formalisms from empirical data. Symbolic descriptions are supposed to stand on their own feet[5]. Their application to engineering and the natural and social sciences is of secondary importance. In quantum mechanics, however, the notion of wave function collapse or state reduction enforces empirical context. Phenomenological observation or measurement creates or constructs real states, which beforehand were indeterminate or didn't exist.

The so called quantum enigma [12]—also known as the measurement problem—is one of the outstanding mysteries in physics and the sciences as a whole. Last but not least, its explosiveness stems from the fact that causality breaks at the most fundamental level of objective, third-personal and context-free descriptions of nature. The way a human experimenter sets up a measurement device—a decision made by human consciousness—determines whether he will find matter and energy behaving like waves spread out and extended in space or discrete particles whose real existence is determined with the actual measurement performed. It appears that human decision making is inseparably connected with the perspective taken upon one or the other experimental setting and its outcomes. Last but not least, inseparability of mind and matter is reasonable since humans have a body and sensing organs built out of atoms and forces guiding them.

3.1. Inseparability and Acausality

A scientifically and philosophically informed means for revealing the essence of information technology does not simply take presuppositions about causality for granted. Therefore, a first step toward developing such a means is questioning if there are causes beyond *causa efficiens*, *causa formalis*, *causa materialis*, and *causa finalis*. In quantum mechanical systems there are inseparable states. Such states occur within combined systems composed of two or more individual systems. Inseparable states can't be reduced causally to states of individual systems. They seem to have no cause; they are acausal.

Mathematically, a combined system is described in multidimensional vector space. Vectors and linear operators in combined vector spaces represent states, properties, and measurements of systems [13]. For instance, suppose one operator represents two alternating decisions of a human (the anthropological part)—let's say observe a (`Plato was a genius`) or observe b (`Plato was not a genius`)—and another one (the instrumental part) represents outcome a (`Plato was a genius`) or outcome b (`Plato was not a genius`). These two operators interact in such a way that alternating decisions and alternating outcomes mix up, entangle, and evolve toward inseparable states. Such inseparable states of combined operators can't be factorized into the states of the individual systems they emerged from or were a part of all the way long.

$$AB_{General} = \begin{pmatrix} p & q \\ r & s \end{pmatrix} \otimes \begin{pmatrix} l & m \\ n & o \end{pmatrix} = \begin{pmatrix} pl & pm & ql & qm \\ pn & po & qn & qo \\ rl & rm & sl & sm \\ rn & ro & sn & so \end{pmatrix}$$

The 4-dimensional matrix above shows a combined operator representing decisions and decision outcomes in a general form.

[4]Ontologically, the empirical is first and foremost phenomenological.

[5]This does not deny the necessity of embodied cognitive skills. If symbolic representation and manipulation are agnostic toward syntax, i.e., physical form or shape, it is bad phenomenology.

For instance, if A is represented as an operator in 2-dimensional vector space with two decisions a = (1, 0) and b = (0, 1) and B is represented as an operator in 2-dimensional vector space with two decision outcomes a = (1, 0) and b = (0, 1), then the following 4-dimensional operator represents the state of a combined system that is separable.

$$AB_{Separable} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \otimes \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

However, the combined state space of decisions A and outcome alternatives B ($AB_{General}$) embraces states which are not separable into the operators of the individual spaces. Take the following example:

$$AB_{Inseparable} = \begin{pmatrix} ? \end{pmatrix} \otimes \begin{pmatrix} ? \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix}$$

$pl = 1$ and $so = -1$ and $po = 0$ and $sl = 0$. If $pl = 1$, then $p \neq 0$. If $po = 0$ and $p \neq 0$, then $o = 0$. But $so = -1$ and therefore $o \neq 0$. It is no surprise that some states in AB are inseparable with regard to A and B. This is a purely structural consideration. It accounts for the fact that there are (higher) combined states and properties which are not reducible to (lower) individual states and properties. $AB_{Inseparable}$ is causally not reducible to operators of the individual systems as it is the case for $AB_{Separable}$. Using the words of a correspondence theorist, the separation between the proposition that Plato was either a genius or not (A) and its verification or falsification by referring to Plato as a putative genius (B) is not tenable anymore.

