Transactional Process Ontology

with a Process Interpretation of the
Transactional Interpretation of Quantum Mechanics

home.swipnet.se/bo_herlin/pdf/tpo-ti.pdf

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Abstract

A certain process concept of time and matter – essentially based on the equivalence mass–energy, the quantization of energy, and on the experience of a "flowing" time – is presented and examined. The possibility to insert a hypothetical universal "surface of the present" in a spacetime description is reconsidered and exemplified by an "active spacetime" according to which time can be regarded as a process that generates a "past" of still existing standing waves. The visual method, used to this end, gives a perspective on how the first-person and third-person perspectives can be conceived as related to each other. The ontology (TPO) thus presented finds support in – and gives a new perspective to – John Cramer's Transactional Interpretation (1985, 2001) (TI) and it seems possible that it can contribute, in somewhat the same way as Whitehead's organic process philosophy (1925, 1928), to an extended naturalistic worldview with a more harmonious relationship between science and religion (e.g. making the transition *theism* ⟶ *panentheism* ⟶ *pantheism* easier, since a mysterious depth – not violating the natural laws – of the Universe is retained).

Finally, a Process Interpretation of TI based on an "active spacetime" is presented (pp. 17–27) – an interpretation which seems to solve a problem of the original TI, namely how to understand its "atemporal" transactions in "pseudo-time".

Included is a supplement on "a more democratic economic system", partly related to TPO, and an appendix containing the belief statement of the World Pantheist Movement, with a short comment and a personal statement.

> "*A clash of doctrines is not a disaster – it is an opportunity.*" (Whitehead 1925)
>
> "*There remains the final reflection, how shallow, puny, and imperfect are efforts to sound the depths in the nature of things. In philosophical discussion, the merest hint of dogmatic certainty as to finality of statement is an exhibition of folly.*" (Whitehead 1928)

More material and eventual updates may be found at http://home.swipnet.se/bo_herlin/time.html

For Gabriela Melinescu

TIME AND MATTER INTERPRETED[1] AS A PROPAGATING TRANSFORMATION OF ORIGINAL CHAOS INTO LIGHT

Before the beginning there was only *chaos*
a chaos of *waves upon waves without end, without time* …

Then some of these waves were *organized* into *rays*[2]
into *light* that was propagated in various directions.

At the *tip* of each ray *time advanced*
and at the *back of time* was *incipient life*
which multiplied the rays
to form ever more *branches*.

These branches *grew* in *coil-like forms*
and their *tips met*, forming the *space*
that *enclosed* their origin.

The space *expanded*
and was filled with chaos and *random*
encounters between the tips
many of which *repelled* one another.

But others *harmonised* and were united
and *stimulated life* to produce forces
that *gathered* the tips into suns and earth,
uniting some of them into plants and animals.

This *process of creation* forms a *tree of life*,
made up of *intertwining* rays
which *distances the world* from its *"past"*
in an ongoing struggle to *transform chaos*.

Thus *'souls' are formed* from branches of the tree
until the *paths* of their rays *part*
and *waves of life return* …

Symbolic world tree from a Chinese relief, second century A.D. (isolated and slightly repaired). The concepts "**space**" (or "**world**") of the text corresponds to the **circumference** of its crown. Note the branches grown into a new union.

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1. By means of an *imaginary observer* outside our time and space (a space which may be visualised as a 1d circle or a 2d surface of a globe – cf. the tree above and diagram 5, p. 7).

2. Formed by *standing waves* superposed on waves of chaos through harmonized *transactions* with *propagating waves* emitted from already established successions of *standing waves* of light formed into finely patterned structures whose tips appear as particles of matter.

The original Swedish version of this 'poem' was written in 1979, later revised (Herlin 2003) and then translated by Angela Adegren 2003 (with a few words later changed by its author).

Preliminary proposal for an alternative ontology

The ontology presented in this paper may be somewhat difficult to grasp because of its combination of two perspectives which often are conceived as incompatible, a "subjective", first-person, perspective and an "objective", third-person, perspective. Since it depends on a visual and intuitive thinking, as well as on a strictly logical understanding, it might be helpful to try to make a preliminary visualization of the process described by the 'poem' on the previous page. Its title, *Time and Matter Interpreted as a Propagating Transformation of Original Chaos Into Light*, refers to a kind of self-reflective process, creating a "past" that is interacting with the present world, which is the basis of this ontology.[1]

The 'poem' was the first result of a personal endeavour to approach and express a worldview without inconsistencies between science and religion. The idea was, and is, in a later formulation: "to reduce the contradictions (and at the same time clarify the differences) between (1) FALSIFIABLE EMPIRICAL KNOWLEDGE[2], based on observations of the world where the *'recorded time'* appears as a *geometrical construction*, and (2) VARIOUS FORMS OF BELIEF[3] concerned with a supposed emergence and growth of individuals (and the Universe) from 'deeper layers', where the *experienced time* ('flowing time', '*active time*') *is* precisely this growing." According to this ontology such a growth – through transformations of propagating waves into a network of *standing waves* ("rays") – forms an "*active 'past'*", which is accessible to consciousness through wave processes (i.e. the "waves of life" of the 'poem'[4]) back and forth in this "past", which consequently could be regarded as a flowing "*free time*".

These concepts of time can be interpreted and visualized as components of an "*active spacetime*", presented on p. 6 of this paper and summarized on p. 15. The text on pp. 4–5 is also intended to facilitate the understanding.

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1. Originally the 'poem' was just a very general conjecture (possible to be understood both quite literally and metaphorically) based on the fundamentals of the footnotes 2–3, and no other references (before the appearance of Cramer's Transactional Interpretation). Having tried to falsify its falsifiable parts, and after some necessary changes, I think it now, indirectly, has sufficient empirical support (see the references on p. 32) to serve as an introductory vision and reference. To facilitate, key concepts are in italics.

2. The fundamental *empirical knowledge* relevant for this proposal is: the equivalence mass–energy, the quantization of energy and the universal, wavelike and enduring, but somewhat unpredictable, properties of elementary particles.

3. The relevant basic statements of "*belief*" would here be: the universally known personal experiences of time, feelings, and life (as an aspect of an inner reality, or God). (Also the first and last three lines of the 'poem' on the next page may be considered.)

4. Both the concepts *"incipient life"* and *"waves of life"* (e.g. the transactions of TI) refer to the idea that our *experiences* and *feelings* are an immediate and, as a consequence, possibly ubiquitous result of the *wave* property of matter.

Some reflections about the concept of time and the "fourth dimension"

The following statement by the philosopher Rudolph Carnap shows that the concept of (experienced) time may be very difficult to grasp:

"*Once Einstein said that the problem of the Now worried him seriously. He explained that the experience of the Now means something special for man, something essentially different from the past and the future, but that this important difference does not and cannot occur within physics. That this experience cannot be grasped by science seems to him a matter of painful but inevitable resignation. … Einstein thought that scientific descriptions cannot possibly satisfy our human needs; that there is something essential about the Now which is just outside of the realm of science.*" [1]

But at the same time Einstein didn't worry about four-dimensionality:

"*The non-mathematician is seized by a mysterious shuddering when he hears of 'four-dimensional' things, by a feeling not unlike that awakened by thoughts of the occult. And yet there is no more common-place statement than that the world in which we live is a four-dimensional space-time continuum. … the world of physical phenomena which was briefly called 'world' by Minkowski is naturally four-dimensional in the space-time sense. For it is composed of individual events, each of which is described by four numbers.*" [2]

This last quotation, published in Einstein's popular "Relativity: The Special and General Theory", seems to be an instance of the "*fallacy of misplaced concreteness*", which Whitehead warned for, five years later in his *Science and the Modern World*. If Einstein and his adherents had taken the ontological problem of four-dimensionality less lightly than this quotation suggests, "the problem of the now" and the static spacetime would perhaps have remained a subject of discussion in science during the twentieth century. The relation is not easy to grasp because four-dimensionality is almost impossible to visualize, especially if "the now", or the temporal world, is to be included.

But if one imagines a two-dimensional temporal world, a visualization is possible: this world could simply be imagined as being like the surface of a crystal growing very fast in an 'atmosphere' of chaotically (randomly) distributed molecules. The growth (corresponding to the '*active time*' presented in this paper) would be caused by the incorporation of molecules of this *surrounding*

1. Schilpp, P.A. (ed.) *The Philosophy of Rudolph Carnap*, from Kitto (2002).
2. Einstein (1920).

chaos into the ordered structure of the 'crystal'. But the order of this 'crystal' should not be considered as simple as that of an ordinary crystal. Its inner structure (more like the *tree* at p. 2) would make the chains of incorporations appear like movements on its surface, and its chaotic surrounding would make it impossible to predict these movements with perfect certainty.

Every chain of incorporation would enter into contact with each other on the surface of the growing 'crystal', and these processes of incorporation may be thought of as interacting so that their paths on the surface change directions as a result of *effective* causality. They may, for example, interact harmoniously and continue entangled with each other on a common path, thus creating growing "societies" on the surface.

Now, imagine that living beings finally appear as a consequence of such entanglements in the two-dimensional temporal world. These beings might have acquired a knowledge of the effective causality that is limited to the surface of the 'crystal', but they would have no idea (through their senses) of their *internal* three-dimensional reality.

This internal reality below the surface, the 'past' of its beings, would probably be active in the process of incorporations, since this might contribute to its stability through self-reference. The differences between good (harmonious) and bad (disharmonious) incorporations (serving as guides for stabilizing actions) might be experienced as feelings by the beings of the surface, but these feelings would probably be considered as immaterial or 'supernatural', since they would not be observed among the objective phenomena of the surface.

However, after careful studies of the objective processes of the neural systems of these beings, some of its members might conclude that observations of these processes in principle may give a complete explanation of their feelings.

But some correlations between processes at separate locations, which could not possibly have been established through *effective* causality might appear.

A close examination of the *recorded* (historical) past of these phenomena might show that the correlated processes of the surface *once* were very closely related. Now, since a carefully recorded *historical past* topologically would correspond to a *real* '*active past*' (i.e. the interior of the 'crystal') a three-dimensional human observer, positioned in the surrounding chaos, could in this case observe that the paths of these correlated processes are, very concretely, entangled in the interior 'past' of the 'crystal'. The human observer could then easily draw the conclusion that processes (i.e. waves of '*free time*') through these paths are contributing, '*final*' causes of the observed correlations and possibly of the feelings as such.

