Essay

Is Negentropy Maximization Principle Needed as an Independent Principle?

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Abstract

I have proposed Negentropy Maximization Principle (NMP) as a variational principle for the evolution of conscious experience. Mathematically, NMP is very similar to the second law although it states something completely opposite. Second law follows from statistical physics and is not an independent physical law. Is the situation the same with the NMP? Is NMP needed at all as a fundamental principle or does it follow from number theoretic physics? Two additional aspects are involved. Evolution can in adelic physics be seen as an unavoidable increase in the algebraic complexity characterized by the dimension $n = h_{eff}/h_0$ of extension of rationals associated with the polynomial defining the space-time region at the fundamental level by socalled $M^8 - H$ duality. There is also the possibility to identify a quantum correlate for ethics in terms of quantum coherence: the good deed corresponds to a creation of quantum coherence and the evil deed to its destruction. How do these two aspects relate to the NMP? Is NMP an independent dynamical principle or a consequence of number theoretic (adelic) quantum physics? If the reduction of quantum coherence in state function reduction serves as a correlate for evil deed, how does the conscious entity, self, know or learn this?

1 Introduction

Discussions in the Zoom group led once again me to worry about the Negentropy Maximization Principle (NMP) [2, 14, 8], which I have proposed as a variational principle for the evolution of conscious experience. Mathematically, NMP is very similar to the second law although it states something completely opposite. Second law follows from statistical physics and is not an independent physical law. Is the situation the same with the NMP? Is NMP needed at all as a fundamental principle or does it follow from number theoretic physics?

Two additional aspects are involved. Evolution can in adelic physics [9] be seen as an unavoidable increase in the algebraic complexity characterized by the dimension $n = h_{eff}/h_0$ of extension of rationals associated with the polynomial defining the space-time surface at the fundamental level by socalled M^8-H duality [11, 12]. There is also the possibility of identifying a quantum correlate for ethics in terms of quantum coherence: a good deed would correspond to a creation of quantum coherence and the evil deed to its destruction.

How do these two aspects relate to the NMP? Is NMP an independent dynamical principle or a consequence of number theoretic (adelic) quantum physics implied by the unavoidable increase of the algebraic complexity? If the reduction of quantum coherence in state function reduction serves as a correlate for evil, how does the conscious entity, self, know or learn this?

In the sequel, the notion of number theoretic evolution, the possible connection between quantum coherence and ethics, and p-adic negentropy as a measure for the information content of conscious experience, allowing to resolve the apparent conflict of NMP with the second law, are discussed. Two options for the NMP are discussed and the conclusion that, in analogy with the second law, NMP is a consequence of number theoretic quantum physics. Also the question how zero energy ontology (ZEO) makes it possible for a conscious entity, self, to learn the distinction between good and evil, is considered. In the case that the deed affects the self, this means learning what deeds are threats for the existence of self.

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2 Background notions and ideas behind NMP

It is good to discuss first the basic concepts and ideas behind NMP [2, 14, 8] .

2.1 Number theoretic evolution

$M^8 - H$ duality is the cornerstone of number theoretical (or adelic) physics [10, 9]. M^8 or rather its complexification is interpreted as complexified octonions and one has $H = M^4 \times CP_2$. M^8 is analogous to momentum space and $M^8 - H$ duality becomes the analog of momentum-position duality when a point-like particle is replaced with 3-surface.

1. The roots of a polynomial P with rational coefficients (they can be chosen to be integers by a suitable scaling) define a set of 3-D hyperbolic spaces H^3 having interpretation as mass shells in M^4.

2. The 3-surfaces associated with these mass shells define 4-surfaces by the holography in H forced by general coordinate invariance. In M^8 the holography is defined by the condition that the normal space of the 4-surface is associative (quaternionic). Therefore associativity becomes the number theoretic variational principle.

3. A stronger condition would be that the 3-surfaces correspond to unions of 3-D hyperbolic manifolds as sub-manifolds of H^3 [17]. The 4-surface in M^8 defines by $M^8 - H$ duality a space-time surface in H.

Physical intuition suggests additional conditions on the integer coefficients of the polynomials P.

1. In [18] the possibility that the integer coefficients of the polynomial P are smaller than the degree $k(P)$ of the polynomial, is discussed. The assumption that the integers are smaller than n has strong intuitive physical motivations and has deep mathematical and physical implications.