So far, from a dynamic point of view, there is nothing said about how such an inseparable state came up in the first place. How did A and B interact over time in order to end up in $AB_{Inseparable}$? Perhaps $AB_{Inseparable}$ is presupposed all the way long? In several previous contributions it was argued that inseparability is an indicator for phenomena where presuppositions are at work [2, 14–17]. We are always already situated in the world and many skills are not propositional in nature. For instance, we notice that it is raining not by formulating a proposition and verifying this proposition by observation. When we are walking on the street, the sky is cloudy, the air is wet, and our skin is sensing water drops, we understand that it is raining. Phenomenologically there is no experience of—and therefore no empirical evidence for—a matchmaking (*adaequatio*) between an intellectual understanding of what it is like to walk in the rain (*intellectus*) and the ontic fact that it is raining outside (*rei*). Nevertheless, in many situations we separate an idea or proposition from its referential object. This ontic perspective facilitates a separation between cause and effect. However, it is not primordial.

It turns out that $AB_{Separable}$ is an ontic case of $AB_{Inseparable}$. The former requires an attitude to describe things, in this case decisions and decision outcomes, as existing independent of observation. Here *techne* is a revealing that hides itself. A leveling down or crossing over (*letheia*) annihilates context and reveals propositions or ideas and their referential objects stripped off their situatedness in the world. This is the positivist viewpoint in epistemology and realism in ontology both of which are ontic views in a presence culture [2]. A presence culture acknowledges that decisions are always already situated within decision situations; they are always already connected with potential outcomes determined with the actual decision made. In order to acknowledge causality and thus things in sequential time, i.e., cause and effect as separate entities, the ontic viewpoint separates or disentangles inseparable states if certain structural aspects hold. In the next subsection it will be demonstrated that these structural aspects bind together exponents of exponential functions to describe things as separate entities and things in sequential time. Here there are no absolute zero points and no derivatives with respect to time. The only derivative is temporality itself where things appear as being open to others and even to everyone else.

3.2. Acausality in Time

In a presence culture things are given as available or ready-to-hand within a horizon [2]. Things are open and accessible to others and even to everyone else [15]. They don't stand in isolated opposition like the proposition about Plato stands over and against the historical person Plato, or a glass of wine stands in direct opposition to a bottle on its right hand side. A piece of paper and the symbols written on it are real in the sense of being open to be read by any other reader. While reading letters, words and sentences on the paper, however, the meaning of a text shows up as an unbroken reading experience. Therefore, it doesn't show up as independent of me reading them, but as meaningful in alignment with my background knowledge. The meaning of the text is present within a chronotope spanning across the gap or separation between me—the reader—and the symbols on the paper. I do not count time steps while enjoying a poem. Reading and grasping a poem come with their rhythm and tone, perhaps even their smell. But temporality is not structured like a causal chain of arguments where a premise is clearly antecedent to a conclusion. Time is not spatially located on a horizontal line with points indicating what was before and what will be after. Temporality embraces sequential time separated into discrete steps or continuous events. However, it will be shown that this is a special case.

A continuous time line can be read from the exponential function[6]. It describes growth and decay in space without absolute zero points. Its derivative is the function itself. There is no absolute beginning and no absolute end. The exponential function is transcendental in the sense of inexhaustible (Euler's number is an inexhaustible number). There is no absolute benchmark for discrete time steps and therefore there is no absolute causal relation where an antecedent event causes a subordinate event. Time is acausal, or better, the time of

[6]From a temporal point of view, the dynamics of combined quantum systems are prescribed by evolution equations, which, in their general form, consist of exponentiations [13].

acausality is temporality. Temporality temporalizes or befalls itself (cf. Section 4).

Acausality spans or broadens the present. Presence is broadening [7]. In a presence culture the future is increasingly inaccessible and the past increasingly difficult to let behind. In a meaning culture[7] going far back in time is equally transcendental and inaccessible as future predictions. The very far past and the far future remain highly speculative, difficult to reproduce, and impossible to anticipate. Therefore, they are not definite or determinate. One way to cope with this uncertainty is to admit that the past and the future are simply inexhaustible or infinite[8]. Transcendentalism embraces uncertainty and openness to interpretation. It eludes certainty. Causality gives certainty. However, it is a special case; an ontic viewpoint that establishes a clear antecedent event and a clear subordinate event, i.e., sequential time. It modifies primordial time (temporality) when exponents *P*, *S*, *Q*, and *R* relate to each other in such a way that inseparable states of combined spaces evolve toward separability as the result of a forgetting, leveling down, or crossing over (*letheia*).

$$AB^{InTime}_{Separable} = \begin{pmatrix} e^{Pt} & 0 \\ 0 & e^{Qt} \end{pmatrix} \otimes \begin{pmatrix} e^{Rt} & 0 \\ 0 & e^{St} \end{pmatrix} = \begin{pmatrix} e^{(P+R)t} & 0 & 0 & 0 \\ 0 & e^{(P+S)t} & 0 & 0 \\ 0 & 0 & e^{(Q+R)t} & 0 \\ 0 & 0 & 0 & e^{(Q+S)t} \end{pmatrix}$$