Three ontologies seen through a few diagrams

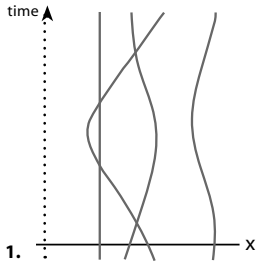
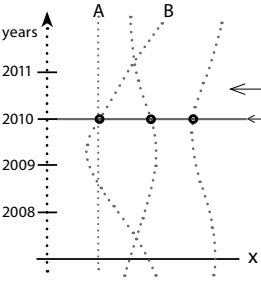


Diagram 1 is a simple, logical construction, with unspecified scales of *time* and *one dimension (x) of space,* in which 4 series of events, e.g. the movements in the world, along x, of 4 bodies, are recorded. But, of course, *the record itself* is *not* moving. This is also true for **diagram 2** (its dotted lines and big dots) and for **diagram 3** (its curved lines).

Diagram 4 is in my view closer to the reality – a hypothetical reality as seen by an *imaginary observer.* Its vertical axis is actually a *spatial* axis (*y*) and, as a 'replacement' of time, its solid horizontal line should be *thought of as moving upward* during the time it is being observed. For the construction of this diagram, the same record of events as that of diagram 3 is used – however, its interpretation should be different, i.e. as being *active.*

Diagram 5 (next page) is of the same, static, kind as diagram 2, but with *two space axes* (the dashed lines) instead of one (like the ones in diagram 4) and with a capacity to show (imaginary) records of hypothetically real, "non-local", processes (the small dotted arrows inside the cone) together with records of objectively observed, real, i.e. "local", processes (the curved dotted line on the surface of the cone).

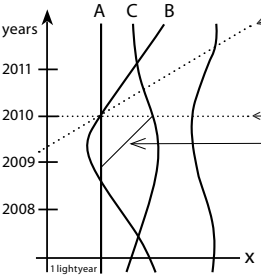


"Future" (theoretically, an *exact* prognosis is possible in the classical view).

Events on 01.01.2010 according to *both* A and B (two accelerating bodies and one encounter between A and B, who are not accelerating, are recorded). However, when the scale is astronomic (as in diagram 3) A and B can't agree on the simultaneity or order of certain events, because no light signal – always with a *universally* constant *apparent* velocity – is received sufficiently soon. The *special theory of relativity* gives *one* solution to this problem (see diagram 3).

< System of coordinates relative to which A is standing still.

2. The black dots indicate **the ontology of classical physics**: only atomic matter in the present exists (and, as sometimes thought, a parallel spiritual world). The time axis is a pure construction showing "*recorded time*".



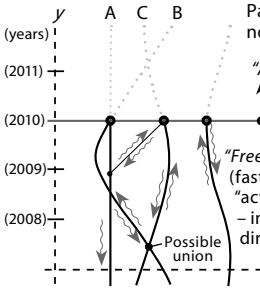
Events 'on' this line are, or will be, regarded as having happened on 01.01.10 from the *perspective of* B, according to the *special theory of relativity.* But this makes the present uncertain – or, as it seems, completely absent – and, as a consequence, the experienced *flow of time* may be dismissed as an illusion.

Events 'on' this line happened on 01.01.2010 according to A.

A ray of *undeflected* light emitted by A. Even C (according to the original version, 1986, of Cramer's Transactional Interpretation) has participated in the creation of it, by returning waves "into the past". Together with waves from A, a standing wave between A and C is formed after a "*transaction*", regarded as "*atemporal*" in this spacetime, since it has only one, *geometrical*, kind of time.

< A's system of *space and time* coordinates, where time has spatial qualities.

3. A tacit ontology of modern physics. The black curved lines represent some events of the Universe, seen as a 4-d spacetime continuum. This is an essentially static vision which has to be interpreted as just one branch of "many worlds" to account for the different ("paradoxical") *possibilities* of quantum mechanics.



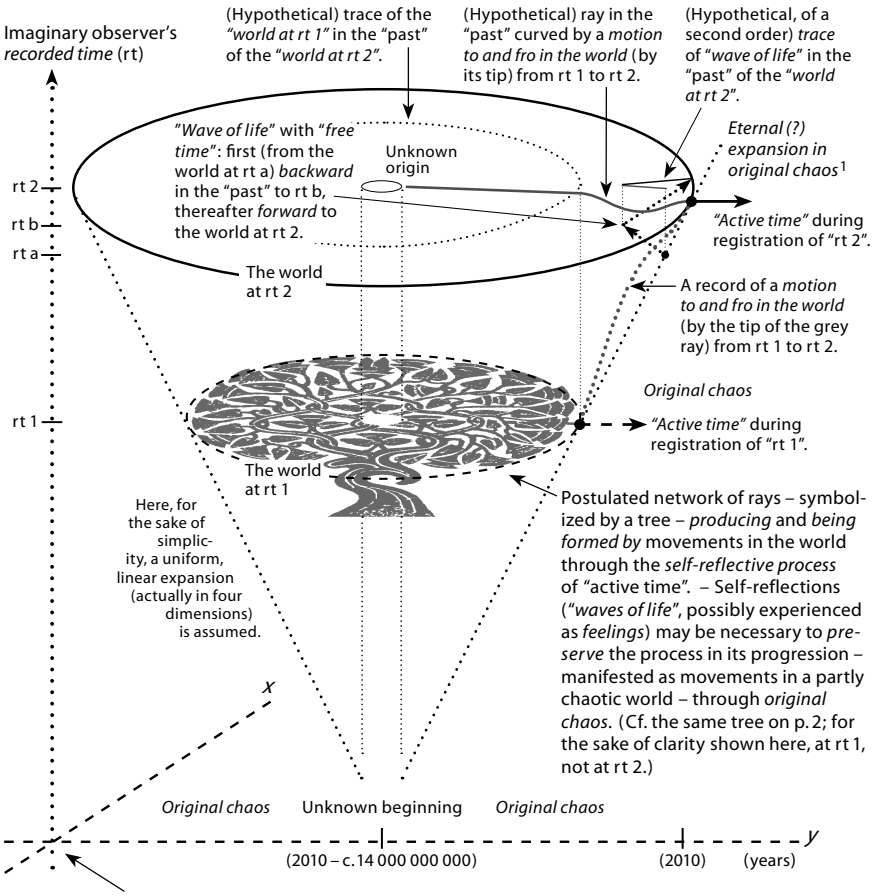
Paths for *potential* events as *one alternative* future among others – i.e. not yet (01.01.10) organized (i.e. assimilated) waves of "*original chaos*".

"Active time" (flow of time, the arrow symbolizes the *growth* of the rays).

The world on 01.01.10 with its active "past" as studied by an observer imagined by A. – The fact that B would imagine an observer studying an *other* simultaneity than that of A is not a problem, since *one can always find a possible absolute simultaneity* and explain B's deviations as the result of *deformations* (preserving the natural laws for B) of the whole tree (web) of standing waves of light (note 2, p. 2) making up the rays growing along with B.

< An *imaginary observer's* system of *space* coordinates as imagined by A.

4. Transactional Process Ontology. This diagram shows an "*active spacetime*", or "*timespace*". The black, solid parts of the curved lines, in the "*active 'past'*", correspond to the "rays" of the "tree of life" at p. 2, and the black dots to the place of their creation, their growth, *mutually experienced* as matter. The "past part" of the rays can only be experienced *individually* as *direct* manifestations of waves of "free time" (*"waves of life"*), for instance as *feelings*. (Some deformations of the kind mentioned in bold letters are studied on pp. 8–11.)



Imaginary observer's system of coordinates, with the recorded time dimension (rt) plus two linear space dimensions (*x* and *y*) out of *four* (in total, *five* dimensions).

[1] The infinite *original chaos* can be regarded as a receptacle for every possible future of the world.

5. An imaginary observer's record of the evolving Universe.

In this diagram the world appears as a circle (i.e. a curvature of the 3d space of *absolutely simultaneous* events according to the explanation in bold letters at diagram 4). The recorded expansion of this world forms a cone, and every 'horizontal' section of its interior (cf. the inserted, symbolical tree) represents the "*active 'past'*" of the actual simultaneity – a "past" which permits ('internal' or 'final') causal chains to go outside the *present* world and back again without violating the *relatively uncertain* causality of nature.

The *imaginary observer* is thought of as observing the entire Universe with no time lapse or interference. The time axis, and thus the cone (*except* each *single* 'horizontal' section), is a *logical construction,* distributing the observations according to the *imaginary observer's* 'experienced' (active) time. The result is actually a *static spacetime diagram* showing *stages* of the "*active spacetime*", or "*timespace*", in which the growth process of the real "active time" is recorded as a cone. Alternatively, it would be possible to arrange the observations into an *animation* showing the world as a 2d surface of a growing, "active 'past'", or arrange them into several diagrams, like the diagrams 2 and 3 on p. 11.

A visual explanation of the "twin paradox" by means of an "active spacetime diagram"

The diagram on the next page, a two-dimensional "active spacetime" comparable to the diagram 4 on p. 6, shows the traces (the parallel grey lines) of two enduring objects, A and B, according to which B has travelled away from A and back again, whereas A has not moved. Both objects may be considered as composed of re- or deflected *processes propagating at the 'speed of light'* (c), *visualized as zigzag lines* (only one such process of each object is showed – cf. p. 11) with a constant angle to the world, W, represented as a horizontal line.

Now an "imaginary observer" outside this world and its hypothetical "active 'past'" (i.e. the space below W – cf. the Universe described by diagram 5, p. 7) could give the following visual explanation of the twin paradox of the special relativity, using the diagram on the next page:

During, for instance, the duration W1a–W1b a propagation back and forth (at the 'speed of light') of a process of the moving object B, has created a longer path[1] in the "active spacetime" than the propagation of a corresponding process of A. But for the same reason, a clock following B is distorted by its constituent processes just enough to show the same amount of time (a completed period) for this process as an equal clock following and measuring the corresponding process at A.

Everything is changed accordingly, so the natural laws will *not* be recorded as changed. (This means that *the traditional spacetime description of relativity is still valid, even if it sometimes is insufficient*.)

But between W1 and W2 there are fewer reflections noted at B than what is noted at A, which observers, who have followed A and B, may interpret, when they meet, as a proof that time has been 'slower' for B than for A.[2] Note that the "proper time" of the photon that is represented by the path C, which has just one reflection, hasn't passed at all. Thus the longest way may seem to be the shortest, but actually every path in the "active 'past'" from one occasion to another has the same distance according to the transactional process ontology.