   The number of these kinds of polynomials of a given degree k is finite as is also the number of corresponding space-time surfaces as points of the "world of classical worlds" (WCW). Also the number of the points of 4-surface is finite in the unique discretization of the 4-surface of M^4 by points in the extension of rationals defined. As a consequence, quantum TGD becomes computable in a rather strong sense. One can also say that the physical system itself defines its approximation. The algebraic complexity of the space-time surface dictates the maximal information content of the associated quantum states.

   The second implication is that finite fields become a fundamental structures of the number theoretic physics besides other number fields (classical number fields, rationals and their extensions, and p-adic number fields and their extensions). These number fields combine to adeles and also infinite primes, integers and possibly also rationals are involved [5, 6, 4].

   A given polynomial defines an algebraic extension of rationals, which makes its manifest in number-theoretic physics via Galois confinement.

2. The higher the degree k of the polynomial, the higher the dimension n and complexity of the extension can be. $n = h_{eff}/h_0$ serves as a measure for the complexity of the system, a kind of IQ, and for the scale of quantum coherence.

3. Since there are many more polynomials of degree k higher than the given degree k_0 than those of lower degree, the degree of polynomial P defining the space-time surface and the dimension n of corresponding extension of rationals n tend to grow in the series of quantum jumps. The world is getting smarter, and this fact seems to follow only from basic number theory.

   This motivates the question whether also NMP follows from number theory and quantum theory in the same way as the Second Law follows from the nondeterminism of state function reduction.

2.2 Quantum coherence and ethics

According to the TGD inspired theory of consciousness [3] any system can be conscious and the distinction between electron and human is only due to the different degree of the complexity of the systems involved.

Quantum coherence means something positive intuitively. This suggests that the creation of quantum coherence could be seen as a good deed at the fundamental fundamental level. The notions of good and evil would be universal.

1. Free will makes it possible also the destruction of quantum coherence. This would be the physical correlate of violence at the fundamental level. Good deeds create quantum coherence and evil deeds destroy it. This formulation of quantum ethics does not seem to relate in any obvious way to NMP or number-theoretic evolution.

2. The selection between good and evil is made in each BSFR as the partition of the system into a subsystem and complement is selected. NMP tells if BSFR can happen for this particular partition or not. If BSFR happens, a bad deed has been done, otherwise the deed is good since quantum coherence does not decrease.

2.3 What does one mean with p-adic negentropy?

To define p-adic entropy and negentropy, one must define p-adic counterparts of probabilities. This definition is possible if the probabilities are in an extension of rationals so that they make sense both as p-adic and real numbers. This poses conditions on entanglement coefficients.

If the entanglement coefficients for the pair of systems defined by subsystem and its complement are in the extension of rationals defined by the polynomial P, the probabilities are in an extension of this extensions since they are eigenvalues of the density matrix and defined by a polynomial whose degree is the dimension D of the state space defined by the entangled states. This suggests a criterion for whether the SFR can take place.

1. The definition of p-adic entropy is given by the Shannon formula by replacing the logarithms of probabilities with the logarithms of their p-adic norms: they are well-defined for any extension of rationals. Note that the entropy is a real number so that "p-adic" might be somewhat misleading.

   The p-adic entropy satisfies the same additivity formula as the ordinary Shannon entropy. Unlike the ordinary entropy, the p-adic entropy can be negative, and this motivates the identification of p-adic negentropy as a measure of information. The total p-adic negentropy can be defined as a sum over the p-adic negentropies for various primes p.

2. The interpretation of p-adic negentropy is as a measure of negentropy of quantum entanglement associated with the partition of a system to a subsystem and complement. One could also consider all possible partitions of the system to subsystem and complement and assign to them the sum of p-adic entanglement negentropies identified as the total p-adic negentropy.

3. The total p-adic negentropy could be interpreted as a measure of the content of the system's conscious information. Ordinary entropy is in turn a measure of the external observer's ignorance of the state of the system (Schrödinger cat). Therefore the apparent conflict between NMP and the second law disappears.

4. A large p-adic negentropy is accompanied with a large standard entropy, and this could perhaps be interpreted so that the creation of conscious information produces entropy at the level of matter [14]. The difference of the p-adic negentropy and the ordinary entropy is non-negative and is guaranteed by NMP and the basic properties of p-adic negentropy. The difference between negentropy and entropy increases even though entropy is created at the level of matter. Number theoretic evolution implies the increase of the total p-adic negentropy.