AB^{InTime} is separable if $W + Z = X + Y$ at each instant of time where $W = e^{(P+R)t}$, $X = e^{(P+S)t}$, $Y = e^{(Q+R)t}$, and $Z = e^{(Q+S)t}$. That $W + Z = X + Y$ must not hold in general and is rather a special ontic case.

$$AB^{InTime}_{Inseparable} = (?) \otimes (?) = \begin{pmatrix} e^{(P+R)t} & 0 & 0 & 0 \\ 0 & e^{(P+S)t} & 0 & 0 \\ 0 & 0 & e^{(Q+R)t} & 0 \\ 0 & 0 & 0 & e^{(Q+S)t} \end{pmatrix}$$

AB^{InTime} is inseparable if $W + Z \neq X + Y$ at each instant of time where $W = e^{(P+R)t}$, $X = e^{(P+S)t}$, $Y = e^{(Q+R)t}$, and $Z = e^{(Q+S)t}$. $AB^{In\ Time}_{Inseparable}$ is primordial. Up to this date, ontological emergence of mental causation from material causal laws has been witnessed nowhere [18]. There are no ontological causes leading from $AB^{InTime}_{Separable}$ to $AB^{In\ Time}_{Inseparable}$. Therefore, it is reasonable to assume that the former is a special ontic case of the latter. If structural aspects hold together exponents distributed among both individual spaces at each instant of time, a leveling down or crossing over (*letheia*) of primordial time (temporality) separates A and B and provides the condition of the possibility for experiencing vulgar time[9] as a succession of present moments (cf. Section 4). However, in primordial time subjective decision (A) and objective outcome (B) are always already combined. Instead of being an aggregate or a unity over time, A and B are combined acausally and thus equiprimordially. The dynamic viewpoint of A and B provides a higher degree of inseparability and therefore a stronger evidence for acausality as each component of A refers to a component of B at each single moment simultaneously and thus equiprimordially [13].

At this point, an acausal means for revealing the essence of information technology stands. $AB^{InTime}_{Inseparable}$ adds to the essence of causality as presented in Section 2. *Causa formalis* and *causa materialis* are too sides of the same coin. The formal representation of an inseparable evolution is not supreme. Quantum concepts can't fully abstract from *causa materialis*. Vice versa, body, matter and syntax alone are not sufficient for causing form or even the essence of information technology. Performer is the information engineer. He or she is the anthropological component and *causa efficiens* as part of an acausal means for revealing the essence of information technology. Eventually, *causa finalis* is the essence itself. It brings itself into unconcealment by resting and remaining-in-itself. This *telos* is not simply an end but an end-in-itself. It is neither subjective (a preference, desire, or value) nor objective (a common good or value) in the sense of opposed to a subject. It comes into being out of temporality. Temporality will be discussed in the next section in more detail. So far it was introduced as the time of acausality.

Acausality is associated with synchronicity, a term introduced by Jung and Pauli who searched for correlated events with no causal link [19]. In physics such events are known under the label of entanglement and activation at a distance. In the life and psychological sciences, there are phenomena like social mirroring or contagious yawning offering an acausal interpretation [15]. They can't be proved or disproved by means of statistical methods. Statistics may kill acausal events. Synchronistic events or acausal means require a non-willing or releasement [2], whereas correspondence tests enforce separability, a leveling down or crossing over (*letheia*) of primordial time (temporality).

The next section introduces temporality as the time of acausality and the essence of information technology. Primordial time is neither a subjective stream of present moments in the observer's mind nor is it an objective though relative flow of events in the external world. Temporality temporalizes ecstatically and horizontally [3, 4]. Temporality is not a concept or a category. It is not epistemological. As an existential and thus more comprehensive and fundamental than a concept or category temporality is ontological; it does not simply have ontic properties. Rather it exhibits general essences. Datability, significance, spannedness, and openness are general essences of equiprimordial time (temporality).

4. TEMPORALITY AND INFORMATION

Science has a natural inclination to strive from epistemology to ontology. It does not only want to know how we as scientists, consumers, citizens, etc. come to know; it wants to know how things really are. A statement as simple as "it is gold" is

[7] In a meaning culture the meaning of concepts (e.g., privacy) stands for or represents something (e.g., a right). Meaning is attributed, predicaments are made. In contrast a presence culture takes linguistic expressions as a medium that overcomes the separation between subject and object, mind and matter, physics and metaphysics.

