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Preestablished Harmony Revisited: Generalised Entanglement is a Modern Version of Preestablished Harmony

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Abstract¹

Leibniz' notion of "pre-established harmony" is one of the central notions of his philosophy. It is the conceptual hinge which allows all monads to be interrelated and coordinated yet not influenced by each other through causal interactions, allowing Leibniz to construct a model of the world where moral justice can be philosophically incorporated. This concept has been viewed with some misgivings during the history of philosophy, finally being dismantled during the post-modern turn. We suggest its revival, based on the concept of a weak or generalised quantum theory, an axiomatic, systems theoretical approach, modelled along the same lines as the algebraic quantum theory. In contrast to quantum theory this drops a lot of definitions and restrictions, and is also applicable to different types of systems. Interestingly, its formalism preserves one central element of the quantum mechanical formalism: the handling of non-commuting or complementary observables. In consequence, the model predicts a generalised form of entanglement, i.e. non-local correlations across distance and time, that are not mediated through signals, but through the make up of the system as such. This seems to be a "mechanism" or coordination which could operate independent of and complementary to standard causal interactions, akin to the way Leibniz conceived pre-established harmony. We argue that such a generalised version of entanglement (GET) is in fact a systematic novel interpretation of pre-established harmony. If this line or argument is prolonged into the realm of morality and ethics, we have in fact a full fledged revival of Leibniz pre-established harmony.

¹ HW and NvS are very grateful to Wayne Jonas from the Samueli Institute who is generous and perceptive enough to support our research. Niko Kohls helped us with some references and with a critical reading of a draft version. HW wishes to acknowledge the long years of training and many discussions he had with his philosophical teacher Prof. Friedrich A. Uehlein on Leibniz, and who originally pointed out the similarity between the concepts of entanglement and pre-established harmony to him. Thus, as far as HW is concerned, this paper is a belated present to F.A. Uehlein's last anniversary.

Pre-established Harmony (PEH) is probably the most controversial and potentially least well understood concept in the philosophy of Leibniz. It cannot be understood as a coherent concept within the framework of 17th and 18th century of linear Newtonian physical thinking. Since our scientific development, the debate and the general frameworks offered were largely dominated by Newtonian physics and an extrapolation of the concepts derived from it into all branches of scientific thinking, and even into the social sciences and philosophy itself, it does not come as a surprise that this Leibnizian concept has fallen out of favour with most philosophers, let alone scientists. It is only with the surreptitious revolution introduced by quantum mechanics (QM) that the general intellectual climate has received an important new stimulus that allows a revitalisation of PEH as a scientific and philosophical concept that can be taken seriously again, even more so than within Leibniz' own understanding. This has to do with the fact, we claim, that Leibniz himself used intellectual structures and ways of thinking that are not linear, but similar to dialectical thinking.

Leibniz' way of reasoning could be called complementaristic in the sense that Niels Bohr, one of the founding fathers of QM, introduced the term into the scientific debate. As Leibniz did not have the explicit, let alone formal, apparatus at hand that later on Bohr and his followers had, he was not able to formulate a coherent concept of PEH, but rather a more intuitive one which was dependent on his metaphysical presuppositions.

In what follows we will try to reconstruct the concept of PEH in a modern version that is building on some seminal insights from QM. In order to do this, we will first explain the difference between the general Newtonian or local world-view as opposed to a Leibnizian or non-local concept of the world. Then we will go on to explain what is meant by "complementarity" and "complementaristic" thinking. In a third step, we will show that this is in fact the structure of reasoning that Leibniz used. In a fourth step, we will delineate the argument that shows that complementarity is at the heart of a much debated feature of QM, entanglement. As a consequence, the generalised version of quantum theory, Weak Quantum Theory (WQT) developed by Atmanspacher, Römer & Walach² predicts entanglement as a generalised systemic property, whenever complementarity is present under certain conditions. We will then proceed to propose that this Generalised Entanglement (GET) does in fact function as a modern reinterpretation of Leibniz' PEH, thus reconnecting science proper with the social sciences and in fact with history and morality in a similar way as it was envisaged by Leibniz. As a moral afterthought, we

² H. Atmanspacher, H. Römer and H. Walach, "Weak quantum theory: Complementarity and entanglement in physics and beyond" ["Weak Quantum Theory"], *Foundations of Physics* 32 (2002): 379-406.

sketch how the moral dimension of PEH might be reflected by this new interpretation.

We are operating on an obvious presupposition: We are taking a moderately realistic stance and take it for granted that our present scientific theories are in fact related to reality in an at least partially truthful way, granting, however, that there may be an over-determination which could just as well be captured by alternative theories. We are also taking for granted that QM being one of the most widely tested scientific theories is a reasonably safe place to start conceptualisation with. Here may also be the place to point out that a lot of the philosophical reasoning regarding science and regarding philosophy of science is still implicitly building on a slightly broadened but still Newtonian picture of the world, hoping for an eventual integration of QM into the Newtonian model of relativity. It may well be the case that this won't be as easy and as straightforward as is mostly taken for granted. Our personal stance adopted here is that QM offers a picture that is not easily reconcilable with a Newtonian view of the world. The key feature of this new world-view is centred on the concept of complementarity, which is neither necessary nor useful within a Newtonian framework. And it may well be the case that a Newtonian approach and a Quantum approach are themselves irreconcilable and complementary aspects of our description of reality.

What this means will become clear soon, we hope, when we take the first argumentative step, describing the concept of complementarity. Before we do that it may be useful to make explicit what we mean by a "Newtonian" approach.

Newton and Leibniz – Two Complementary Figures: Locality versus Non-locality

As is well known, Newton and Leibniz were roughly contemporaneous writers. While the agile, talkative and communicative Leibniz travelled all over Europe, was seen in many circles and courts, corresponded with the mighty and important of his time, Newton was quite reclusive, a difficult person to get along with, and not at all communicative³. His "Principia" seem to have been a grudging reaction to his realising that if he did not communicate, Leibniz would find the same discoveries on his own and would publish his findings straight away. Not only were the two giants complementary characters in terms of societal standing and personality, they also adopted complementary approaches. One standard way of putting it would be to say that Newton tried to explain the world as a mechanism of outer relations, comparable to a clock-work running smoothly, while Leibniz adopted the explanatory approach of inner relations. Newton wanted to explain the

³ M. White, *Isaac Newton: The Last Sorcerer* (London: Fourth Estate, 1997)

world as a rational array of locally acting forces, imbuing each other, the particles they acted upon and all future events with a linear structure of causation⁴. Leibniz, on the other hand, wanted to explain the development of the world as a process following an inner development such that outer contact and seeming material impact of one particle onto another were not the causes and consequences of outer, material movements, but the mirrored reflex of an inner development. In that debate, mainly documented in Leibniz' letters to Clarke⁵, who acted as a go-between for Newton, the more modern phraseology which we are going to use, was prefigured in essence: Newton adopted a local world model, while Leibniz adopted a non-local one. Newton proceeded along the path of outer relations, while Leibniz preferred inner relations.