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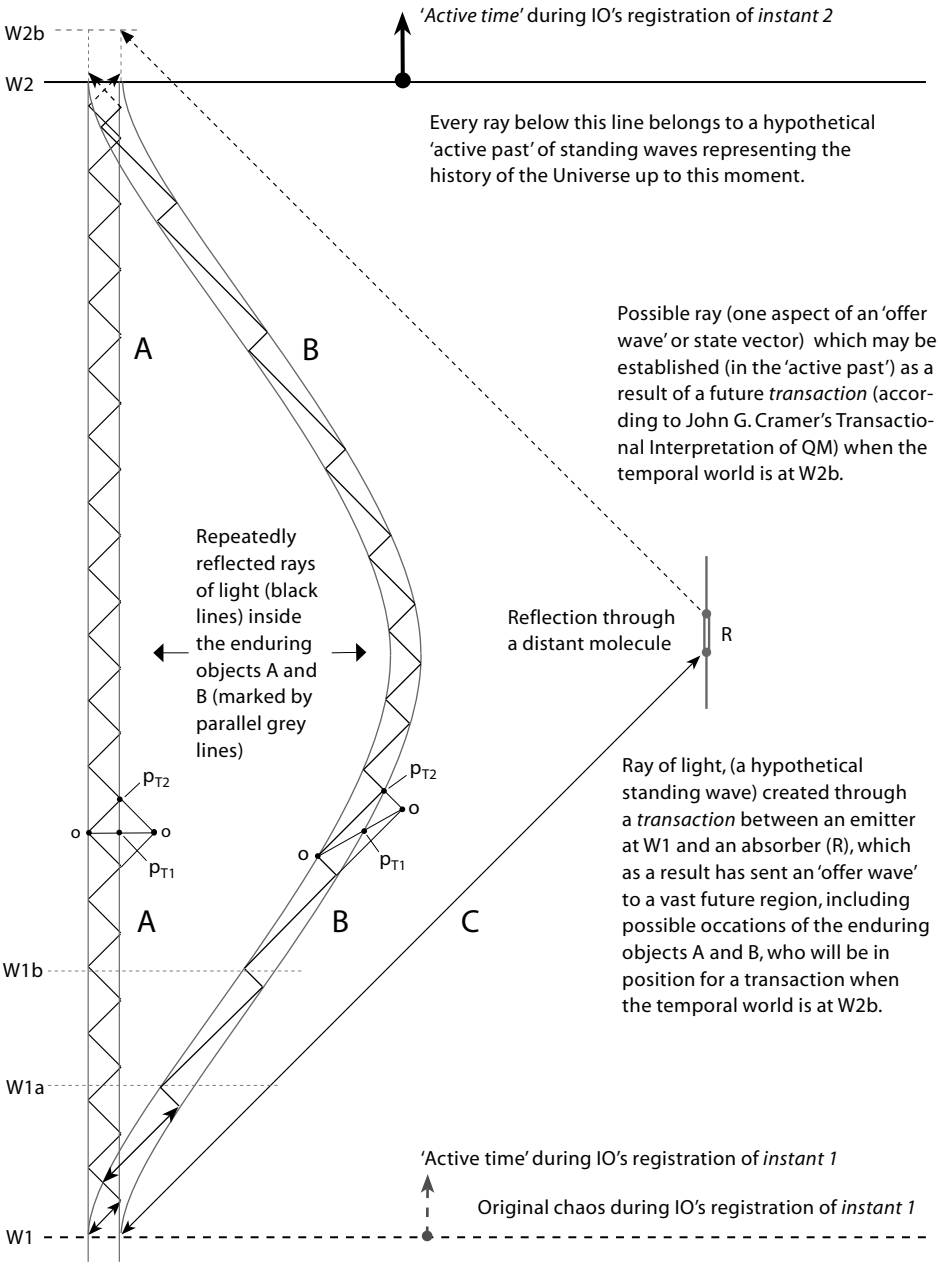
1. A path of two "rays" of standing waves according to the Transactional Interpretation of Quantum Mechanics by John Cramer (1986). A possible hidden reality that is better understood as an "active past" of an "active spacetime" than as a static "reality" of an Einsteinian spacetime.

2. Length contraction is not considered here, but would not change the result considerably. See *Visualizing Proper Time in Special Relativity [with a Light Clock],* at <http://physics.syr.edu/courses/modules/LIGHTCONE/LightClock/default.html>.



IO = An *imaginary observer*.

W1, W2, W2b = The world during registration of *instant 1, 2,* and 2*b* by an *imaginary observer*.

p_{T1}, p_{T2} = An enduring point (p) at the *center* of a measuring rod at an earlier and a later time.

o, o = Events at the ends of the measuring rod. These events may be regarded as simultaneous by an observer at A as well as at B, because light signals emitted from these occasions meet each other at the center (p) of the measuring rod in both cases.

A construction of an abstract static spacetime vs. a visualization of an active spacetime

Consider the upper and the two lower diagrams on the next page. Compared to the *evident* differences between the upper one and the diagrams below, the difference as to how they should be *interpreted* is much more important.

The upper diagram (a "snapshot" from an animation by Rob Salgado[1]) shows how the "world lines" of a spacetime *diagram* are being "traced out" by the atoms of two mirrors – (the top of) the vertical lines – and a reflected photon (the grey ball) of an *imaginary light clock*. The "real ('temporal') world" seems here to be regarded as made of some kind of very small hard spheres. But because an absolute present isn't found, the reality is often regarded as better represented by the *diagram itself* (i.e. a block of world lines without a flowing time) than by descriptions which consider the present as the ultimate reality.

Interpreted in this way, the grey "world lines" of the upper diagram actually show an *imaginary process* constructed by a *real observer* at rest relative to the objects represented as tracing out these lines; whereas **the lower diagrams** shows (or at least are supposed to show) the "tracing out" – and establishing in an "*active spacetime*" – a (hypothetically) *real* process (not just a diagram), as seen by an *imaginary observer.*

As a result of complicated processes (not yet understood but, through its lightlike directions of propagation, reminding of the process which is about to be described) the *atoms of the two mirrors* repeatedly (at a certain rate of propagation controlled by internal processes) reproduce themselves (i.e. their creative processes). This forms a growing structure of "*rays*", here symbolized by the grey zigzag lines, the *tips* of which represent the propagating *temporal world*, whereas their lower part represents the "*active 'past'*".[2]

An event at the top of this network, resulting in the emission of a photon, is *not* to be understood as the emission of a more or less piont-like particle. Instead, according to Cramer's Transactional Interpretation, an "offer wave" (corresponding to the state vector of other interpretations [3]) is sent out as a kind of search-light (the grey "triangle"). This (coherent) wave, or wave-complex, is probably (almost?) *instantly* spread out in every possible time-, light-, and space-

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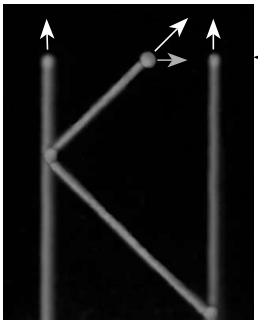
1. *Visualizing Proper Time in Special Relativity [with a Light Clock],* at <http://physics.syr.edu/courses/modules/LIGHTCONE/LightClock/default.html>.

2. Cf. the "zigzag picture of the electron" and other fermions in Roger Penrose (2004): *The Road to Reality*. pp. 628–644.

3. **Waves**, most generally, may be defined as periodic changes of any kind – always decomposable (according to Fourier) into a (often complicated) set of simple rotations (or sine-waves) representing periodically added amounts of change (superpositions).

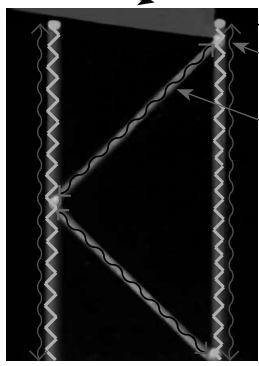


The last record of a continuous series of instants of an imaginary world of particles.

1.

An animation made of instants, like this one, and a few other animations, by Rob Salgado,[1] intended as a pedagogical aid to the understanding of special relativity, has inspired to the appearance of the diagrams below. Salgado's animations are well suited to their purpose, but the rendering of photons as billiard balls may be misleading when trying to understand quantum mechanics. However, the method of "tracing out" spacetime diagrams using an imaginary "light clock" may be helpful, also when trying to get a critical understanding of a (process) Interpretation of the TI".

2.



3.

tw 1, tw 2 = *the temporal world at two instants, 1 and 2*

like direction and then successively reduced (cf. *"decoherence"*, p.23) according to the arrangement of its environment (imagine the *instant* distribution of a *low phase speed* immediately perceived when a screw starts to rotate).

Not until the series of processes of the atoms of the potentially reflecting mirror has grown to a point where a reinforced interaction between the emitter and an electron of one of its atoms hypothetically *is in accord ('in line') with the zigzag structures*[4], will an eventual "confirmation" wave, sent back (in the "past") to the initial emitter, be responded to so that a transaction occurs. This transaction reduces ("collapses") the offer wave to a *real* standing wave with a limited extension in space[5], i.e. a ray, which contributes to a network of an "active past". (This process account is a departure from the original Transactional Interpretation[6] and its static spacetime, according to which the present moment is non-existent and, as a consequence, any relation between a temporal world and an "active past" as well. In the original version the transactions are regarded as *atemporal* "handshakes across spacetime", and consequently the standing wave mentioned by Cramer is just to be regarded as a metaphor.)

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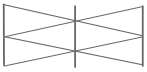
4. Cf. the figure above and the rotating zigzags of the electron in Penrose (2004), p. 630.
5. Cf. the explication of the straight propagation of light in Feynman (1985), pp. 53–54.
6. It is closer to the view expressed in Cramer (2001): The Plane of the Present, pp. 8–9.

A hypothetical process of reinforcement where the "active past" has an important role

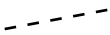
The wavy lines of "free time" in the diagram on the next page correspond to *experiences,* like feelings, and and can not be studied objectively by a 'third person'. In this model, the relations are drawn from the perspective of an imaginary, "fourth-person", observer. The old behavioristic formula S–R, or S–O(rganism)–R (e.g. as proposed by D. O. Hebb), should then be extended to the *non*-behavioristic formula S–O–Experience–O–R or S–O–E–O–R. (Cf. Whitehead's phases of concrescence:[1] I (S–O), II (O–E), III (E–O), IV (O–R).)