[8] Primordial time (temporality) is finite and the boundary, end or frontier of this finiteness is authentic future or indeterminacy (cf. Section 4.1).

[9] The term "vulgar" is not meant to be a value judgment.

ontological. Being is at stake. Epistemology is concerned with the ways we come to know that "it is gold," e.g., by way of understanding how sensory stimulation from golden surface material changes as a function of movement. Cognition is at stake.

In the introduction (cf. Section 1) information technology was introduced in terms of causality. In the previous section it was argued that besides traditional causes (instrumentalism and anthropology) acausality adds to the essence of information technology. Our implicit understanding of information is often purely instrumental. We are less interested in what information thematically is—its essence—and more concerned about its utility. Information is for processing, education, entertainment, notification, reporting, etc. Semiotics agrees with such an instrumental view. There is a pragmatic aspect to information besides syntax and semantics. Syntax is simply the physical form of information. Think of the linear operators in Section 3.1 with components 1 and 0. On a semantic level operators and their components have a meaning. Operators represent two alternating decisions or observations: `Plato was a genius` (1, 0) or `Plato was not a genius` (0, 1) and two alternating outcomes: `Plato was a genius` (1, 0) or `Plato was not a genius` (0, 1). This information turns pragmatic once it is used to explain acausality.

However, there is more to information than its meaningfulness and usefulness. Meaning attributions are arbitrary. Conventionalized meaning, however, often conceals arbitrariness. Attributing a trait of Plato's intellect to 1 and 0 is arbitrary. Certainly genius is not reducible to bits. Acausality reveals this non-reducible character of traits and information in general. In many situations of circumspect taking care and skillful coping we do not attribute meaning and usefulness to physical forms. Rather meaning and usefulness are made present [2]. Information encountered shows itself as what it is in a meaningful and pragmatic way. Semantics and pragmatics are not something extra to syntax. They are to be found and made present within the physical form itself. Unless a conspicuous encounter with information makes me wonder what it really means—for instance, I may find Chinese letters underneath a painting without the slightest understanding of Chinese language—I do not start grappling with meaning and pragmatics in an explicit and thematic way.

In summary, the essence of information technology is far more than a (causal) processing of information on different layers of abstraction (syntax, semantics, and pragmatics). Information is temporal. Temporality is the time of acausality. This time is not chronological. Causality requires chronological time. Cause and effect are separate entities in time. Effect comes after cause and, vice versa, cause is prior to effect. Chronological time and causality derive from temporality. They are released by an awaiting that retains.

4.1. Making Present, Awaiting, and Retaining

What makes QM particularly apt for modeling and understanding decision making and other cognitive phenomena is indeterminacy[10]. In contrast to classical uncertainty, indeterminacy in QM does not presuppose a particle—its properties like angular momentum or position—to be pre-determined though not yet known. Like in the Plato example in Section 3.1 states and properties represented as vectors or linear operators may be superposed. Before a decision is made about Plato's intellect two even mutually exclusive options constitute one state of potentiality[11]. In quantum physics properties like position may be superposed and have contradicting values or values violating the law of total probability. A wave function is distributed or spread out though the particle it represents can only exist at one discrete position. The probability that a particle exists at one particular position A and not at another position B may not add up to the total probability of 1. It looks like that in a wave scenario a particle can be at several positions simultaneously. Unless a measurement determines position with the measurement made it is undetermined. Grasping this outmost uncertainty is at the heart of temporality.

Temporality temporalizes out of an authentic future. Authentic future is not something outstanding. It is not something missing or lacking. There are no information deficits in primordial time. For instance, if I want to buy a new car and my savings already cover 3/4 of the full price, then 1/4 is still outstanding and expected to add to my savings within the coming months. My expectation of the remaining amount of money to be saved is always already in foresight of the full price for the car to be saved. Future savings are outstanding. Indeterminacy and authentic future, however, are not outstanding because uncertainty (position of a particle, Plato's genius, etc.) is not epistemological (due to a lack of knowledge) but ontological. In the car savings case uncertainty is epistemological. I do not yet know if the remaining amount will add up to my savings within the coming months. However, I do know what the remaining amount is: 1/4 of the full price. The full price is pre-determined and my uncertainty is relative to it.