The terminology of "local" versus "non-local" events is a child of relativity theory. A good conceptual analysis can be found in Reichenbach⁶. Simply put, special relativity postulates that the ultimate speed a particle in the universe can travel with is the speed of light. Hence, all parts of the universe that are theoretically reachable by a light ray sent out from a radiating source are locally connected, because they can receive the causal influence transmitted by this light signal. This means that a canon ball fired against a target, a radio phone signal directed towards a communication partner, an electric signal released by a switch within an electric circuit can all be causal signals hitting a target, reaching a distant partner, operating a computer. What is impossible in this world-view is an analysis that postulates that the target attracted the canon ball, the communication partner remotely triggered the phone call, or the computer came on all by itself, because a certain file needed displaying or a certain operation wanted to be carried out. Since the travelling of causal signals needs time, even if it is only the small amount of one second to travel roughly 300.000 kilometres, signalling from the future into the present and thus final causation is not possible⁷. Neither is a causation between spatially separated regions that are not locally connected a possibility within such a model. In other words, a Newtonian-causal model of the world allows only for effective causation, in Aristotelian terminology. Newton was well aware of that fact. Indeed, he found his own solution to planetary motion that allowed for a seemingly non-local cause,

⁴ HP Stapp, "Transcending Newton's legacy," in *Some Truer Method Reflections on the Heritage of Newton*, eds. F. Durham and RD Purrington (New York: Columbia University Press, 1990), 227-245.

⁵ Leibniz GW: "Streitschriften zwischen Leibniz und Clarke (1715-1716)" in *Hauptschriften zur Grundlegung der Philosophie Vol. 1*, eds. A. Buchenau, and E. Cassirer (Hamburg: Meiner, 1966), 120-241.

⁶ H. Reichenbach, *The Philosophy of Space and Time* (New York: Dover, 1957)

⁷ P. Fitzgerald, "Tachyons, backwards causation and freedom", *Boston Studies in the Philosophy of Science* 8 (1971): 415-436.

namely gravity, to move planetary bodies without intermediate forces, quite disconcerting, as he indicated in a letter to his friend Bentley. He wrote:

"It is inconceivable that inanimate brute matter should, without the mediation of something else which is not material, operate upon and affect other matter without mutual contact... that one body may act upon another at a distance and through a vacuum without the mediation of anything else by and through which their action or force may be conveyed from one to another is to me so great an absurdity that we believe no man who has in philosophical matters any competent faculty of thinking can ever fall into it."⁸

Locality, then, is the doctrine that only material causes in contiguous contact with one another can bring about changes in the universe. It is the task of science to unravel the material and mathematical structure of this network of forces and causes. While for Newton there still was the implicit, if largely hidden, hope that those mediating forces may turn out to be spiritual in nature, the pace of history has done away with them and disenchanting the structure of the world. In today's physical concept there are four fundamental forces that rule the world, each mediating its influence via virtual particles, i.e. minute bits of (virtual) matter⁹. Most of them have been empirically discovered and analytically described, the photon being the most prominent of them mediating the electromagnetic force. Only Newton's gravity, ironically, defies the hunt for a substrate, as the graviton, the purported particle conveying gravitational forces, is still on the run and only a theoretical entity.

In the light of such a world-view Leibniz' "inner relations" seem to be at best an outdated, outlandish concept, and at worst a revisionist weapon in the hands of those that refuse to adapt to the pace of history. Leibniz had upheld his doctrine against fierce argument from Newton's quarters. He postulated that the outer development of the world was just a consequence of inner developments within monads, the full reason of which was not the past history of a monad, but the future end state of potentially expressing the whole from an individual perspective¹⁰. Hence causality in a Leibnizian sense is at the same time effective and local as well as final and non-local. Causation has to be discussed and understood from a potential future state of maximal possible perfection and maximal possible expression of totality, too. This, however, in modern terminology, is a non-local concept of causation. With Leibniz, causes do not necessarily run from the past to the future, as in Newton's

⁸ HW Turnbull ed., *The Correspondence of Isaac Newton – Vol 3* (Cambridge: Cambridge UP, 1961), 253-254

⁹ P. Davies, *Superforce - The Search for a Grand Unified Theory of Nature*, (London: Unwin, 1985)

¹⁰ GW Leibniz "Monadologie 1714" in *Hauptschriften zur Grundlegung der Philosophie Vol. 2*, eds. A. Buchenau and E. Cassirer. (Hamburg: Meiner, 1966), 435-456.

world-view. They do not necessarily depend on material signals, but are also a consequence of a future end state yet to be reached, together with the formal constitution of the whole kosmos. This we would call a non-local view of causation.

But did Leibniz deny physical causation, effective causation in Aristotelian terminology, the network of local causes to be derived from Newtonian physics? Certainly not! He thought that such causes were operative in the material world but that they are not the most fundamental and not the only causes in the universe. They act contingent upon and dependent on the development of each monad¹¹. Since every monad in its development is not at all influenced by other monads, but only reflects the development of the whole from its own individual standpoint, the whole development of the world is coordinated as a universe of monads expressing this whole from their respective individual standpoints and perspectives such that this outer development is a reflection of the sum total of all inner developments of monadic lives. This is the reason why Leibniz insisted on the fact that monads are “windowless”, not physically influenced by external events, but expressing inner developments. The mechanism by which all these developments are coordinated is called pre-established harmony by Leibniz. It hinges around the thought that the central monad, God, cannot but construct the best possible of all universes, and hence all the movements, developments and perceptions of all monads are the ones that are most compatible with the greatest good for the whole.

Now, this thought is certainly peculiar, over-complex and far from intuitive, one would think. It necessitates a strange doubling of the world: an inner world that develops and thereby necessitates an outer world that exchanges material signals in accordance. Yet this apparent causation is just a fiction, one might think, because the real causation happens on an entirely different level, namely in the inner development of monads. Every strict naturalist, Newtonian thinker and realist used to straight argument must feel like on a roller-coaster when following this thread. Leibniz even seems inconsistent at places, vacillating between a description that is one time taking on the outside perspective, describing the material aspect and development of the world, another time adopting an inner perspective, analysing the mental aspect and inner development of a monad. One time he seems to conceive of the world in purely idealistic terms, as being the reflection of mental activity only. At another time he seems to adopt an atomist stance describing his monads as infinitesimally small elements of matter. But then, how would these infinitesimal particles be able to sustain the full life of complex thinking monads, such as we are ourselves in Leibniz' view?

¹¹ Ibid.

Take it or leave it, Leibniz' model is difficult to grasp and difficult to come to grips with, as long as we follow a pathway of linear thinking that is quite useful for practical, everyday matters, but seems to forsake us here, when trying to understand such complex concepts.

Complementarity

Our argument moves on here to state that the way Leibniz reasoned and the reasoning necessary to adopt in order to understand him has to be complementaristic. What we mean by that will become clear, once we have discussed the meaning of the term in modern day physics. Let us digress, therefore, briefly into the history of modern physics, where the term was proposed by Niels Bohr to describe the fundamental nature of matter¹².

Bohr used the term complementarity to denote a strange fact that he had discovered. Fundamental truths about the material reality of our world cannot be expressed by linear concepts that move along one trajectory from asserting a property to denying it, where only one or the other is true. When describing macro-physical events we can use such a linear, Newtonian approach. Boolean logic applies here. We can assert that a particle has a certain place in a coordinate system, or it does not. At the same time, we can measure its momentum, and it will have a certain, clearly defined momentum. The measurement of the momentum will not impact on the measurement of place, and vice versa. In the quantum realm, when it comes to subatomic particles and their constituents, such as protons or electrons, or photons, these rules seem to be inapplicable¹³. Here, when we measure the localisation of a particle precisely, its momentum becomes maximally blurred and vice versa. At no time is it possible to measure both aspects with arbitrary precision at the same time. This is, because properties of quantum only come into existence through interaction with something else, for example the measurement apparatus, and we have to choose different measurement devices to measure location or momentum respectively, which are mutually exclusive. Now, one might argue, we could use both set-ups in sequential order, and first measure the exact location and then the momentum of the particle, or the other way round. This option is not available in quantum mechanics, because if we measure momentum precisely, all the possibility of measuring the location of the particle is lost, and the other way round.