Symbols used in the diagram on the next page

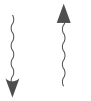


Neural network of standing waves. The vertical lines may symbolize, for instance, (the nuclei of) *atoms*, and the tilted lines *photons* – established as rays in accordance with (a "process interpretation" of) Cramer's Transactional Interpretation of QM (pp. 10–11, 17–27). (The diagram is vertically compressed compared to a normal spacetime diagram – and of course extremely simplified.)

Well established causal path (as a hypothetical trace in the "active 'past'") from stimulus to response.

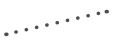


One of several lines of possible neural reactions caused by the stimulus S_{n+3}.

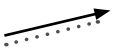


Hypothetical influences in "free time" (very much faster than the propagation symbolized by ↕) through the "active 'past'" of enduring objects (e.g. synapses) of the organism back and forth through its atomic coils of standing waves.

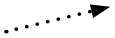
Causal path serving as a fast link of waves (superposed on standing waves) between different regions of the "past".



Hypothetical non-local activation (in the world immediately after W_{S3}) of anticipation of the future, augmenting the probability of a reaction modeled on $R_{n, n+1, n+2}$.



Causal path partly established as a result of a positive interaction with the "active 'past'".

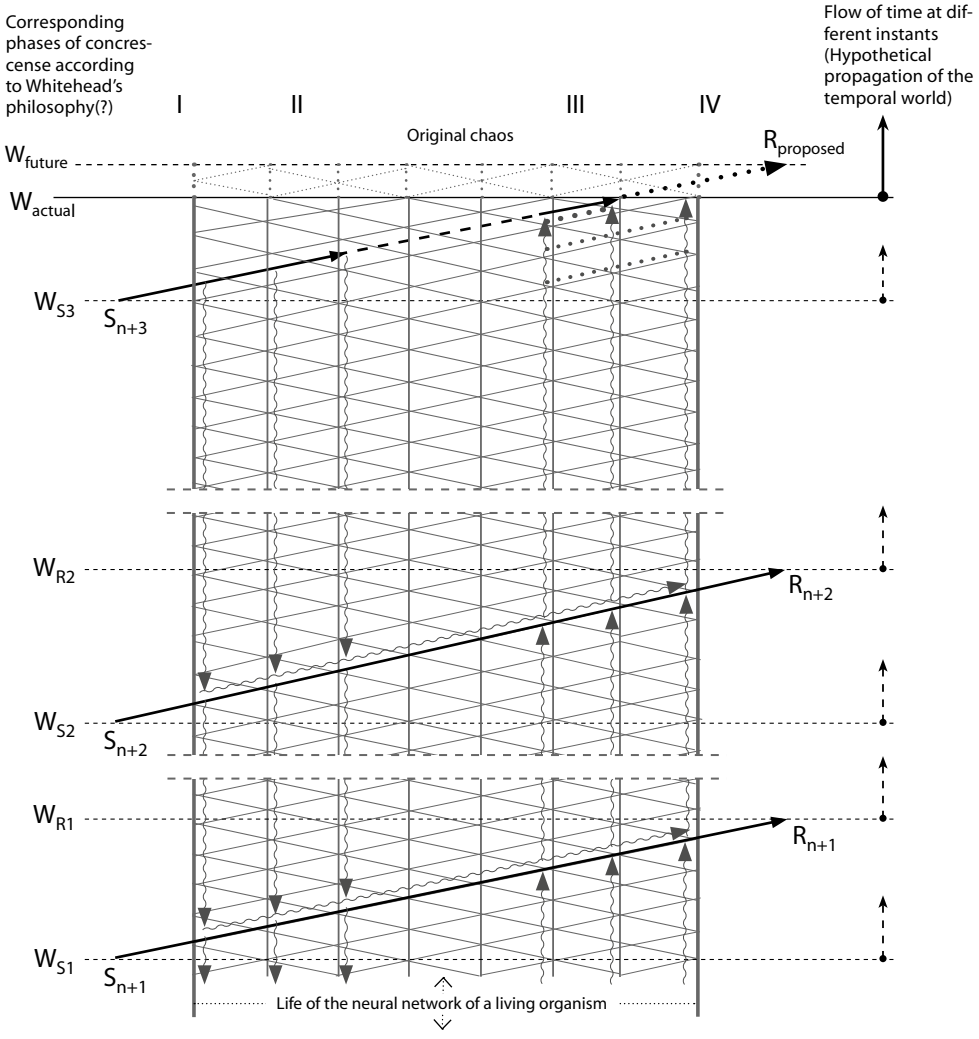


One of several possible future responses, an anticipation of the future. – The appearance here of moments of *indecision* in the causal process (before the reduction of the "offer wave", or state vector, to a standing wave – see p. 11) is a condition for our free will, i.e. for the processes of "free time" in the "active 'past'" to affect the *probability* of various results within the limits of *effective* causality.

$W_{...}$ = An instant of the "past", the "future" ("original chaos") or the now of the world.
$S_{...}$ = A stimulus which may contribute, together with $R_{...}$, to the formation of "eternal objects" according to the philosophy of A.N. Whitehead (1928).
$R_{...}$ = An actual or proposed response.

1. Whitehead (1928).

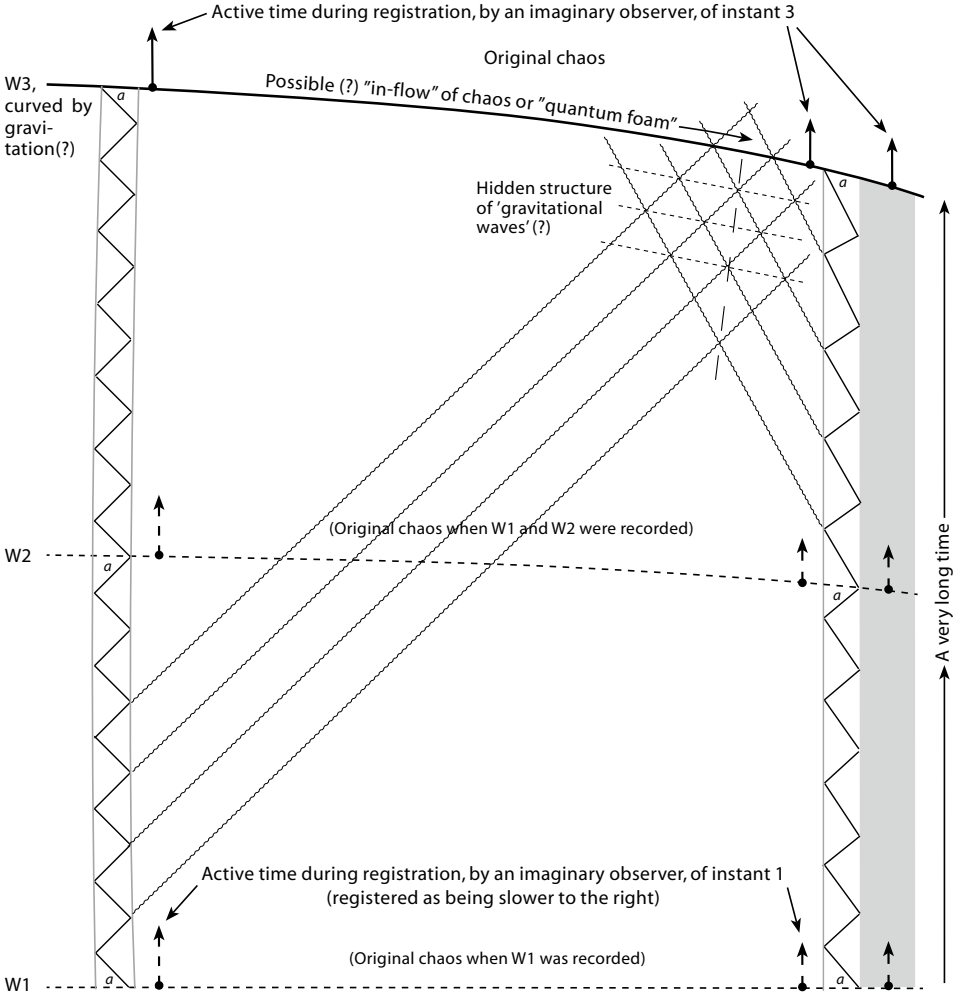
The "E-part" of this formula (symbolizing processes below the line "W_{actual}", i.e. in the "active past") has characteristics which, in my opinion, are not too far from that which humans who have had an "out-of-body" experience often describes. The hypothetical processes of this region might be projected by processes of "free time" into the actual brain – which could explain non-local phenomena on different levels, (e.g. ESP-phenomena if they exist), and makes it uncertain whether the physical death necessarily is a definite end of a conscious existence. The *importance of the temporal world* in relation to this hypothetical "past" seems to be the *creation of good relations*, and, since it is a cosmic unifying structure, a possible afterlife should *not* be thought of as just an *individual* survival (for instance, a potential suicide bomber should *not* expect a paradise).



1. Whitehead (1928) and Sherburne (1981).

Possible development of the temporal world close to a big mass

The "active past" of this diagram (the space below W3) is curved somewhat like a traditional spacetime diagram of general relativity – but it's "hidden structure of 'gravitational waves'" might depend on "free time" processes in this "past", and the whole diagram should be thought of as developing as a function of "active time". Since gravitation is still a very mysterious phenomenon, the diagram should be regarded as just an audacious conjecture, inspired by a transactional process view.



W n = The (temporal) world at instant n
a = Constant (?) angle everywhere (the "inflow" of chaos may be both/either perspectival and/or real)
= Part of a big mass

Concluding words about the "active spacetime"

The now classical, 4-dimensional *static* spacetime construction is shown to be insufficient for a description of the reality that covers, for instance, quantum phenomena. Although it describes motions, it is in itself a static description with a fixed future and no room for the description of relations that imply different possible futures. The Universe may be an, at least, 4d *active* reality

To transform a static 4d spacetime into a good *representation* of an *active* spacetime, choose in it a suitable (possible), 'universal' instant as a rough 3d "(hyper-) plane of the present", which may cover the whole Universe as a closed, "circular", dimension (cf. p. 7). This plane is an instant of the "temporal world", in Whitehead's words (1928), and its flow of time can be symbolized by an arrow fixed to it. As the plane is displaced in the direction of the arrow (e.g. in new diagrams), the space behind it – originally the past of the chosen instant, now symbolizing a vibrating network – should grow into an unstructured region symbolizing a surrounding, hypothetical, "***original chaos***", and be thought of as assimilating some of its unintegrated vibrations and turning an unformed ***"open 'future'"*** into an established historical fact – hypothetically a *still active "past"*.