5. A possible concrete biology inspired interpretation is that the system tries to extract as much information as possible from the incoming organized energy (metabolic energy) and in an ideal situation only completely unorganized thermal energy remains, what is produced by dissipation. What we call energy saving is exactly this efficient extraction of information. Conscious information-producing systems that use metabolic energy to increase hbar dissipate. This is what Jeremy England discovered [1, 7].

2.4 Zero energy ontology very briefly

The key notions of zero energy ontology (ZEO) are zero energy states defined as pairs of quantum states at the 3-D boundaries of the space-time surface at the opposite boundaries of a causal diamond (CD= $cd \times CP_2$, where c is causal diamond of M^4) having interpretation as a 4-D perceptive field. For how the space of CDs forms the backbone of the "world of classical worlds" (WCW) see [20].

Geometrically, the zero energy states are superpositions of space-time surfaces connecting the opposite boundaries of CD. The space-time surfaces satisfy holography and are analogous to Bohr orbits. Twistor lift leads to a proposal that they correspond as extremals of 6-D Kähler action to 4-D minimal surfaces which are simultaneously extremals of 4-D Kähler action. An intriguing fact is however that since the field equations reduce to a 4-D generalization of 2-D holomorphy, they are also extremals for a very large class of actions. The possible implications of this are discussed in [20].

There are two kinds of state function reductions (SFRs).

1. One can assign to CD a passive boundary, which is only scaled during "small" SFRs (SSFRs) and the states at it are unaffected: this is the counterpart for Zeno effect. SSFRs correspond to repeated measurement of the same observables at the passive boundary. The additional observables measured at the active boundary of CD must commute with these observables.

   The states at the active boundary are affected in SSFRs and the geometry of the future light-one implies that the active boundary drifts farther away from the passive boundary in the statistical sense at least. Therefore the temporal distance between the tips of the CD increases. This corresponds to the flow of geometric time correlating with the sequence of SSFRs defining subjective time.

2. When the measured observables are changed to new ones, not commuting with the original ones, the state at the passive boundary changes and BSFR takes place. Passive boundary of the CD becomes active and vice versa and the arrow of time changes. CD begins to increase in the opposite direction of geometric time. The implications are discussed from the point of view of consciousness and quantum biology in [20].

It took a long time to become convinced that quantum jump can involve the creation of an entirely new CD. Birth would be a universal quantum phenomenon. The minimal interpretation is that a new perceptive field is created. ZEO also allows the "Eastern view" in which a new Universe would be created.

3 Negentropy Maximization Principle revisited

NMP is mathematically analogous to the second law of thermodynamics and the proposal has been that it serves as the basic variation principle of the dynamics of conscious experience. NMP says that the information related to the contents of consciousness increases for the whole system even though it can decrease for the subsystem. The number theoretic evolution is such a powerful principle that one must ask whether NMP is needed as a separate principle or whether it is a consequence of number theoretical quantum physics, just like the second law.

Consider in the sequel BSFR as the counterpart of the ordinary state function reduction. I'm not completely sure whether the following arguments can be also applied to SSFRs for which the arrow of time does not change.

One can consider two alternative formulations for NMP.

3.1 Option I

Option I is the simpler and physically more plausible option.

1. BSFR divides the quantum entangled system at the active boundary of CD into two parts, which are analogous to the measurement apparatus and the measured system. The selection of this partition is completely free and decided by the system. This choice corresponds to an act of free will. Depending on conditions to be discussed, the action of the measurement to this pair can be trivial in which case the entanglement is not reduced. The measurement can also reduce the entanglement partially or completely and the p-adic entanglement negentropy and entropy decreases or becomes zero.

2. If the partition into two parts is completely free and if the choice is such that NMP, or whatever the principle in question is, allows BSFR, the quantum coherence decreases. Number theoretic evolution suggests that the principle telling when BSFR can occur is number theoretic.

   There is a cascade of BSFRs since BSFRs are also possible for the emerging untangled subsystem and its complement. The cascade stops when the entanglement becomes stable.

3. What condition could determine whether the reduction of the entanglement takes place? What could make the entanglement stable against BSFR?

   Number theoretical vision suggests an answer. Physical intuition suggests that bound states represent a typical example of stable quantum entanglement. Bound states correspond to Galois confined states [19, 13, 15, 16] for which the momenta of fermions are algebraic integers in an extension of rationals but total momentum has integer valued components. This mechanism for the formation of the bound states would be universal.