For more macroscopic systems this is different, classical physics with Newtonian descriptions can be applied because these systems are not as isolated as

¹² N. Bohr, *Causality and Complementarity: Essays 1958-1962 on Atomic Physics and Human Knowledge* (New York: Vintage, 1966)

¹³ J. Audretsch, "Blick in die Quantenwelt I: Grundlegende Phänomene" in *Verschränkte Welt Faszination der Quanten*, ed. J. Audretsch. (Weinheim: Wiley-VCH Verlag, 2002), 1-32.

individual quantum. Their properties are created through the interaction with their environment and the relative impact of the measurement device can be kept negligible.

In QM, however, it is unavoidable to use operations and descriptions that are mutually exclusive and maximally incompatible, yet necessary to describe one and the same item completely.

Complementarity, then, refers to descriptions that are maximally incompatible and mutually exclusive, yet necessary to describe one and the same item.¹⁴

Please note several features of this provisional definition:

It is not Bohr's definition, but our own, following Meyer-Abich¹⁵ and Atmanspacher¹⁶. Bohr never gave a definition. Wisely, one might surmise, or because of a lack of clarity of the concept, or because it defies defining.

Complementarity is a feature of descriptions, not of things. It refers to the fact that the reality of things, as they really are, seems to escape our understanding, which, after all, is evolutionarily modelled along the lines of the necessity for survival in a largely Newtonian, classical world of facts, dangers, and opportunities. Only when we start uncovering the deep structure of the world, it seems, we are suddenly forced to resort to such artificial high level constructs as complementarity.

Complementarity does not refer to simple linear and contradictory terms, such as black-white, loud-silent, hot-cold. It embraces maximally incompatible constructs. It is instructive to have a look at complementary concepts in physics: location and momentum, energy and time are famous so called canonical variables that are complementary. They are not opposites, but maximally incompatible.

Complementarity is challenging not as such, since we have a lot of maximally incompatible constructs in our world. Eating a cow and at the same time milking it, for instance, are two maximally incompatible actions, or driving a car and at the same time travelling by train. However, these concepts normally relate to different situations either in space or in time, which cannot be at the same time true. Complementary descriptions are such that they refer to the same item at the same time. They are necessary to describe one and the same thing or situation.

¹⁴ KM Meyer-Abich, *Korrespondenz, Individualität und Komplementarität* (Wiesbaden: Steiner, 1965)

¹⁵ Ibid.

¹⁶ H. Atmanspacher, "Erkenntnistheoretische Aspekte physikalischer Vorstellungen von Ganzheit," *Zeitschrift für Parapsychologie und Grenzgebiete der Psychologie* 38 (1996): 20-45.

The challenge of QM, thus, is that there are entities in this world that require complementary descriptions, such that mutually exclusive, maximally incompatible descriptions are necessary to fully understand them.

Please observe that technically speaking, complementarity is at the root of the defining characteristic of QM, the Heisenberg uncertainty relation; all analytical efforts hitherto have shown that it is irreducible¹⁷. Heisenberg's uncertainty relation is a formal description that captures this situation in a nutshell: Whenever we are dealing with complementary concepts, the precise definition or measurement of one of them automatically makes the measurement of its complementary counterpart maximally uncertain, and vice versa.

Our guess is that Leibniz was a complementaristic thinker in that sense of the word. He was aware of the fact that the description of the deep structure of the world requires mutually exclusive, maximally incompatible descriptions that have to be applied at the same time to fully grasp this deep structure of reality. This seems to us to be the reason, why his descriptions appear to be sometimes contradictory and defy easy linear outlines. One might argue that what we have dubbed here complementaristic thinking is cold philosophical coffee and well known by the name of dialectical thinking. This may be true, and we must confess our partial ignorance here. However, the term dialectical thinking has had so many meanings in the history of philosophy that we find it more useful to abstain from this traditional terminology.

Also note that complementarity implies that the maximally incompatible descriptions are irreducible. There is no higher order concept that can reunite them in the sense that a better description will unite the dialectical poles. The complementary descriptions, for instance, of a photon as a particle and a wave, depending on the experimental set-up of measuring light that reflect the complementary measurement approaches for location and momentum, cannot be united into a "wavicle" that combines them both¹⁸. Of course, our higher level construct of "light" does in fact unite these descriptions, one could argue. While this is true on a coarse grained description, there is no way round the fact that on the fine grained level of description necessary for physical theory, there is no uniting concept for two complementary descriptions.

¹⁷ I. Kim and G. Mahler, "Uncertainty rescued: Bohr's complementarity for composite systems," *Physics Letters A* 269 (2000): 287-292.

¹⁸ It is of course possible to measure elements of complementary pairs at least with partial precision at the same time. However it is not possible to do both purely. We use the example here for demonstrative purposes.

Hence our suspicion is that traditional dialectic thinking is quite akin to what we call complementaristic thinking here, but is not always identical with it. Complementaristic thinking seems to be a special case of dialectical thinking, which in some instances may have been exemplified by certain authors, such as by Hegel in his logic, but due to our unfamiliarity with the deeper meaning and tradition here, we abstain from drawing connections.

Another, important difference introduced by the modern terminology of complementarity into the philosophical tradition of dialectical thinking is the fact that with complementarity, observations and measurements change the system in question, and hence it seems justified to use it as a term in its own right.

It is an interesting aside, here, to point out that Bohr has very likely taken his concept from the philosophy and psychology of his days¹⁹. His main sources were the philosopher Harald Höffding, his reading of Kierkegaard, who espoused exactly the type of dialectical thinking mentioned above, the psychologist Edgar Rubin, who had introduced ambiguous stimuli, and William James who had first used the term “complementary” to describe the different aspects of personality in patients with multiple personalities²⁰.

It has been pointed out recently by Reich that another specific way of thinking seems to supplant formal, linear algorithmic reasoning at least in some pre-adolescent youths²¹. Formal reasoning is, according to Piaget, the final developmental stage of the reasoning faculty in children. Reich pointed out by empirical examples that a way of thinking originally dubbed “complementaristic” thinking by him and later renamed “relational and contextual reasoning” is in fact superseding this formal, algorithmic thinking. It seems to be operating whenever moral and relational conflict has to be resolved. Its specific signs are the ability to understand that no simple solution to a problem exists; that in order to solve a moral problem often two incompatible stances have to be embraced; that the context of the situation has to be considered, and no clear-cut algorithmic pathways to an optimum solution exist for every situation. Reich has explicitly made clear that this kind of reasoning is also at the root of understanding the riddles of quantum mechanics²².

¹⁹E. Plaum, “Niels Bohrs quantentheoretische Naturbeschreibung und die Psychologie,” *Psychologie und Geschichte* 13 (1992): 94-101

²⁰L. Rosenfeld, “Niels Bohr’s contribution to epistemology,” [“Bohr’s contribution to epistemology”] *Physics Today* 16 (1963): 47-54

²¹KH Reich, *Developing the Horizons of the Mind: Relational and Contextual Reasoning and the Resolution of Cognitive Conflict* (Cambridge: Cambridge, 2003)

²²KH Reich, “Relations- und kontextbezogenes (komplementaristisches) Denken. Theorie, empirische Befunde, Anwendung” in *Transpersonale Forschung im Kontext*, eds., W. Belschner, J. Galuska, H. Walach and E. Zundel. (Oldenberg: BIS, 2002): 11-39

Complementarity, and a specific way of reasoning related to it, is at the root of modern physics. It leads to a concept of the material world that is explicitly different from the Newtonian-Einsteinian view, as can easily be gleaned by Einstein's continuous attacks on QM²³. Einstein was not vindicated in any of his attacks and thought experiments. One of his attacks had as its vehicle the now famous Einstein-Podolsky-Rosen (EPR) thought experiment or paradox, which pointed out one very peculiar consequence of QM and complementarity: entanglement²⁴. Einstein thought that this was a particularly good example of QM's irrational general structure. It is this very structure we will turn to now.