Authentic future is not chronological. But future chronologically conceived is founded in indeterminacy or authentic future. Savings of 3/4 of the full price of a car is prior to savings of the full price I will or will not have in my account in the future. For indeterminacy or authentic future there is no full price. It is not the case that a full price is not known. It doesn't exist. Indeterminacy is an end or a future that is not outstanding. It is always already given though most of time hidden, concealed, or forgotten[12]. Being-toward-indeterminacy is presupposed but leveled down or crossed over when time is experienced as a succession of present moments. Such a flow of events or stream of experience finds its formal expression in separable entities or $AB^{In\ Time}_{Separable}$ (cf. Section 3.1), a requirement for chronological

[10] cf. Flender and Müller [16] for an application of QM to privacy decision making.

[11] If Plato really was a genius or not, is, of course, a matter of debate. It is not pre-determined. Therefore, such historical examples lend themselves for illustrations of effects as found in QM.

[12] For Heidegger this outmost uncertainty is death or being-toward-the-end [3, 4]. He acknowledges that a common understanding of death is demise. I prefer not to use the term death as a synonym for indeterminacy. The reason is that the common or vulgar connotation of death as demise is most difficult to shake off, a requirement for its transformation into authentic future.

being. However, $AB^{In\ Time}_{Inseparable}$ is primordial. Temporalized components refer to each other instantaneously, simultaneously, or equiprimordially. Primordial time (temporality) is finite and the boundary, end or frontier of this finiteness is indeterminacy. Having-been, presence and authentic future are equiprimordial in temporality. The present is released in an awaiting that retains. Once W, X, Y, Z relate to each other ($W + Z = X + Y$) equiprimordiality is modified in such a way that a succession of present moments arises. The immediate future is constantly anticipated and the immediate past is constantly slipping away. A condition of the possibility for transcendentalism, inexhaustibility or infinity is that the equiprimordial awaiting that retains is annihilated or de-contextualized. The making present of "now and now and now" is predominant; the awaiting that retains fades into the background. A constant making present is released without conceiving its origin in an awaiting (authentic future) that retains (having-been). A stream of present moments conceals horizontal ecstasies (awaiting, retaining, and making present) of temporality. This concealment (*letheia*) constitutes the *modus operandi* of everydayness.

As scientists, managers, consumers, citizens, etc. we are always already in-the-world. This "always already" refers to presuppositions which are not necessarily resolute, grasped or conceived but leveled down or crossed over due to one's being within a common factual world. In everyday taking care—our business as usual as scientists, managers, consumers, citizens, etc.—we observe, manage, consume and participate as "one" does it. The time of the "one" is a making present that forgets. It forgets an awaiting that retains as the condition of the possibility for its release. A good example is taking care of time itself as one coordinates one's behavior with other people.

Suppose you have booked a 1 week meditation retreat together with a friend. In the evening of the first day of your stay you make an appointment for the next day. You agree with your friend on having a first meditative exercise at sunrise. Both of you and possibly most of the population on earth know what a sunrise is. In our shared and common world the sun as a natural clock is always already discovered. Before sundials as well as mechanized, electrified and digitized clockwork were invented, the sun was a thing encountered at hand ready to be used. In *circumspect* taking care it was used as a natural pointer to sunrise, noon and sunset according to which everyday activities were coordinated. The next morning you and your friend wake up at sunrise. Both of you look into the sky and you see the sun at the horizon. "Now it is time to have a meditative exercise" is what both of you understand and share publicly in measuring time with the oldest clock on earth, the sun. Usually and most of the time we take care of things and time itself as "one" does it. Implicitly and unthematically we understand what time it is and what we have to do. Although primordial time is leveled down or crossed over we understand temporality temporalizing itself ecstatically and horizontally. With every "now, that it is time to have a meditative exercise" (sunrise), an "on that former occasion" (earlier when the sun rose, yesterday, the days before, etc.) and a "then, when the sun will have reached its peak or will set" (later on at noon or sunset) are presupposed and equiprimordially understood though not explicitly articulated.

Saying "now it is time to have a meditative exercise" is a discoursing articulation of a making present that temporalizes itself in unity with an awaiting that retains [3, 4]. In measuring time, the sun gets made public in such a way that it is encountered for you, your friend and perhaps other practitioners joining you as "now" and not later, earlier, tomorrow, or yesterday. Time is a stream of present moments. Chronology, whether discrete or continuous, requires a sense of what was before and what will be after. The "now it is time to have a meditative exercise" is a present moment within a flow of time, an inner duration or a continuous time experience whereby the equipromordial making present of an awaiting that retains is leveled down, crossed over, or forgotten. This vulgar understanding of time levels down or forgets the having-been and the awaiting and just reveals at sunrise "now it is time to have a meditative exercise."