Such a *description* is, I think, much closer to a credible ontology than the old 4d spacetime. I have also called the described *active spacetime* "***timespace***", since it is a space that includes at least two concepts of time, combining time as a flow ("***active time***") with its geometrical aspect, the "depth" of the "***active 'past'***", and allowing hypothetical processes back and forth in this "past" ("***free time***") to be conceived, e.g. the transactions of (a "process interpretation" of) Cramer's Transactional Interpretation of QM.

The hypothetical "active 'past'" and the processes of "free time", regarded as real, belong to an *extended (hidden) natural region* of "timespace" which may be called "*subnatural*" – *not* to be confused with a "supernatural region" violating the natural laws, which as far as I am aware doesn't seem to exist.[1]

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1. This region seems to be close to Whitehead's naturalistic concept of God as expressed in the following quotations from Whitehead (1928): *Process and Reality*, pp. 350, 348:

"Each actuality in the temporal world has its reception into God's nature. The corresponding element in God's nature is not temporal actuality, but is the transmutation of that temporal actuality into a living ever-present fact. […] This nature itself passes into the temporal world according to its gradation of relevance to the various concrescent occasions."

"It is as true to say that God creates the World, as that the World creates God."

However, instead of the last quotation I would prefer the following formulation:

It is as true to say that the world creates its 'active past', as that this 'past' sustains and stabilizes the creative process of the world. This is in my view closer to *pantheism* than to the alleged *pan*en*theism* of Whitehead (who, in my view, often seems equally close to pantheism).

ADDENDUM 15.03.09

In a new paper by Henry Stapp (2009, 2 March), a concept of time, "process time", is presented which seems close to my concept "active time" as applied on pp. 10–11. This "process time" is contrasted with the "physical time" – which I have called "recorded time" since it, in my view (and as I have understood Whitehead [1925]), is an abstract construction with no ontological significance.

When John Cramer in 1986 published his Transactional Interpretation he did not consider a process time, although Stapp in 1976–1979, had proposed an *"ontology that is similar to that of Whitehead"* in which *"[t]here is a creative process that consists of a well-ordered sequency of individual creative acts called events",* and according to which *"[w]hat ever is created exists, and nothing else exists"* , where *"[t]he order of occurrence of events need not coincide with any particular temporal order."* (Stapp 1979)

And yet Cramer (1986) says that *"Stapp (1975, 1977, 1980) has proposed a very general nonlocal model which we regard as a precursor of the present work. It is not an interpretation because it does not propose any specific mechanism for quantum events. Rather it is a world model similar to that originally proposed by A.N. Whitehead, but suitably modified to deal with the manifest nonlocality demonstrated by the tests of the Bell inequality."*

If Cramer had considered a concept of process time in his interpretation from 1986 he would not have encountered the ontological problem of the fixed future, implied by the static spacetime, and which made him consider the possibility to introduce a "plane of the present" in his interpretation (Cramer 2001).

My solution seems closer to that of Stapp than to that of Cramer (2001)[2], but it differs from both solutions in that it acknowledges that it is possible to make the ontological proposition that an absolute simultaneity is a meaningful concept. In that case the actual *"order of occurrence of events"* would coincide with my "active time", as I would like to define it, and the completed events would constitute an "active past", a region of the *real* "active spacetime" or "timespace" not to be confused with a part of an abstract static spacetime.[3]

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2. However Cramer (1986) presents a mechanism of transactions, as an explanation of quantum collapses, which seems plausible to me.

3. But according to Stapp (2009, p. 17) *"… one can represent process time by the coordinate along a fifth axis drawn perpendicularly to the fourdimensional plane indicated in Figure 6* [cf my fig. 2, p. 11]. *Then each instant in process time that is associated with a particular actual event will define a full four-dimensional space-time subspace* [cf. my "active spacetime"] *in which lies the surface* ō ['now'] *upon which the quantum state jumps to its new value* [cf. fig. 3, p. 11]. *If one extends via process 2* [Schrödingers wave equation] *the quantum state on this surface* ō *into the part of the full four-dimensional space-time that lies* ***earlier*** *than* ō [the lower part of fig. 3, p. 11]. *then, within this five dimensional space, one has a perfectly rational meaning for the assertion that each quantum collapse* ***changes the past*** [or rather, according to TPO, the 'active past']." (Emphasis of the original, my comments in square brackets)

A Process Interpretation of the Transactional Interpretation of QM

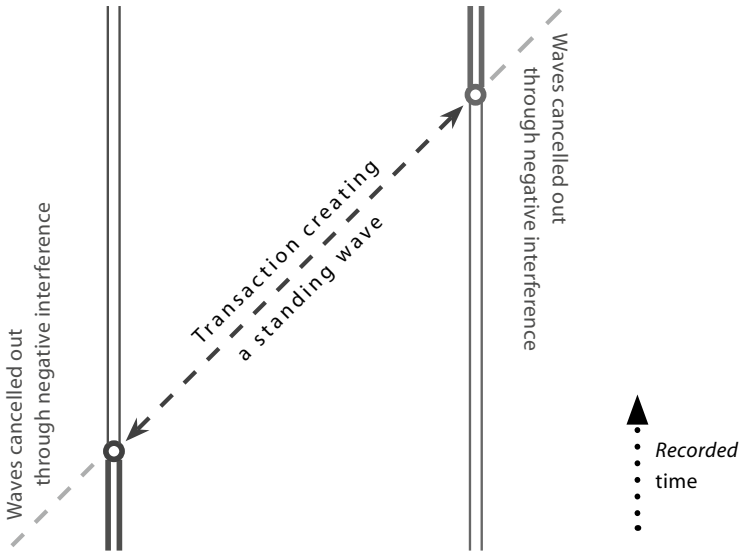

Fig 1. A transaction according to the Transactional Interpretation of Quantum Mechanics.

In John G Cramer's article "*The Transactional Interpretation of Quantum Mechanics*" (1986)[1] there is a simple diagram, much like Fig 1 with the exception that the dotted lines are replaced with a graphic representation of superposed waves negatively interfering (where the waves are cancelled out) and positively interfering (where the transaction is) with each other.

According to the abstract: *"The basic element of TI is the transaction describing a quantum event as an exchange of advanced and retarded waves* [by Cramer called "offer" and "confirmation" waves]*, as implied by the work of Wheeler and Feynman, Dirac, and others. The TI is explicitly nonlocal and thereby consistent with recent tests of the Bell Inequality [e.g. by Alain Aspect], yet is relativistically invariant and fully causal. … The TI permits quantum mechanical wave functions to be interpreted as real waves physically present in space rather than as "mathematical representations of knowledge."*

1. Now a rather well established interpretation of QM, intended to facilitate the understanding of QM. There is also a popular presentation in the article "The Plane of the Present", at http://arxiv.org/ftp/quant-ph/papers/0507/0507089.pdf . Ruth E. Kastner at the University of Maryland argues in favour of TI in Kastner (2010).

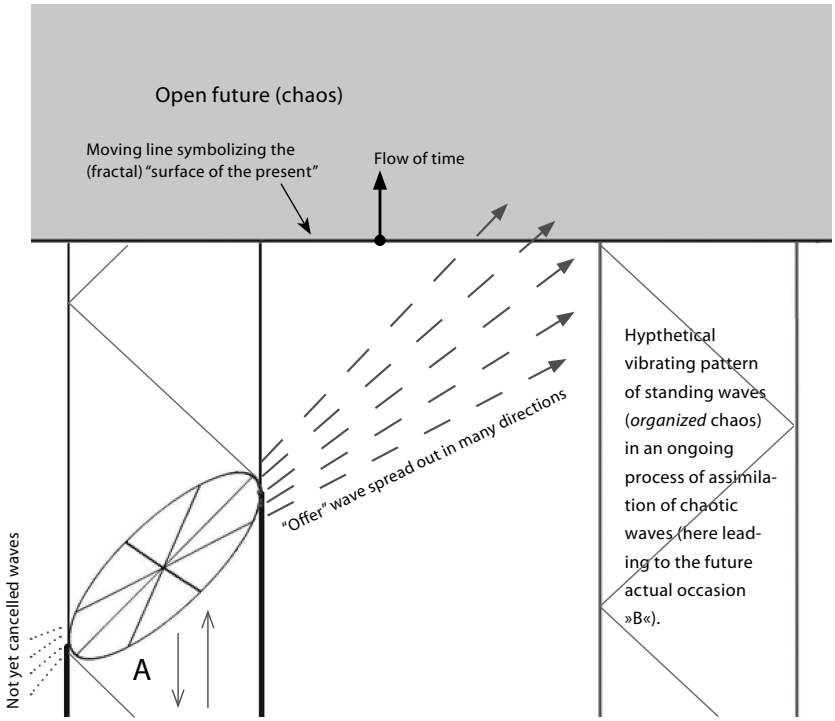

Fig 2. Combined interpretation of Fig. 1 in Sherburne's "Key" and Fig. 4(a) in Cramer's "Transactional Interpretation" (1986) modified by the introduction of a process concept of time. Unlike in Fig 3, the actual occasion B has here not yet appeared.

The result of a transaction may be the appearance of a photon or an electron, but because the transactions of TI are considered as happening across a static spacetime, Cramer has to regard them as following a "pseudotime" sequence.

Compare Fig 1 on the previous page with a figure in "*A KEY to Whitehead's Process and Reality*" (Sherburne 1981, p. 10)[2], representing "a simple physical feeling" . This figure may be considered as an essentially one-dimensional illustration of an act of causation, i.e. an exchange between the actual occasions A and B. The time dimension is missing, but the arrow, pointing from A to B, symbolizes "the 'vector' … that bears the A-ness of A into B" (*op. cit.* p. 10), obviously a first-person perspective. Now, if you imagine a second dimension perpendicular to the plane of the page, and *let B take a position higher than A* above this plane (making the arrow point at B at an angle of, say, 45 degrees to the paper), the vertical component of this "vector" may represent time.

2. Page 10, and several other pages from this book, may be found on the Internet (via <http://books.google.com>); if not, you can get an idea of the illustration from Fig. 3, on the next page, where the *tilted* part is a slightly edited version of the figure in the "KEY". It is here shown in a projection that makes its circles oval, some less important letters are deleted and a dashed arrow is inserted.