   A natural number theoretical proposal is that the entanglement is stable if the entanglement probabilities obtained by diagonalizing the density matrix characterizing the entanglement belong to an extension of rational, which is larger than the extension, call it E, defined by the polynomial P defining the space-time surface. An even stronger condition, inspired by the fact that cognition is based on rational numbers, is that BSFR can take place only if they are rational.

   This kind of entanglement would be outside the number system used and one can argue that this forces the stability of the entanglement. A weaker statement is that the reduction is possible to a subspace of the state space for which the entanglement probabilities belong to E (or are rational).

4. This option could replace NMP as a criterion with a purely number theoretical principle. This does not however mean that NMP would not be preserved as a principle analogous to the second law and implied by the number theoretic evolution in turn implied by the hierarchy of extensions of rationals.

Could free will as the ability to do evil or good deeds reduce to number theory that is to the choice of a partition, which leads to either increase or decrease of entanglement negentropy and therefore of quantum coherence?

The basic objection can be formulated as a question. How can the conscious entity know whether a given choice of partition leads to BSFR or not? Memory must be involved. Only by making this kind of choices, a system with a memory can learn the outcome of a given choice. How could the self learn, which deeds are good and which are evil? The answer is suggested by the biologically motivated view of survival instinct and origin of ego [21] based on SSFRs as a generalization of Zeno effect.

1. Conscious entity has a self characterized by the set of observables measured in the sequence of SSFRs. BSFR as a reduction of entanglement occurs when a new set of observables not commuting with the original set are measured. In BSFR self "dies" (loses consciousness). Second BSFR means reincarnation with the original arrow of time.

2. The perturbations of the system at both boundaries of CD are expected to induce BSFRs and to occur continually. Therefore the arrow of time is fixed only in the sense that it dominates over the opposite arrow.

3. Self preserves its identity (in particular memories defining it) if the second BSFR leads to a set of observables, which does not differ too much from the original one. The notions of survival instinct and ego would reduce to an approximate Zeno effect.

4. This mechanism would allow the self to learn the distinction between good and evil and also what is dangerous and what is not. A BSFR inducing only a brief period of life with a reversed arrow of time could teach the system when the BSFR leads to a reduction of entanglement and loss of coherence.

   The harmless BSFRs could provide a mechanism of imagination making survival possible. Intelligent systems could do this experimentation at the level of a self representation of a system rather than in real life and the development of complex self representations would distinguish higher life forms from those at a lower evolutionary level.

3.2 Option II

Option II is stronger than Option I but looks rather complex. I have considered it already before. NMP would select a partition for which the negentropy gain is maximal in BSFR or at least, the decrease of the negentropy is minimal. One must however define what one means with negentropy gain.

Before considering whether this condition can be precise, it is good to list some objections.

1. Is the selection of this kind of optimal partition possible? How can the system know which partition is optimal without trying all alternatives? Doing this would reduce the situation to the first option.

2. Free will as ability do also evil deeds seems to be eliminated as a possibility to either increase or decrease entanglement negentropy and therefore quantum coherence by choosing the partition of the system so that it reduces negentropy.

3. If the BSFR cascade would lead to a total loss of quantum entanglement, the entanglement negentropy would always be zero and NMP would not say anything interesting. On the other hand, if the selection of the partition is optimal and the number theoretic criterion for the occurrence of the reduction holds true, it could imply that nothing happens for the entanglement. Again the NMP would be trivial.

4. What does one mean with the maximal negentropy gain?

3.3 What does one mean with a maximal negentropy gain?

Option II for NMP says that for a given partition BSFR occurs if the entanglement negentropy increases maximally. What does one mean with entanglement negentropy gain? This notion is also useful for Option I although it is not involved with the criterion.

1. Entanglement negentropy refers to the negentropy related to the *passive* edge of the CD (Zeno effect). Passive boundary involves negentropic entanglement because NMP does not allow a complete elimination of quantum entanglement (bound state entanglement is stable). The new passive boundary of CD emerging in the BSFR corresponds to the previously active boundary of CD.

2. For option I for which the concept of good/bad is meaningful, the number theoretical criterion could prevent BSFR and stop the BSFR cascade. There is however no guarantee that the total entanglement negentropy would increase in the entire BSFR cascade. This would make the term "NMP" obsolete unless NMP follows in a statistical sense from number theoretic evolution: this looks however plausible.

   The unavoidable increase of the number theoretical complexity would force the increase of p-adic entanglement negentropy and NMP as an analog of the second law would follow from the hierarchy of extensions of rationals.

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