Complementarity and Entanglement

In their theoretical analysis of QT Einstein, Podolsky and Rosen use a thought experiment of two electrons which causally interact for a certain time after which they are separated which means that there is no longer any causal interaction. According to QT these electrons then form part of a common wave function, which defines the collective state of both electrons but not the states of the individual electrons. When a measurement is performed on one of the electrons (A), a state of this electron comes into existence and simultaneously the other electron (B) adopts an according state so that the wave function as a whole is not violated. Since one could measure for example either position or momentum on electron A, Einstein and his co-authors saw that this fact leads to a paradoxical situation unless one assumes that the properties of position and momentum are not simultaneously real. This, however, implies that the process of measurement carried out at electron A determines the property of electron B even though they do not causally interact. This, according to Einstein, Podolsky and Rosen, "no reasonable definition of reality could be expected to permit"²⁵. A relatively easy, non-technical summary can be found in the discussion of the Bohr-Einstein debate²⁶.

This strange feature of holistic correlations in QM that predicted synchronised, parallel developments of spatially distant events, as long as they remained part of one unbroken quantum system, was a central feature of the arguments for and against QT for more than 30 years. Some argued that this was the discovery of a fundamental feature of physical reality, others, like Einstein, considered it a proof for the incompleteness of QT. It was not until David Bohm adapted Einstein's thought

²³ C. Held, "Die Bohr-Einstein-Debatte und das Grundproblem der Quantenmechanik," in: *Verschränkte Welt Faszination der Quanten* (Weinheim: Wiley-VCH, 2002): 55-76

²⁴ A. Einstein, B. Podolsky and N. Rosen, "Can quantum-mechanical description of reality be considered complete?" *Physical Review* 47 (1935): 777-780.

²⁵ Ibid.

²⁶ C. Held, "Die Bohr-Einstein-Debatte und das Grundproblem der Quantenmechanik," in *Verschränkte Welt Faszination der Quanten*. (Weinheim: Wiley-VCH, 2002), 55-76.

experiment and John Bell pointed out a simple combinatorial argument that the idea became experimentally testable²⁷. Bell's argument lead to an inequality relation that pointed out the boundary within which polarisation measurements of photons within a two-particle system should fall if they are uncorrelated. Some 15 years later the first experimental set-up for such measurements were realised²⁸.

Meanwhile such experimental set-ups have become very sophisticated, isolating quantum systems over long distances of some miles, even. They all, unequivocally, have vindicated QM and proved entanglement to be an empirical fact. Most recent experiments have become so sophisticated that loopholes for a realistic interpretation that attribute the missing knowledge of the measured values to our epistemological ignorance, while the actual nature of the system is determined by underlying, so called hidden variables – an attempt of followers of a classical, Bohmian-Einsteinian-Newtonian route of interpretation – have become next to impossible to maintain²⁹.

It is now quite an accepted fact among most physicists that entanglement is a real and irreducible feature of the quantum world, necessitated by the fundamental complementarity between single observables and the holistic description of the system³⁰. It is also clear that quantum entanglement proper is a very specific feature of quantum systems that are still whole, unmeasured and well isolated from their environment. For every measurement means that the coherence of the system is decaying and that the entanglement between its constituents is broken. This fact is known by the notion of “decoherence”, and much research is being devoted to the

²⁷ JS Bell, *Speakable and Unsayable in Quantum Mechanics* (Cambridge: Cambridge University Press, 1987). J. Audretsch, “Blick in die Quantenwelt II: Verschränkung und ihre Folgen,” in *Verschränkte Welt Faszination der Quanten*, ed. J. Audretsch (Weinheim: Wiley-VCH, 2002), 33-54.

²⁸ A. Aspect, J. Dalibard, “G. R: Experimental test of Bell's inequalities using time varying analyzers,” *Physics Review Letter* 49 (1982): 1804-1807. A. Aspect, P. Grangier and G. Roger “Experimental realization of Einstein-Podolsky-Rosen-Bohm-Gedankenexperiment: A new violation of Bell's inequalities,” *Physics Review Letter* 49 (1982): 91-94

²⁹ PG Kwiat, S. Barraza-Lopez, A. Stefanov and N. Gisin, “Experimental entanglement distillation and 'hidden' non-locality” *Nature* 409 (2001): 1014-1017. A. Stefanov, H. Zbinden, N. Gisin and A. Suarez, “Quantum correlations with spacelike separated beam splitters in motion: Experimental test of multisimultaneity,” *Physical Review Letters* 88 (120404) (2002): 1-4

³⁰ A. Zeilinger, “A foundational principle for quantum mechanics,” *Foundation of Physics* 29 (1999): 631-643.

question as to how far quantum correlations reach out before they decay completely³¹.

Weak Quantum Theory and Generalised Entanglement

Atmanspacher, Römer and Walach have recently proposed a generalised or weaker version of quantum theory: Weak Quantum Theory (WQT)³². This is a very general, axiomatic theory which is modelled along the lines of modern algebraic quantum theory (QT³³). It is a somewhat more general and at the same time less restricted theory. For it does not define all operations necessary for the full-fledged QT, but only the very basic concepts and operations, using a minimal set of definitions and operations. For instance, it does not employ addition and subtraction, and thus no probabilistic calculus is possible as is used in QM for calculating the probabilities of superimposed measurements. Also WQT does not limit the degree of non-commutativity between complementary observables as QT does by using Planck's constant. Thus, while WQT defines multiplicative operations and thus allows for the handling of complementary observables, it does not limit the degree of non-commutativity. Please note that an algebraic expression for complementarity is non-commutativity, meaning that the sequence of measurements is relevant for complementary or non-commuting observables. While this degree of non-commutativity is precisely given by the Heisenberg uncertainty equation in QM, where it is defined by Planck's constant, no such limitation exists in WQT. However, it can be demonstrated that by adding some restrictions and definitions, QT can be fully recovered from WQT, thus making WQT a more general, albeit weaker version of the theory.

These features altogether, however, allow WQT to handle non-commuting and thus complementary variables. One of the most important features of QM is thus preserved in the structure of WQT, and thus WQT predicts entanglement in any system, provided the same structural preconditions hold as in QM proper.

Specifically, such a generalised version of entanglement or Generalised Entanglement (GET) is to be expected, whenever the following conditions hold conjointly:

A system can be isolated from its environment or has constituted itself.

³¹ G. Mahler, J. Gemmer and M. Stollsteimer, "Quantum computer as a thermodynamical machine," *Superlattices and Microstructures* 31 (2002): 75-85

³² Atmanspacher, Römer, Walach, "Weak quantum theory," 406.

³³ We speak of "Quantum Mechanics" when we refer to the physical theory that is concretely used for modelling and calculating physical outcomes, and of "Quantum Theory" when we refer to the general structure.

There are different elements within that system.

The description of some elements in the system is complementary to the description of the whole system.