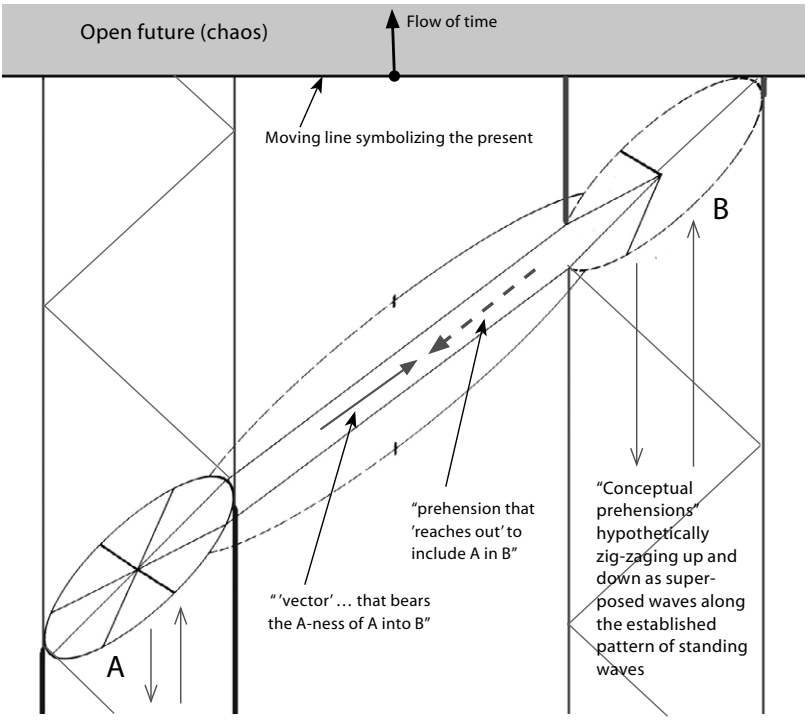

Fig 3. An essentially two-dimensional interpretation of Figure 1, p.10, in Donald Sherburne's "Key to Whitehead's Process and Reality" inspired by Cramer's Transactional Interpretation.

Seen from above the imagined illustration will still look the same, just a little foreshortened, but viewed almost horizontally and completed with vertical lines it contains the same relations as Cramer's diagram, with its "offer wave" ("retarded wave") symbolized by Sherburne's solid arrow. Although Whitehead's "simple physical feeling" originally may have referred to a *first person perspective*, this arrow, in a *third person perspective* (of an imaginary observer), may be regarded as corresponding to an emission of, for instance, a (potential) photon. The zig-zag lines inside the vertical lines represent here the atomic processes preceeding and following the actual events at A and B.

But in Cramer's conventional spacetime diagram time is a static *dimension*, an abstraction constructed by a series of successive observations which it, in Whitehead's words (1925), would be a "fallacy of misplaced concreteness" to identify with time as an aspect of an actual process.

A practical solution to this problem is, according to the Transactional Process Ontology (TPO), to draw a horizontal line just above the right oval in the new TI diagram, which is already done in Fig 3 (Fig 2 is explained on the next page) representing the present, and wipe out the part of the diagram which is above the line. This part will represent an *open future* and may be imagined as

consisting of a "*chaos of waves upon waves* …" (there is no "material *substance*" in Whitehead's *process* philosophy). The horisontal line may be regarded as the cross section of a 2-dimensional surface representing the real, 3-d, world (which cannot be drawn here), as it *propagates 'upward'* through chaos. Everything in the world appears as moving on this 3-d (hyper-)surface, so the part *below* this "surface of the present", *if it still exists*, is in any case not perceived by us.

There is one more important thing in my interpretation of the figure on p. 10 in Sherburne's *KEY*: the dashed arrow pointing from B to A is absent in Sherburne's illustration, even if he says that *B's "prehensions" "'reaches out' to include A in B"*. Perhaps the absence of such an arrow is motivated by our well experienced inability to reach backwards in time. But in Fig. 4b in Cramer's original article (1986), there *is* such an arrow – and also the usual arrow showing 'time' as a *dimension* of spacetime. This static dimension is problematic, and Cramer's solution – to regard the transactions as "atemporal" or as appearing in a "pseudo-time sequence" (TI, chapter 3.2) – is in my view insufficient. It doesn't give a good description of the reality, nor does it solve the problem with the closed future of the geometrical concept of time.

The introduction of a "surface of the present" into the diagram, as I just have described it, makes a different interpretation possible.[3] The part below this surface may be regarded as *real*, as a real 4d space *outside the 'flowing' time, but in immediate relation to it*, an *"active past"*. It cannot be examined directly by our senses or instruments – but since there already is a *movement upward* in the diagram *real propagations of waves downward and back again* shouldn't be inconceivable. In the case of a transaction, as described by Cramer, the interactions would have to be extremely fast, but I don't think it is necessary to regard the velocities involved as infinite, which an "atemporal" transaction might seem to imply.

Fig 2, p. 18, shows some directions of an "offer wave"[4] (corresponding to the "state vector" of the standard QM formalism) which, if it is real, propagates at the same extremely high speed as that with wich a single exchange of a transaction has to propagate according to TI. This doesn't mean that the *phase speed* of the waves along the "surface of the present" would be higher than the "propagation" of light in a vacuum, but nothing seems to prevent the offer wave to

3. In the chapter "The Plane of the Present" in the book *Time and the Instant*, John Cramer proposes a solution that seems not to be too far from mine. However he doesn't seem to draw the full consequences of it, perhaps because he is a physicist that is mainly concerned with an easy practical use of QM, not with philosophical questions like its ontology.

4. Corresponding to that of Fig 4a in the original TI <http://www.npl.washington.edu/npl/int_rep/tiqm/TI_fig_04.html> (ok 2010). An alternative version of these diagrams is shown on pp. 10–11 of this paper.

spread out (spacelike as well as lightlike and timelike) almost immediately, thus being able to 'instantly' communicate the state of the system to all parts that are "within the reach" of the offer wave. Most important: at the instant described by Fig 2, the actual occasion B, at which a transaction A–B is possible, has not yet appeared. (For more details, see the section about "QED", next page.)

A few words about the active 4D reality

Fig. 2 and 3 may be conceived as images of a (hypothetical) 4d reality as seen by an *imaginary observer* in a "fourth-person" perspective, with an *original chaos*, an *active "past"*, and a 3d *hypersurface of the present* moving into the chaos.[5]

This imaginary fourth-person perspective can help us to see more clearly the relationship between a *third-person perspective* and a *first-person perspective*.

When the "surface of the present", i.e. the (temporal) world, 'moves' into the original chaos, as a result of the growth (through "*assimilation*" of chaotic waves during the transactional processes) of patterns of relatively stable standing waves of matter, these patterns appear as moving particles of matter in the world. The observable interactions involved (including exchanges of photons) are instances of *efficient* causality, and the observers may easily agree upon a general third-person perspective of what happens (actually, the third-person and first-person perspectives are, in principle, not limited to beings with higher developed sense organs or consciousness).

Since, according to TPO, every *interaction in the world* is the result of an invisible growth of its participants (in the direction of the expansion of the "past") it is, conversely, possible that these deeper *processes of growth* are affected by the interactions at the "surface". This means that the related first-person experiences may depend on the patterns of the involved standing waves *and* whether hypothetically *superposed* waves resulting from the causal activity at the "surface of the present" are in *harmony* with them or not.

In this way, the feelings of every being are *directly* related to his/hers/its own past through positive or negative interference with standing waves of earlier transactions, (now belonging to the hypothetical "active 'past'") in a way which helps it/she/him to be preserved as an individual through searching for pleasant feelings or avoiding unpleasant ones. The origin of our feelings is thus explained as patterns of vibrations present at every interaction, but only accessible as a first-person experience. (See pp. 12–13.)

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5. An abstract diagram of this movement (perhaps contributing to the expansion of the Universe) can be made by introducing a geometric time as a fifth dimension, as shown by the vertical axis in diagram 5, p. 7.

FEYNMAN'S VISUAL APPROACH IN HIS POPULAR "QED"

The physicist and Nobel laureate Richard Feynman approaches the problem of causality from a different perspective than that of Whitehead's. In his well known "QED"[6] he has taken an explicitly positivistic attitude in that he describes what physicists actually *do* and how they are quite satisfied when their theories give the predicted *results* (this is evidently a third-person perspective) while Whitehead often employs a first-person perspective. This gives Whiteheads philosophy a very wide scope, but makes it also very difficult to grasp. It may be easier to start with a third-person perspective.

The positivist attitude also means that one doesn't speculate about what happens between the setup of an experiment and its result. For instance, Feynman tries not to say anything definite about the nature of the photon, even when he represents it by a "wiggly line from A to B *for no good reason* [my italics]".[7] Still, just before this quotation, he talks about the basic action of a photon that "goes from place to place" as if a photon were like a little ball.

There are an infinite number of paths that photons might 'take' from one place to another, and every 'movement' along a possible path can, according to Feynman be thought of as accompanied by a syncronized "stopwatch", whose hand, at the arrival of a photon, will stop at different positions depending on which way the photon has taken. The results of the hands that represent photons following a path close to a straight line, will correlate better than those representing photons that follow very crooked paths[8], and therefore the paths near the straight line will make a greater contribution (through positive reinforcement) to the transmission of energy than the other paths. This is how Feynman explains, in his "QED", why light seems to propagate along straight lines – without saying much more about the photon than that it "goes from place to place".

But, according to TI, this is not really what a photon does. It may "appear" at different places, but in between, before it is absorbed by a receiver, it is better conceived as a widely and instantly spread "offer wave" with a *phase speed* like that of the measured "speed of the propagation" of light in vacuum. Equal phases of the wave contribute (in the absence of obstacles) to propagating concentric *hyper*-spheres[9] until a possible receiver appears in "timespace" after

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6. Richard Feynman: *QED: The Strange Theory of Light and Matter*.

7. Op. cit. p. 88.

8. Since small deviations from these paths in general has less influence on their total length than deviations from a crooked path.

9. A hyper-sphere (with a 3d hyper-surface) is considered here, instead of the usual light-cone, since there is not sufficient reason to hypothesize that the offer waves of a photon, before being absorbed, are just propagating in a direction in "timespace" that corresponds to the (at least apparent) speed of the propagation of light (which "forms" the cone).

series of processes like those described on p. 10–11 (see also Fig 2–3, p. 18–19).