4.2. Essences of Temporalized Information

Temporality is not a concept or a category. It is not ontic. As an existential and thus more comprehensive and fundamental than a concept or category temporality is ontological; it does not simply have ontic properties. Rather it exhibits general essences[13].

4.2.1. Datability

Datability is a general essence of equiprimordial time (temporality). In taking care of time itself (time measurement) every making present or saying "now" is accompanied by a "then, when" and "on that former occasion, when." Every ontic statement like "it is gold" implies a "now, it is gold" and, equiprimordially, an awaiting ("then, it will still be gold") and a retaining ("on that former occasion, it already was gold"). An athlete who is always already in the flow of what he is doing (e.g., the running, jumping, or dribbling of a basketball player) is making present by awaitingly retaining. In taking care of the game he is within time as a succession of an immediate past (the not-anymore), the present now, and an immediate future (the not-yet). However, this flow is derivative or vulgar if datability is hidden, concealed, crossed over, or leveled down. *"If circumspect taking care were simply a succession of experiences occurring in time, and even if these experiences were associated with each other as intimately as possible, letting a conspicuous, unusable tool be encountered would be ontologically impossible"* [3, 4].

4.2.2. Significance

Time is likewise derivative or vulgar if significance is nullified. In average everydayness, if I wake up in the morning and have an appointment at sunrise, I do not ponder or reason why I have this appointment, what it is good for, or for the sake of which desire or preference I made it. I just have it. Like datability significance is crossed over or leveled down in *circumspect* taking care of a situation. In primordial time, however, temporality temporalizes "in-order-to" take care of a situation. Its significance tells that it is time for what shows itself or is given, which may either be appropriate or inappropriate. For instance, it is appropriate to catch up with my friend for having our first meditative exercise and it is inappropriate to go back to bed and have a couple of hours extra sleep. For a basketball player it is appropriate

[13] An apt German word for general essences is "Wesensmomente".

to take a three-point shot when it's time for taking the lead, or, it's inappropriate, when there is a bad defense in the zone depending on the situation and his circumspect taking care of it.

4.2.3. Spannedness

Temporality broadens the presence. Authentic making present is broadening[14] [21, 22]. Temporal ecstasies broaden the presence in the sense that they span across future, past, and present. Making present, awaiting and retaining are equiprimordial ecstasies. The present is released from an awaiting that retains. This horizontal spannedness of future, past and present has its primary moment in an anticipation of indeterminacy (authentic future). Through temporality temporalizing itself ecstatically and horizontally out of authentic future information comes into existence. The meaning or significance of information in general is temporality. To say that information is this or that is to let-it-come-toward-itself (awaiting), let-it-be-as-it-already-was (retaining), and let-it-be-encountered-as-it-is (making present). To say that information "is" admits the existence of information. Existence means being-ahead-of-itself. Being-ahead-of-itself temporalizes out of authentic future. Indeterminacy shines into what it is not: information. This spanning or broadening of temporal ecstasies finds it formal expression in $AB^{In\ Time}_{Inseparable}$ (cf. Section 3.1). Here temporalized components refer to each other instantaneously, simultaneously, or equiprimordially. Past, present and future are equiprimordial as long as W, X, Y, Z do not relate to each other ($\mathrm{W} + \mathrm{Z} \neq \mathrm{X} + \mathrm{Y}$).

4.2.4. Openness

Last but not least, primordial time is open to others and even to everyone else. It is public or shared. Openness is a condition of the possibility for coordinating our behavior with others. Like things and others encountered in circumspect taking care and scientific investigation we are always already together with others no matter if they are physically present or not. Time shows itself as open or public and thus it is shared like things and others encountered in everyday taking care. Being together with things and others encountered is always already being-in-time. For instance, we share an astronomical calendar and use it for coordinating our behaviors, from the planning of our careers to weekly meetings. Perhaps in the natural sciences and historiography such shared and agreed upon conceptions of time are shaken more than in any other realm of human life. Temporality is prior to any specialized discipline and prior to any distinction. It is the condition of the possibility for information to come into being out of indeterminacy (authentic future) by temporalizing itself. It is the time of acausality, a *techne* for revealing the essence of information as that what remains and rests-in-itself.

[14]Heidegger calls this making present "Moment" (*Augenblick*). See §65 (Temporality as the Ontological Meaning of Care) in [3, 4]. I prefer speaking of broadening because it captures the other ecstasies (awaiting and retaining) more elegantly.