If those conditions jointly hold, WQT predicts entanglement between the elements of the system whose description is complementary to the description of the whole system. While, historically speaking, entanglement has been first discovered to be a feature of QM by virtue of QM's superbly precise formalism, the analysis of WQT would suggest that probably entanglement in a generalised version is a much more general feature of our world, and QM and quantum entanglement are very special cases of this more general structure.

It is worthwhile noting a couple of limitations and caveats at this point:

While quantum entanglement proper is fairly well established through repeated series of direct experimental tests, GET is, at this point, a purely speculative concept developed out of a more general formalism similar to QT. Although the analogy with QM should make GET a plausible option, it is only a theoretical derivation without a direct experimental proof as yet.

However, some empirical hints exist and have been described elsewhere³⁴. Very broadly speaking, the parapsychological data-base can be reinterpreted as empirical examples of how macroscopic non-locality might show. Integral part of this data-base is its typical unreliability, when probed for causal stability. This has to do with the fact that systems mimicking efficient causality but in fact operating on a correlational or non-local systemic connectedness, as we think parapsychological effects do, cannot be used for direct signalling. In classical QT this is a straightforward consequence of the formalism together with the restrictions laid upon the speed of signals by special relativity, and sometimes referred to as Eberhard's theorem³⁵. Such a signal-transmission prohibition theorem is also

³⁴ J. Wackermann, C. Seiter, H. Keibel and H., Walach, "Correlations between brain electrical activities of two spatially separated human subjects," *Neuroscience Letters* 336 (2003): 60-64. S. Schmidt, R. Schneider, J. Utts, and H. Walach, "Remote intention on electrodermal activity - Two meta-analyses," *British Journal of Psychology* 95 (2004): 35-247. H. Walach, S. Schmidt, "Repairing Plato's life boat with Ockham's razor: The Important Function of Research in Anomalies for Mainstream Science," *Journal of Consciousness Studies* 12,2 (2005): 52-70.

³⁵ JE Burns, "What is beyond the edge of the known world?" *Journal of Consciousness Studies* 10, 6-7 (2003): 7-28. P. Eberhard, "Bell's theorem and the different concepts of locality," *Nuovo Cimento* 46B (1978): 392-419.

immanent in WQT, as has recently been made plausible³⁶. Thus, any attempt to “prove” a causal stability within a correlational system that implicitly distils a signal out of the experimental system is bound to break GET, if it is operative. Hence, only such experimental set-ups that observe some border-conditions have a chance of experimentally replicating the effect³⁷. So far, only very few experimental systems have been developed that obey those boundary conditions. It seems that in these specialised cases GET can be maintained and experimentally validated³⁸. However, it is too early to firmly build on these results. Nevertheless, some empirical hints do exist, we contend.

At present, very little is known about the boundary conditions that are necessary for GET to arise. This has to do with two facts.

a) We do not know precisely what “complementary” means in non-physical and non-formally defined contexts. In QM it is rather clear which observables are complementary. This is less clear in our everyday world and in the language we use to denote meaningful situations. Hence, a thorough scrutiny of the underlying concepts, a good understanding of what situations and descriptions can claim to be “complementary” has yet to be established. Some rather vague ideas have been formed and are described below.

b) While in QT entanglement can be quantified this cannot be done in WQT. Thus GET could be a much weaker phenomenon, or, on the contrary, it could be in single cases rather strong. Little is known about any quantifiable elements in the theory that would allow precise predictions and derivations. Thus, for the time being, only qualitative rather than quantitative predictions can be formed.

The regularity introduced by GET is not mediated by signals. It is a consequence of the purely systemic make-up of the system in question. This is a concept not easy to grasp for some modern minds that are used to thinking in purely mechanistic, and one might hasten to add: Newtonian, terms. However, it is essential to understand that entanglement is a result of form and of a systemic ordering. Thus

³⁶ W. Van Lucadou, H. Römer, H. Walach, “Synchronistic Phenomena as Entanglement Correlations in Generalized Quantum Theory” [“Synchronistic Phenomena”], unpublished manuscript submitted to *Journal of Consciousness Studies* (2005)

³⁷ N. von Stillfried and H. Walach, “The Whole and its Parts: Are Complementarity and Non-locality Intrinsic to Closed Systems?” *International Journal of Computing Anticipatory Systems* 17(2006): 137-146.

³⁸ J. Wackermann, C. Seiter, H. Keibel, H. Walach, “Correlations between brain electrical activities of two spatially separated human subjects,” *Neuroscience Letters* 336 (2003): 60-64. J. Wackermann, JR Naranjo, “EEG correlations in spatially separated subjects - results of a replication study,” *Internal Talk at the Institute for Frontier Areas (IGPP)*, Freiburg, Jan 21. 2004.

misinterpreting entanglement correlations as causal signals leads to all sorts of impasses and paradoxes.

In QM complementarity and entanglement are ontic features of reality. This means that it has to do with the very structure of matter itself and is not only due to our knowledge³⁹. In WQT no such clear determination can be made. In many instances complementarity may be epistemic, i.e. due to the way we know the system under description. For a pragmatic understanding, however, this does not make a big difference.

One obvious danger of such a concept as GET is its universal applicability. This engenders the immanent danger that GET can easily be invoked to “explain” everything not well understood and hence sloppy thinking could be invited. While this is true, the only way round is a tight coupling of strict empirical research together with lucid conceptual analysis, an enterprise certainly necessitating transdisciplinary collaboration.

Once the potential problems and dangers have been considered and are in clear view, it is possible to envisage the potential benefit of a concept such as GET. It is a concept of great explanatory power. This has been demonstrated already by some attempts at explaining some hitherto badly understood empirical facts and at re-conceptualising others more elegantly. Here is a selection:

GET is a useful concept to understand some puzzling facts within alternative and complementary medical research and for explaining some of the purported principles used in such areas as homeopathy, spiritual healing, and possibly elsewhere⁴⁰.

If our analysis is correct, we would expect GET also between different treatment groups of blinded medical trials. It has been demonstrated that indeed the response

³⁹ H. Atmanspacher, H. Primas, “Epistemic and ontic quantum realities” in *Time, Quantum, and Information*. eds., L. Castell and O. Ischebeck (Berlin: Springer, 2003), 301-321.

⁴⁰ H. Walach, “Generalized Entanglement: A new theoretical model for understanding the effects of Complementary and Alternative Medicine,” *Journal of Alternative and Complementary Medicine* 11 (2005): 549-559. H. Walach, “Heilen durch “Energien”: Theoretische Überlegungen” [“Energien”] in *Heilung – Energie – Geist: Heilung zwischen Wissenschaft, Religion und Geschäft* eds., WH Ritter and B. Wolf (Göttingen: Vandenhoeck & Ruprecht, 2005), 80-105. H. Walach, “Entanglement model of homeopathy as an example of generalised entanglement predicted by Weak Quantum Theory,” *Forschende Komplementärmedizin und Klassische Naturheilkunde* 10 (2003):192-200.

rates between treatment and placebo groups in clinical trials are highly correlated ($r = .78$)⁴¹. While due to the retrospective nature of the study it is not possible to rule out other explanations, it would be expected by theory that at least part of that correlation is due to generalised entanglement correlations. If this is true, it would have massive implications for the methodology of clinical trials and for purposes of registration of medicinal products worldwide.

GET can be used to reconstruct and understand the empirical data-base of parapsychology. Not only can it be used to understand the “mechanics” of parapsychological effects, but also to understand, why these effects are so evasive to experimental testing (see above, point 2)⁴². In a very general sense, WQT is applicable whenever observations themselves introduce changes to the system. This is a property it has in common with QM proper and which no other classical theory can account for.