A potential absorber of a photon has to appear at a locus in "timespace" where its direction to the emitter corresponds to the direction of the path at wich "something propagating at the speed of light" would have arrived to it from the emitter. But actually it is, hypothetically, just the *phases* of the not yet manifested photon which propagates – as mentioned – with the speed of light. It seems that it may be the direction, in "timespace", of this propagation to the receiver, that is crucial for its absorbtion of a photon. As mentioned on p. 11, this direction should be in line with the zigzag structures of both the emitter and the receiver. The recordable time needed for this process, from the emission of the photon to its absorbtion, is the time 'it takes' for light 'to go' from one place to another – probably following a straight line according to the visual model in Feynman's "QED".

returning from a third-person to a first-person perspective

The final absorber, according to TI has to be "chosen" by the emitter of the offer wave of the photon. At first, as far as I have understood "*decoherence*" according to Wojciech Zurek (2002), the initial, "pure", state vector (i.e. offer wave) has to be reduced ("precollapsed") (excluding impossible states through extremely fast distribution of internal information about the state of the quantum system) to a process of "unitary evolution" which gives the probabilities for all the possible outcomes (having the total sum, 1). The final outcome is the result, according to TI, of a process of transactions of waves between the emitter and possible absorbers, which reinforce certain waves at the same time as other waves are weakened until there is only one definite vibrating structure (a complex of standing waves) left between the emitter and the "chosen" absorber.

Interpreted according to process philosophy, such a path may, in Whitehead's words correspond to a "simple physical feeling" or a "prehension". The emitting occasion is now a historical past, but, according to TPO, perhaps still interacting, in an "active 'past'", through transactions with later occasions. Hypothetically, these paths of standing waves form a network[10] of relations in the active "past" which cannot be studied through objective observations, but may be very important, both to "dead" matter (aggregates of molecules) as an internal regulating source of information, and, to us and other animals, as a deep, "subnatural" (see p. 15) source of emotions.

But it seems that positivism still dominates in physics, chemistry, biology, medicine and even in psychiatry. Scientists are still regarding the (at least in principle) recordable processes of the nervous system as complete representations of

10. Together with the vibrating paths formed by other elementary particles.

our personal experiences. But if this reality is the (hyper-)surface of a deeper reality, as I have tried to describe it, it is possible that the important part of the memory is situated elsewhere (pp. 12–13). The "past" may, for instance, be a still active inner source of information about earlier events and thus serve as an important part of our memory, projecting feelings and perceptual experiences of the past into the present brain (see pp. 12–13). Therefore studies of the nervous system of an individual should combine studies of the body with studies of the historical past of the individual and her/his own experiences of it as active "past".

CONCLUSIONS

Sherburne's original illustration, which is inserted in Fig 3 (p. 19) and in which A and B are two actual occasions of two enduring objects, has fused the space and time dimensions, along which A and B are separated, into essentially one dimension. In other words, the space between A and B actually separates them along a dimension of space as well as a dimension of time. In Fig 3, B has a higher position than A, which describes the distance in time between these occasions. Sherburne's illustration is also completed with a dashed arrow and with vertical lines, with a zig-zag structure inside, symbolizing the *enduring* objects of which A and B are two *actual occasions* att different instants.

Now the illustration has definite liknesses with Fig 1, which shows the transaction that completes the passage of a photon from an emitter to an absorber.

But there is one very important difference. The time dimension in Cramer's illustration is the geometrical dimension of Minkowsky's spacetime, which is just an "abstract logical construction", since the actual emission *no longer exist* at the *recorded time* of the actual absorbtion – if the *world of the flowing time* is *identified* with the *reality*. In any case, whether there is no definite present[11] or if only the present exists[12], the transaction between an emitter and an absorber would have to be considered as a pure abstraction. In Whitehead's words: *"It looks … as though memory, as well as induction, would fail to find any justification within nature itself."* (Whitehead, 1925, ch. III) Whitehead's solution, as I understand it, is to enrich the description of reality with a first-person, subjective, perspective. Then A would be an actuality for B even after the initial occasion. But if it is actual *only* for B (as a first-person experience) the *objective reality* of the transaction between emitter and absorber ("across spacetime", in Camer's words) is still missing.

The solution to this problem, according to the TPO, is to admit a continued *objective* existence, in a hidden 4d space, of every actual occasion as transformed

11. As in the Einsteinian worldview.

12. As in the Newtonian worldview.

into real standing waves. In Fig 2 and 3, the space below the horizontal line, symbolizing the present, is to be understood as symbolizing this hypothetical space (as perceived by an imaginary "fourth-person"). So the vertical dimension here is better conceived as a dimension of the "extensive continuum" (Whitehead 1928) of an "active past", rather than a dimension of time. Time ("active time") is here the upward advancement of the (hyper-)surface of the present into the "original chaos" (a "vacuum" full of activity at the quantum level). Therefore, and since the future is hypothesized as open, the actual occasion B is not present in Fig 2.

Now, this fourth dimension, as a *real* space dimension, may contain processes which continue in it (waves passing to and fro as superpimposed disturbances of its standing waves), only felt within ourselves. Thus Whitehead's first person perspective is now combined with an imaginary perspective of a *real 4d hidden space dimension*. Through this "subnatural" space it is theoreticallly possible that *information may be exchanged*, e.g. from a point in the relatively slowly advancing 3d space of the present *backward* to some *hidden locus of entanglement* of divergent processes and then *forward* to another point of the present. The *unifying* character of such processes can, for instance, explain the undivided character of consciousness and makes it uncertain whether our death necessarily is the end of our consciousness (see pp. 12–13).

A final remark: the temporal world (or the present) should not be interpreted as corresponding to a fine, straight line (i.e. a hyperplane or 3d space) as it is represented here (for convenience). It could more accurately have been drawn as rather fuzzy and irregular. Interpreted as such it may also be symbolized rather well by the circumference of a tree, like the one at p. 2.

A challenge to the transactional interpretation

In the article "Multiple Interaction-Free Measurement as a Challenge to the Transactional Interpretation" Avshalom C. Elitzur and Shahar Dolev give an account of a *"variant of the TI"* that *"… implies a time quite different from that given by present-day physics. It necessitates 'time-outs' during which the intermediate transactions are performed in some Deeper time. Physical theory does not acknowledge such a feature of time, but in what follows we will try to show that it might be just such an extension of the theory that is needed for a better understanding of quantum phenomena."*[13]

The authors, being on the whole positive to TI, finally hypothesize that spacetime "*is in itself subject to dynamics, at least at the quantum level.*"

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13. Elitzur / Dolev (2006) The article is about 16 p long, "moderately technical" and, at least partly, relatively easy to understand. It can be purchased at http://scitation.aip.org/

In the same publication in which the article above is published, there is an article by John Cramer (2006)[14] which gives a short presentation of the TI, accessible to a non-mathematician. It continues with an interesting thought experiment which seems to implicate reverse causation.[15] However Cramer concludes:

"In closing, we must comment that it seems likely to us that there is some hidden flaw in the reverse causation scheme proposed here, and that retrocausal observer-to-observer signal transmission must inevitably fail. However, at present no such flaw is apparent to us, and our TI analysis of the experiment has not provided any indication of such a flaw. Therefore, we must present our retrocausal modification of the Dopfer Experiment as a new quantum paradox."

It seems that Cramer still refers to a traditional spacetime in which every interaction follows the "normal" paths of light.

As an alternative, see pp. 10–11, where an *"active spacetime"* or "timespace" is described – a hypothetically real 4-space with an advancing present as a 3d (hyper-)surface (3-surface) making fast processes back and fourth in the "past" possible. In such a space, the offer wave of TI may be emitted *in any direction*, also reaching more or less 'horisontally', in the active spacetime. The emission may be an (almost?) immediately established fact, with its distribution of oscillations in four dimensions in timespace syncronized to the phases of the emitter (now located in the "active past"). Just the phases of these oscillations would, at the advancing 3-surface, propagate at the speed of light.

According to this description, the "speed of light" may be an illusion created by the speed of growth of the "active 'past'". Hypothetically, the offer waves of the entangled photons of John Cramer's reverse causation thought experiment may be spread *instantly* to both detectors, not, as Cramer seems to suppose, with the "speed of light". The offer waves might therefore immediately adapt to changes of the experimental apparatus, maybe as a "precollapse" according to Zurek's decoherence interpretation (2002), before any of the transactions is completed. These transactions will then be completed (as a final "collapse of the

14. About 6 p. long it can be purchased at http://scitation.aip.org/ (ok 2010).

15. A pair of entangled photons are emitted at the instant t_I (Fig 4) through systems of double slits, to the detectors D_I and D_2 where the distance from the emitter to D_1 is considerably longer than that to D_2. Now, since the photons are entangled, the conditions chosen at D_1 are decisive for the outcome at D_2. If D_I is prepared so that the photon is received through a "double slit", wich forces the photon to appear where it contributes to an interference pattern, or if D_1 is prepared to receive the photon through just one slit, which contributes to no pattern, the same should happen at D_2. But at the arrival of a photon at D_1, the other photon has already appeared at D_2, so the necessary information to the photon at D_2 would have to have arrived before it can be sent from D_1 by the "received photon". "Thus we have a reverse causation and a causality paradox." (Cramer 2006)

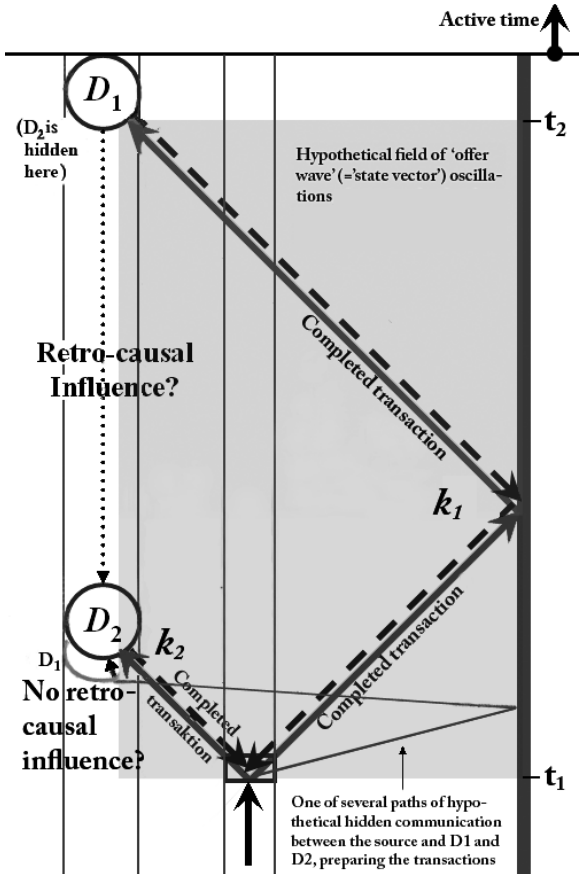

Fig 4. This diagram (an alternative to an illustration in a PowerPoint presentation by John Cramer) suggests a possible solution to his "new quantum paradox" briefly described in footnote 15 (note that D_1 is situated at some distance behind D_2). Cf. pp. 10–11.

state vector", here in two steps after the precollapse) when the possible paths between emitter and absorbers (their becoming "active 'pasts'" still growing in "timespace") correspond to the normal paths of light.[16] No paradoxical, or potentially destructive, retrocausation is thus necessary – if the conditions at D_1 are preserved between the emission and the completed transactions.