5. CONCLUSION

In his 1946 foreword of Brave New World, in retrospective, Aldous Huxley speculates about how he would have had rewritten his dystopian novel 15 years earlier [22]. He reasons about a third alternative between an insane life in Utopia where genetic engineering, brainwashing and recreational use of drugs produce happy consumers who appear to be plugged into a universal happiness machine and a lunatic world of primitive people who resisted any economic and technological progress.

"Religion would be the conscious and intelligent pursuit of man's Final End, the unitive knowledge of the immanent Tao or Logos, the transcendent Godhead or Brahman. And the prevailing philosophy of life would be a kind of High Utilitarianism, in which the Greatest Happiness principle would be secondary to the Final End principle—the first question to be asked and assured in every contingency of life being: 'How will this thought or action contribute to, or interfere with, the achievement, by me and the greatest possible number of other individuals, of man's final end?'"

Huxley's dream of a society composed of freely co-operating individuals devoted to the pursuit of sanity has a Final End, a *causa finalis*, in mind. Today, 70 years after he wrote his foreword, science may be in a position to enter the middle way, a third alternative between naive technological enthusiasm and nostalgic, ultra-conservative, or even total rejection of progress. Perhaps it is an irony of fate that science—the prestigious and success-laden project of modernity and representative of an enlightened, reasonable and secularized world—offers reconciliation with the spiritual, enchanted, and numinous.

For a long time the presupposition of knowledge being freed from value has been responsible for scientific progress. Objective, third-personal, and context-free knowledge—the fruit of science—is rid of subjective ends, motives, desires, interests, and feelings, all of which can be subsumed as being valuable. Value-free knowledge, however, is a fallacy. There is no science without presuppositions. There is only science whose foundations so far have remained unexamined. This is not to deny that even a traditional (meta-) discipline like philosophy presupposes conditions upon which its interpretations rest. However, it makes a difference whether presuppositions are simply taken for granted or if they are well-founded by means of reasonable arguments and phenomenological evidence.

Arguments and evidence employed in this contribution draw from QM [11]. QM offers unequaled opportunities because it raises foundational questions in a precise form. So far, applying QM to phenomena and problems outside of physics has been highly successful and, last but not least, its explanatory power for concepts (i.e., existentials to be precise) as general and specific as information and temporality has been substantiated in this article. There is growing evidence that effects and laws of QM also hold for macroscopic phenomena. However, far more revolutionary is the fact that applying QM to cognition is not equivalent but the same as altering and refining the cognitive apparatus of the scientist as an acausal measuring instrument.

Now we live in an age with unprecedented possibilities for extending our capacities and abilities to reveal. Information technology and the Internet are extensions. They challenge us and we challenge them. For a long time we thought about technological apparatus being something purely instrumental, i.e., causality as traditionally conceived (cf. Section 2). Galilei was the first who employed an apparatus—a telescope—to verify a scientific hypothesis. He wanted to observe and verify if earth is indeed orbiting the sun. Today, our apparatus still extends into the material world but acausality and temporality as developed in this article challenge us to become part of observation.

In this article I tried to be as objective and value-free as possible. The method of doing so may appear unconventional. Questioning the very nature of causes, means, ends and values—the presumptive opposition of subjectivity and objectivity—seems like a deconstruction. Perhaps it is a deconstruction with the supposition of a value-free connotation—a branch of consciousness studies—which bears the potential to bring science and technology forward and guide us through the cognitive era that just started.

Investigating the relationship of first-person experience and third-person facts has been at the center of consciousness studies for quite a while. Unfortunately, we are still in the dark when it comes to give causally necessary and sufficient conditions for consciousness to arise. We are able to package reasons and causal chains of arguments into narratives explaining how causality, means, ends and values may have evolved. However, explanations after the fact still lack causally necessary and sufficient conditions as desired for a full-blown materialist theory of consciousness. For instance, retinal cells and the visual cortex may be necessary for seeing shape and color. However, they will never be sufficient for explaining visual consciousness. Repeatable and reproducible observations of a particular constellation of firing cells in the visual cortex prior to or "simultaneous with" a visual experience of a particular object is not sufficient evidence for visual consciousness of that particular object (*post hoc ergo propter hoc*). Non-materialist accounts are equally problematic as nobody can convincingly deny having a body and living in a material world.

Abstaining from causal material explanations leaves at least two other options for making sense of consciousness [23]. First, including one or many intentional beings into narratives is subject of various religious traditions, in particular monotheism, e.g., the Judeo-Christian tradition, or polytheism of antiquity. Second, there are (pantheist) approaches neither claiming mechanistic laws and necessity underlying consciousness nor referring to a higher being or eternal creator as the missing link to the mystery.