GET explains elegantly, how phenomena of transference and counter-transference in psychotherapy operate by reconceptualising them as non-local correlations⁴³.

Complementarity in WQT can be the basis to reinterpret some fundamental philosophical concepts such as substance and process, yielding a surprising resolution of Zeno’s paradox, by reducing them to the basic complementarity of time and energy⁴⁴. WQT also gives us a clue to understand the complementarity between matter and mind as a result of the basic complementarity of time and energy and thus helps to clarify, how two different concepts of time are necessary. Such a model, by the way, is very similar to Leibniz’ concept of “inner time” as being primary and fundamental for physical time to emerge.

It is very likely that once the boundary conditions are better understood, some further quite elegant re-conceptualisations may be possible. For instance, if we admit that a basic complementarity rules between individual and society then we can immediately see, how, between individuals belonging to certain groups with a strong

⁴¹ H. Walach, C. Sadaghiani, C. Dehm and DJ Bierman, “The therapeutic effect of clinical trials: understanding placebo response rates in clinical trials – A secondary analysis,” *BMC Medical Research Methodology* 5 (2005): 26.

⁴² Van Lucadou, Römer and Walach, "Synchronistic Phenomena"

⁴³ H. Walach, “Generalisierte Verschränkung - Ein theoretisches Modell zum Verständnis von Übertragungsphänomenen,” *Zeitschrift für Psychotraumatologie, Psychotherapiewissenschaft und Psychologische Medizin* 5 (2007): 9-23

⁴⁴ H. Römer, “Weak Quantum Theory and the emergence of Time,”[“Weak Quantum Theory”] *Mind and Matter* 2,2(2004): 105-125. BD Josephson, F. Pallikari-Viras, “Biological utilization of quantum nonlocality,” *Foundations of Physics* 21 (1991): 197-207. J. Summhammer, “Quantum cooperation of insects” in *arXiv:quant-ph/0503136 v1* 15 Mar 2005, (2005)

systemic cohesion, non-local correlations might arise. This would explain a whole host of phenomena, from sociological drifts to family patterns, from a separate temporal line of psychological “inheritance” of topics and tasks to historical movements.

In the same vein, GET could be a powerful explanatory tool for biology. It has already been pointed out that it is highly likely that nature, in her path through evolution, would not only use the classical principles of random mutation and natural selection, but also non-classical coupling through entanglement processes⁴⁵. Whether these processes would be due to direct quantum-like entanglement or more akin to a generalised version of entanglement need not concern us here, since the final effect would be the same. It is to be expected that a separate, non-classical route of coupling, for instance between certain species and some aspects of their environment and together forming a closed system would allow for non-causal, yet quite effective communication and much more efficient biological communication⁴⁶.

GET might also have consequences for physiology and anatomy. It would predict a hyperfast communication system within the body and may provide an additional mechanism for coordination alongside classical channels such as receptor-ligand binding or electromagnetic coupling. It may well be the case that at least part of some ancient healing traditions that purportedly balance “energy” may in fact exploit this route of communication within the body⁴⁷.

Philosophically speaking, GET re-introduces formal and perhaps also final causation. While efficient causation requires some physical interaction between elements and an exchange of energy, the form of regularity introduced by GET is not dependent on signals but only on the formal make-up of a system. The system in question need not be confined to the present time frame. It is also conceivable that it is constituted by a *zeitgestalt*, a systemic cohesion through time. In that case the regularity introduced by GET would be similar to what Aristotle used to call “final causation”. If the boundary of the system in question links up contemporaneous elements then the regularity introduced by GET would be similar to what in an Aristotelian terminology would have been called formal causation. Thus, the regularity introduced by GET, although not being causal in the strict modern sense of the word, since it is not mediated via the exchange of signals – hence our occasional

⁴⁵ M. Hulswit, *A Semeiotic Account of Causation. The 'Cement of the Universe' from a Peircean Perspective* [“Cement of the Universe”]. (Nijmegen: PhD Thesis, 2000)

⁴⁶ FJ Varela, “Describing the logic of the living. The adequacy and limitation of the idea of autopoiesis,” in *Autopoiesis A Theory of Living Organization*, ed. M. Zeleny (North Holland: Elsevier, 1981): 36-48

⁴⁷ Walach, “Energien,” 105

allusion to a-causal or non-causal effects – is nonetheless a regularity which reminds us of causality. Thus, one could say, GET broadens our view of what causation might be. This, incidentally, is a fact that links up this attempt with the Peircean concept of causation⁴⁸.

Those very brief sketches may give at least a glimpse of the potential explanatory power of GET. Granted then that it is at least a rational, conceivable concept founded in an extrapolation from one of the best scientific theories we have. In what sense might it be a modern revival of Leibniz' pre-established harmony? Before we tackle this decisive question, let us stop briefly, summarise and remind ourselves of the most important features of this concept.

WQT predicts a generalised form of entanglement to arise in all systems which contain elements whose description is complementary to the description of the system as a whole. This entanglement would be a pure consequence of the formal make-up of the system, not mediated by signals. It could be rather strong, or very weak, as WQT does not place any restriction on the degree of commutativity that would be the formal expression of this complementarity. Since GET is a systemic property, it depends decisively on our understanding and definition of what it is to be a system. The latter as well as our understanding of "complementarity" are at present rather loose concepts and far from clear.

We can expect a system to be defined by any sort of clear border that delineates an inner from an outer space, at least temporarily, and allows us to distinguish the system from the rest of the world⁴⁹. Such a partitioning of the world is always to some extent arbitrary, yet it is obvious that the world does contain different systems that can be distinguished from others: There are individuals of different species. There are different biological species. Individuals form families, groups, communities, nations. We have virtual systems that operate only temporarily, such as all passengers in one underground train during rush hours, or all members of a holiday excursion, while the excursion lasts. And we have systems that are quite distributed and yet can be defined by some commonality, such as all cells that make up our immune system, all members of a multinational company working for it worldwide. Finally, systems can be linked through time, such as members of a family tree, or descendants of a particular group of people. Organs in our body can be seen

⁴⁸ Hulswit, "*Cement of the Universe*"

⁴⁹ FJ Varela "Describing the logic of the living. The adequacy and limitation of the idea of autopoiesis," in *Autopoiesis A Theory of Living Organization*, eds., M. Zeleny (North Holland: Elsevier, 1981): 36-48. N. Rescher, "Leibniz and the Concept of a System," *Studia Leibniziana* 13 (1981):114-122

like that: for instance, the liver has a high turnover of cells such that after 3 months virtually every cell has been replaced and thus by way of constituency the organ is continually new, and yet always identical. As an aside, we see how WQT could be used to come to grips with the fiendish problem of identity through change that has puzzled so many generations of philosophers.

Complementarity is a central concept, as we saw. Here are some rough sketches, of what may be complementary concepts in our everyday world:

One such pair has been mentioned already: Individual and Community or Society. Both entail each other; none can be reduced to the other. They are maximally incompatible by way of description, and yet in many cases one needs both perspectives for a complete description of what it is to be human, for instance.

Another one would be Love and Justice. In educational contexts this might reflect as Freedom and Structure. Some high level description for our attempts at explaining the world may be Science and Religion. Well known from the Arts is the pair Form and Content, which also seem complementary.