However, random changes of D_1 *after* a clear, unchangeable absorbtion at D_2, but *before* the absorbtion of the entangled photon at D_1, might not give any correlations between D_1 and D_2 – or else, if observed, the correlation could be a result of a restriction, mysteriously limiting the experienced free will of the experimenter or the functioning of the experiment apparatus). More probably entangled photons 'refuse' to appear under 'impossible conditions', or if they do, cause tensions in the "active past", perhaps somehow ('secretly') communicated to the present in a way that does not change any record of the historical past.

16. Here the emitter has a "privileged role" regarding which path is chosen, since it is "the echo received by the emitter which precipitates the transaction rather than that received by the absorber." (Cramer 1986)

SUPPLEMENT

Toward a more democratic economic system

An examination of the concepts of *ownership* and *commercial value* clearly shows that they are psycho-social constructions and that they, consequently, should not be treated as isolated attributes of human beings and objects (a common "fallacy of misplaced concreteness", to use the words of a process philosopher[1]). Considering the human society as a flexible and integrated *system*, closely interacting with its environment, one may arrive at something like the presented idea of a possible, if not easy, way toward a democratic society with less social injustices, and probably more sustainable, than our dominating kind of society.

The original version of the text below is written for a Swedish debate, but since we live in a global economy, it may be of some relevance also to the rest of the world. As it is very concentrated, one should be careful not to interpret it too rigidly. Instead, try to find different interpretations, and perhaps better and more elaborated formulations of its ideas.

***

Perhaps the most important question, which any society aspiring to be democratic has to solve, is the rules that regulate the behaviour of its enterprises. To that end the following points may be worth consideration:

To be able to take *local initiatives* for the common good – not for the sake of competition – enterprises must be able to buy their means for production and to sell their products in a sufficiently *free market*. *But the enterprises themselves*

(1) *should not be bought or sold by external shareholders* (since this would leave other stakeholders without influence on decisions of vital importance for their lives, which would, per definition, violate democratic principles) and should pay decent salaries to its employees (or members) rather than dividends;

(2) *should be democratically governed*, internally and externally, by all those who are appreciably affected by and involved in the activities of the enterprises (when necessary, for practical reasons, through a democratically elected board), with a special concern for minorities, the environment and other species;

(3) *should be included in a democratically controlled social distributive system* designed to avoid poverty, unnecessary bankruptcy and excessive wealth, to make important services like health care, schools and communication accessible to anyone, and reduce large scale harm caused by local activities.

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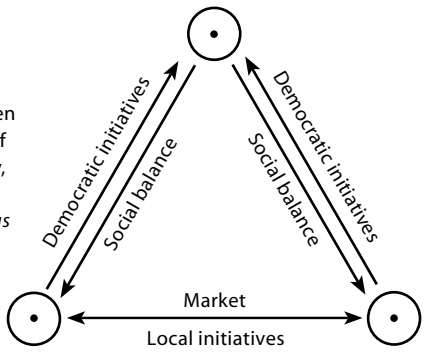
1. Alfred North Whitehead in *Science and the Modern World* (1925).

Since these points are mutually dependent, a process toward a better attainment of all of them might for instance start with efforts to improve the democracy according to point 2, which would, ideally, end in the liberation of the enterprises from the dominance of their owners, satisfying point 1 – whereby economic aid according to point 3 should guarantee their survival. But since it is probable that a distributive system according to this point would not be well developed before a more general attainment of point 1, it would be necessary to try to establish a *positive feed-back process* with gradual changes. To this end a strong support by *personally engaged participants* would be necessary. It should be a *creative process*, where the points 2 and 3 gradually become more elaborated and developed (and where already working democratic institutions, like well functioning law and educational systems, have to be defended).

Even if experience shows that a well functioning democratic system is incompatible with a centrally planned production and market, it may be necessary that a global, fairly centralized, distributive system according to point 3 contributes to an acceptable moderation of the uneven distribution of wealth that may be the result of a free market. The attainment of this point may be facilitated, for instance, by the establishment of a growing number of non-profit organizations *without (external) owners* – governed according to point 1 and 2. A socially integrated, democratically governed, (system of) non-profit bank(s), which may guarantee a financial support to such organizations (together with some agreement(s) that uninvested profits is to be redistributed to the society), could be an embryo of a new, social distributive system. As a start, it would be wise to *stimulate a general interest* in the kind of organizations that may belong to such a system.[2]

- = An individual, deeply felt *stabilizing activity,* hypothetically sustained by the *"active past"*, especially when stimulated by the culture of the society (e.g. philosophy, literature, undogmatic religion, etc.), *preventing vicious circles*.



Important relations on *every level* of the society to be balanced in a democratic economy. (Especially '*democratic initiatives*' and '*social balance*' may need careful attention.)

2. A proposal that seems very close to the above is given by Joel Magnuson in his book *Mindful Economics: How the U. S. Economy Works, Why it Matters, and How it Could Be Different* (New York, NY: Seven Stories Press, 2008). In my view an excellent and very readable popular introduction.

APPENDIX

The belief statement of WPM*

1. We revere and celebrate the Universe as the totality of being, past, present and future. It is self-organizing, ever-evolving and inexhaustibly diverse. Its overwhelming power, beauty and fundamental mystery compel the deepest human reverence and wonder.

2. All matter, energy, and life are an interconnected unity of which we are an inseparable part. We rejoice in our existence and seek to participate ever more deeply in this unity through knowledge, celebration, meditation, empathy, love, ethical action and art.

3. We are an integral part of Nature, which we should cherish, revere and preserve in all its magnificent beauty and diversity. We should strive to live in harmony with Nature locally and globally. We acknowledge the inherent value of all life, human and non-human, and strive to treat all living beings with compassion and respect.

4. All humans are equal centers of awareness of the Universe and nature, and all deserve a life of equal dignity and mutual respect. To this end we support and work towards freedom, democracy, justice, and non-discrimination, and a world community based on peace, sustainable ways of life, full respect for human rights and an end to poverty.

5. There is a single kind of substance, energy/matter, which is vibrant and infinitely creative in all its forms. Body and mind are indivisibly united.

6. We see death as the return to nature of our elements, and the end of our existence as individuals. The forms of "afterlife" available to humans are natural ones, in the natural world. Our actions, our ideas and memories of us live on, according to what we do in our lives. Our genes live on in our families, and our elements are endlessly recycled in nature.

7. We honor reality, and keep our minds open to the evidence of the senses and of science's unending quest for deeper understanding. These are our best means of coming to know the Universe, and on them we base our aesthetic and religious feelings about reality.

8. Every individual has direct access through perception, emotion and meditation to ultimate reality, which is the Universe and Nature. There is no need for mediation by priests, gurus or revealed scriptures.

9. We uphold the separation of religion and state, and the universal human right of freedom of religion. We recognize the freedom of all pantheists to express and celebrate their beliefs, as individuals or in groups, in any non-harmful ritual, symbol or vocabulary that is meaningful to them.

Original version agreed on December 7, 1997

Bruce Blaisdell, Hilary Caws-Elwitt, Bill Garrett, Jan Garrett, Henry Gibbard, Paul Harrison, Ron Hooft, Deng Yongkang, Julie Legge, Jocelyn Markey, Tor Myrvang, Jeff Pitcher, Bernt Rostrom, Sue Williams, Adam Yonce

Revised on November 18, 1999

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Comment on the belief statement of WPM

It seems to me that the belief statement of WPM agrees very well with my Transactional Process Ontology (TPO). However, it apppears that this ontology makes it possible to add the following to the second sentence of the sixth paragraph of the belief statement ("The forms of 'afterlife' available to humans are natural ones, in the natural world …"): "… which, according to a [i.e. TPO's] 'possibilist' interpretation of time, may include a *still active 'past'*." – The WPM "Universe" seems, then, to correspond quite well to the *'active spacetime'* of TPO, which comprises: the present (temporal) world, its (active) 'past', and its (open) 'future' (still in the form of an 'original chaos').

– As far as I see, point 4 of the belief statement is perfectly compatible with my supplement on 'a more democratic economy' (pp. 28–29), which is intended to be sufficiently open to different solutions to avoid being too close to a definite political tendency.

– The only change as to ones understanding of the belief statement of WPM, that this comment may imply is, as far as I can see, an awareness that natural processes may extend into an "active 'past'" – which just should increase ones awareness of the importance of its points.

Pantheism based on TPO may be quite close to a pan*en*theism compatible with TPO (i.e. a naturalistic panentheism with a universally sustaining "God" that is neither literally omnipotent nor omniscient) – which means that the main relations between theism, panentheism, pantheism and atheism may be represented like this (which suggests the possibility of fruitful collaboration between pantheists and panentheists):

theism → *panentheism* ↔ *pantheism* ← *atheism.*

BVH

A personal pantheistic statement

– To get a credible worldview, I think our *reason*, our *models of reality*, and our *ethics*, have to be based on *more or less direct objective observations of nature* and *only very general subjective (inner) experiences* – and consequently always open to changes.

As a result of such experiences by myself and others:

– I *do not believe* that our Universe is created by an omnipotent mind capable of violating its basic principles (i.e. its rather well confirmed 'natural laws').

– But I *do* believe that the Universe is a vibrating unity of which I and every other being are relatively freely and creatively interacting parts. Since it seems that a credible model (capable of giving confirmed predictions) of this Universe may have to refer to a "past" beyond its propagating 'now' to be without rational gaps, the Universe may *actually* be extended into such a region. It may be a source of inner experiences (by theists often referred to as God) and yet an integrated part of the Universe.

– Accepting and conforming to these points, I think it is *most important* that we, whenever possible, contribute to the creation of good, harmonious relations in the present (with a global concern for the future) and – as far as it is not in conflict with this – try to minimize suffering.

BVH

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