A vision like Huxley's third alternative supposes a final end: a deity or end-in-itself. Such an approach abandons value-free explanations in the traditional sense. It acknowledges individualism and relativities of preferences, ends, and values. However, relativities are not merely subjective as opposed to objective. They are objective in the sense of information and temporality as developed in this contribution.

AUTHOR CONTRIBUTIONS

The author confirms being the contributor of this work who wrote and conducted what is laid-out and approved it for publication.

ACKNOWLEDGMENTS

For their support the author would like to thank all individuals and institutions who know they made an essential contribution to the author.

REFERENCES

1. Descartes R. *Descartes: Meditations on First Philosophy: With Selections from the Objections and Replies*. Cambridge: Cambridge University Press (1996).
2. Flender C. Aesthetics as incentive: privacy in a presence culture. In: Atmanspacher H, editor. *Proceedings of 8th International Conference on Quantum Interaction 2014 (QI 2014), No. 8951 in LNCS*. Filzbach: Springer (2014). p. 165–176.
3. Heidegger M. *Sein und Zeit, 19th Edn*. Tübingen: Max Niemeyer (2006).
4. Heidegger M. *Being and Time*. Schmidt D, Stambaugh J, editors. Albany, NY: State University of New York Press (2010).
5. Heidegger M. *The Question Concerning Technology, and Other Essays*. New York, NY; London: Harper & Row (1977).
6. Heidegger M. *Die Technik und die Kehre, 13th Edn*. Stuttgart: Klett Cotta (2014).
7. Gumbrecht HU. *Production of Presence: What Meaning Cannot Convey*. Stanford: Stanford University Press (2004).
8. Noë A. *Varieties of Presence*. Cambridge; London: Harvard University Press (2012).
9. Schwab K. *The Fourth Industrial Revolution - What It Means and How to Respond, Anthology Series*. Tampa, FL: Foreign Affairs (2016).
10. Tononi G, Koch C. Consciousness: here, there but not everywhere. *Philos Trans R Soc Lond B Biol Sci.* (2015) **370**:1–17. doi: 10.1098/rstb.2014.0167
11. Khrennikov A. Quantum-like modeling of cognition. *Front Phys.* (2015) **3**:77. doi: 10.3389/fphy.2015.00077
12. Rosenblum B, Kuttner F. *Quantum Enigma: Physics Encounters Consciousness*. New York, NY: Oxford University Press (2011).
13. Kronz FM, Tiehen JT. Emergence and quantum mechanics. *Philos Sci.* (2002) **69**:324–47. doi: 10.1086/341056
14. Flender C, Kitto K, Bruza P. Beyond ontology in information systems. In: Bruza P, editor. *Proceedings of the 3rd Quantum Interaction Symposium, DFKI, No. 5494 in LNAI*. Saarbrücken: Springer (2009). p. 276–88.
15. Flender C, Kitto K, Bruza P. Nonseparability of shared intentionality. In: Bruza P, editor. *Proceedings of the 3rd Quantum Interaction Symposium, DFKI, No. 5494 in LNAI*. Saarbrücken: Springer (2009). p. 211–24.
16. Flender C, Müller G. Type indeterminacy in privacy decisions: the privacy paradox revisited. In: Busemeyer J, editor. *Proceedings of the 6th International Symposium on Quantum Interaction (QI 2012), No. 4620 in LNCS*. Paris: Springer (2012). p. 148–160.
17. Flender C. Quantum phenomenology and dynamic co-emergence. In: Song D, editor. *Proceedings of the 5th Quantum Interaction Symposium (QI 2011), No. 7052 in LNCS*. Aberdeen: Springer (2011). p. 205–210.
18. Bitbol M. Ontology, matter and emergence. *Phenomenol Cogn Sci.* (2007) **6**:293–307. doi: 10.1007/s11097-006-9041-z

19. Atmanspacher H, Primas H. *Recasting Reality - Wolfgang Pauli's Philosophical Ideas and Contemporary Science*. Berlin; Heidelberg: Springer (2009).
20. Gumbrecht HU. *Unsere breite Gegenwart*. Berlin: Suhrkamp (2010).
21. Gumbrecht HU. *Our Broad Present: Time and Contemporary Culture*. New York, NY: Columbia University Press (2014).
22. Huxley A. *Brave New World*. London: Vintage Classics (2004).
23. Nagel T. *Mind & Cosmos - Why the Materialist Neo-Darwinian Conception of Nature is Almost Certainly False*. New York, NY: Oxford University Press (2012).

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.