In the history of religion we frequently find, what we would call, complementary descriptions. The typical Christian concept of Christ being God and Man and the dogmatic formulations of the council of Chalcedon are prime examples for this⁵⁰. The Buddhist notions of Emptiness and Form are complementary concepts. The Daoist concept of Dao being everywhere and nowhere in particular, being the balance of seemingly opposite forces also seems to embrace a similar notion. It is not by accident that Niels Bohr, when awarded the prestigious Danish Order of the Elephant chose, as his coat of arms, the Chinese Daoist symbol of Ying and Yang with the inscription “*contraria sunt complementa*”⁵¹.

In very general terms, one could look at the paradoxical structure of some religious and mystical texts as an attempt to express the fundamentally complementary nature of the Basic Reality. Our philosophical and religious tradition in the West has also used similarly complementary concepts to express this situation: Cusanus used the notion of “*coincidentia oppositorum in Deo*” and the quite impossible metaphor of a circle whose centre is everywhere and whose circumference is nowhere. And the basic theological concepts in the Christian religion, such as the Trinity, immanence and transcendence, God’s Love and God’s Justice – all those concepts seem to carry

⁵⁰ KH Reich, “The Chalcedonian definition, and example of the difficulties and the usefulness of thinking in terms of complementarity?” *Journal of Psychology and Theology* 18 (1990): 148-157.

⁵¹Rosenfeld, “Bohr’s contribution to epistemology,” 54.

some inherent incompatibility with them that is reminiscent of the basic structure of complementarity.

Also, the language of the Christian mystics who use a lot of paradoxical formulations to communicate their experience, seems to support the view that the basic reality as they experienced it has such an inherently complementary structure⁵². Whether it is the “tremendum et fascinosum” of Otto, whether it is Augustinus’ “deep inside and yet way beyond the self”, whether it is the apophatic “superradiant darkness” or “dark light” of writers from the Pseudo-Dionysian tradition, or Eckhart’s poor soul that is “gottes ledic” and thereby experiences the birth of the son and hence fullness⁵³ – we quite often find a similar structure to what we have identified as “complementary”: maximally incompatible descriptions necessary to describe one and the same item.

It goes without saying that such a sketchy description is far from solid scholarship and that in every single case a deep analysis would have to unravel whether the claim is actually true. However, we submit that for the purpose of this essay it is enough to point out further venues for research and potential streams of similar concepts. It is in this vein that already Bohr himself thought that his concept of complementarity was ultimately rooted in the deep structure of reality and a basic epistemological tool.

Let us now turn back to Leibniz and discuss how the concept of GET could be a modern formulation for his concept of pre-established harmony, and what consequences this would have.

GET as Pre-Established Harmony

If what has been said in the last section bears out, then in GET we have a new and quite universal principle of connectivity through formal structure, and potentially through meaning. It is interesting to note that it was exactly such a principle that was sought by C.G. Jung and the quantum physics pioneer Wolfgang Pauli in their long exchange of letters that culminated in their joint publication⁵⁴. Jung named this principle, somewhat clumsily, “synchronicity”⁵⁵. And Pauli noted,

⁵² K. Albert, *Einführung in die philosophische Mystik*. (Darmstadt: Wissenschaftliche Buchgesellschaft, 1996)

⁵³ T. Hohn, *Meister Eckharts Lehre von der Gottessohnschaft* (Frankfurt: Peter Lang, 2000)

⁵⁴ CA Meier ed., *Atom and Archetype: The Pauli/Jung Letters 1932 - 1958* (Princeton: Princeton University Press, 2001) CA Meier, ed., *Wolfgang Pauli und C.G. Jung. Ein Briefwechsel 1932-1958* (Heidelberg: Springer, 1992)

⁵⁵ CG Jung, “Ueber Synchronizität” *Eranos Jahrbuch* 20 (1952): 271-284. CG Jung, “Synchronizität als ein Prinzip akausaler Zusammenhänge” in *Naturerklärung und Psyche*

in a letter to Jung, that synchronicity, taken as a principle of connectivity through meaning, is complementary to causality as a principle of connectivity through physical interaction⁵⁶. It seems that in the Jung-Pauli dialogue a similar philosophical intuition, with ever more clarity, has been expressed. For Leibniz, pre-established harmony was the “mechanism” he needed to make plausible how his system of inner relations could work out. For Jung and Pauli, synchronicity was a principle that allowed psychological meaning to have a place in the natural world. In fact, Pauli used to say that physics would only be complete once it allowed for the psyche to be part of physical theory⁵⁷. It seems that GET does precisely that.

In WQT mind and matter can be seen as two complementary aspects of reality, derivative of the more fundamental complementarity between process and substance, and hence between time and energy⁵⁸. Thus, mind is no longer seen to be simply secondary to the evolution of matter, but theoretically co-dependent with matter on a much more fundamental and irreducible physical relationship. The mechanism for the coordination of these fundamental categories and their individual specifications is GET.

This theoretical model allows the mind to not only be a derivative of material processes but as a complementary reality to its material substrate, the body, be a reality of its own dignity⁵⁹. Hence we would expect GET to be a universal principle of connectedness through form and meaning, complementary to physical causality by interaction and exchange of energy. Thereby, meaning, consciousness and the mind become intimately intertwined with the material world. This, however, is precisely how Leibniz described and used PEH⁶⁰. As has been pointed out above,

eds., CG Jung and W Pauli (Zürich: Rascher, 1952): 1-107. CG Jung, “Synchronizität als ein Prinzip akausaler Zusammenhänge” in *Gesammelte Werke Die Dynamik des Unbewussten*. vol. 8. (Olten: Walter, 1971) CG Jung CG, “Ein Brief zur Frage der Synchronizität” in *Parapsychologie Entwicklung, Ergebnisse, Probleme vol. 4, 5*, ed. H Bender Auflage edn. (Darmstadt: Wissenschaftliche Buchgesellschaft, 1980), 747-754.

⁵⁶ CA Meier ed. *Wolfgang Pauli und C.G. Jung. Ein Briefwechsel 1932-1958*. (Heidelberg: Springer, 1992), pp. 41f, 57, 176-192.

⁵⁷ KV Laurikainen, *Beyond the Atom. The Philosophical Thought of Wolfgang Pauli*. “Berlin, Heidelberg: Springer, 1988”. H. Römer, Wolfgang Pauli als philosophischer Denker: Kausalordnung und Sinnordnung. *Philosophisches Jahrbuch* 109(2002), 354-365.

⁵⁸ Römer, “Weak Quantum Theory,” 125.

⁵⁹ H. Walach, “The complementarity model of brain-body relationship” *Medical Hypotheses* 65 (2005):380-388.

⁶⁰ GW Leibniz, “Neues System der Natur und der Gemeinschaft der Substanzen, wie der Vereinigung zwischen Körper und Seele 1695”. in *Hauptschriften zur Grundlegung der Philosophie vol. 2*, eds., A. Buchenau and E. Cassirer. Hamburg: Meiner, 1966: 258-271. Leibniz GW: Zur prästabilierten Harmonie (1696). In: *Hauptschriften zur Grundlegung der Philosophie*. Edited by Buchenau A, Cassirer E, vol. 2. Hamburg: Meiner; 1966: 272-275.

GET as a universal principle would reach out through the whole of nature, from very small to very big. It would not respect time barriers and it is defined by only two, but relatively clear defining parameters: by systemic boundaries and the complementarity of single, local descriptions with global descriptions.

Above we have identified Individuality and Communion as such a pair of potentially complementary descriptions. As generic notions, they apply to every system that unites subsystems which can be identified as individual units, and so forth. Hence, by virtue of this single pair of complementary notions – “individuality” and “communion” – we immediately have a very general “mechanism” by which the world as a whole system may be structured and ordered, since all single elements of every subsystem and all partial systems as such, would be correlated by virtue of this generalised entanglement relation between all elements. Hence, in addition to all classical causal processes, the framework of WQT would predict another, complementary system, complementing the system of classical causation via signals and physical interaction with an element of coordination through formal coherence using GET. This seems to be the same as what Leibniz had envisaged when he proclaimed that the world of causes and the world of free decisions are not mutually exclusive but complement each other. The difference here is that what Leibniz called “Entschlüsse – decisions” is interpreted in this framework as formal coherence of elements of a system. It might be based on formal decisions in the full sense of the word in systems of conscious and free agents, such as individuals or societies. But it may be just as well a set of changes in other systems that may trigger coordinated actions in correlated systems, just by virtue of formal coherence.

An intuitive example could be the delicate balance that comprises our eco-sphere and which seems to “intelligently” balance processes such that life, once established, can sustain itself. Lovelock and Margulis called this the “Gaia Hypothesis”⁶¹. Here we would have a coordination of seemingly isolated and disparate systems that are coordinated by a systemic principle of coordination. However, we need no hidden hyper-structure such as “Gaia”. WQT suggests that the coordination is a result of generalised entanglement.

Thus, GET is a kind of universal coordinating and unifying principle not operating by causal signals, but by pure formal principles. Hence it would fulfil at least one function which PEH performed in Leibniz’ system.

However, there is yet another, more subtle and intriguing similarity. And this has to do with the moral dimension. In Leibniz’ system, pre-established harmony

⁶¹ JE Lovelock and L. Margulis, “Homeostatic tendencies of the earth's atmosphere” *Proceedings of the first ISSOL meeting. Origins of Life* 5 (1974): 93-103. L. Margulis, JE Lovelock, “Biological modulation of the earth's atmosphere” *Icarus* 21 (1974): 471-489.

serves another important function. It allows for the fact that free actions are being contained within a larger whole that still guarantees optimal benefit for the whole relative to all possibilities. Leibniz has been chided and criticised for his claim that this world is the best of all possible ones. Yet in his system this thought is absolutely consequential, and most writers understand this dictum in a logical sense.

The framework offered here persuades us to take a more naturalistic stance. If all individual elements of a system are coupled by non-local correlations, simply by virtue of belonging to that system as individuals, and all systems are again coupled to each other and to larger systems comprising them, then each action of one element of a system has repercussions for all other individuals, even if only imperceptibly small. Now, if one individual, out of his or her free choice, chooses some action that is against the benefit of the whole for the sake of one's own individual benefit, egoistically as it were, then the balance of the system is disturbed. By virtue of the coordinating mechanism of GET we would expect that this has repercussions on the rest of the system and its elements. Technically speaking, the egoistic individual has placed him- or herself outside the systemic coordinating context and fails to partake, at least to the degree that the action has placed him- or herself outside, in the coordinating action of the whole. Friction arises. The smooth flow of coordinated events is ever so slightly disturbed. Not only that. This action is also one element in the temporal system of the individual in question. Hence it potentially affects future elements of the individual's own history, by virtue of the non-local correlation with other elements belonging to the system forming the individual's trajectory through time. It is difficult to tell, exactly how this would affect the development of the individual, without further precision which is not possible at this time. But in very general terms, it is easy to see that a consequence of WQT and GET would be a coordination of present and future events by virtue of a correlational, non-local mechanism. What we have here, then, at least in principle in a very crude outline and as a possibility, is a mechanism for morality, for guilt and atonement.

It might well be the case that amoral, unethical, unlawful and egoistic acts, alienating an individual from the larger context of the system he or she belongs to, will wring future imbalances that manifest as frictions, as aversive life-events, as strikes of destiny, etc., that demand acts of atonement to re-instantiate the original balance. This seems to be a fundamental intuition of societies through the ages, and interestingly enough, it has been re-invigoured by modern forms of systemic family therapy that place much emphasis on such balances⁶².

⁶² B. Hellinger, *Acknowledging what is: Conversations with Bert Hellinger* (Phoenix, Az: Zeig, Tucker, 1999)

We think it is easy to see how a generalised mechanism of entanglement, as offered by WQT and GET, could, eventually, if well understood, form the basis for the re-interpretation and understanding of such concepts as karma, or guilt, atonement and morality in a very general sense. It would remain the task for a sound philosophy of religion and for theology to further elucidate the thoughts sketched out here.

Clearly, touching on the issues of good and evil and trying to describe their relationship is one of the trickiest and most difficult enterprises possible. Normally, good and evil are conceived as moral opposites, treated linearly, and by modal logic also as partially falling under the general laws of bivalent logic. Some action can be either right or wrong in a certain context, and hence the outcome good or evil. This is how some simplistic views of morality operate.

However, it seems likely that good and evil are not opposites, but complementary and hence maximally incompatible descriptions of actions, results or situations. If this is true, then we would expect them to be part of a more universal principle, also coordinated by a generalised form of entanglement.

Let us analyse the system a perpetrator forms with his or her victim. Since an evil act is normally called evil because it affects some other person, a perpetrator forms a system with his or her victim by the very act of the evil deed. The same is of course true for every action involving two persons, whether good, neutral, or evil. However, an evil deed, such as, say wilfully injuring or even killing a person, seems to be different in the sense that through premeditation, intention, and the knowledge of its normally deviant and prohibited or sanctioned nature a much stronger systemic boundary is drawn than by a neutral action, of, say, giving a stranger directions to a hotel. Now, the predictions of the model entail that the perpetrator and his victim are non-locally coupled by GET. Evil injected into this system by an act of moral transgression cannot remain separate from the perpetrator, but will be part of his life also, and should, in one form or another, fall back on him or her at some point.

This sounds completely counter-intuitive, as we see many evil-doers walk away from their crimes without being even identified, let alone sued. However, we rarely oversee the whole trajectory of a person's life and we normally do not reckon other elements of a person's extended system, such as his children, family, or dear friends, to be part of this person's individuality. If we did, we might find more often than not that evil acts, by virtue of non-local coupling, fall back on the very perpetrators. At least this would be implied by the model, and it is certainly a question open to empirical scrutiny.

Another way of viewing this would be that evildoers are very often themselves victims of abuse that prolong the chain of perpetration and violence along the trajectories of their and other people's lives. The tragic situation seems to be that the victims of seemingly random violent perpetrations enter into the dire circle of the system of violence out of no apparent reason or guilt of their own. This position that victims of violence frequently are apparently without guilt is the last stumbling block for Leibniz' Theodicee as well as for any other system trying to explain evil. It would be adding blame and shame to the victims' injuries to discuss any potential role of their own or any relatives' guilt here. We do not purport to solve the problem. All we are saying is that the mechanism of GET would allow for such processes to be naturally included in our knowledge of our world, without having to resort to supernatural explanations.

In the same vein, the well known strategies propagated by most major religions to change evil should now be more readily understandable. Rarely, if ever, do religious texts preach the extermination of the evildoer as a means to rid the world of evil. It is mostly a means to atone guilt, and not to get rid of evil. At least in the Christian and in the Buddhist tradition the theoretically known, if rarely lived, means to withstand the dynamics of the chain of evil actions is the so called "love of the enemy" in the Christian tradition and the "universal compassion with all sentient beings" in the Buddhist tradition. By refusing the quasi-automatic drift into the system of the evil-doer and by not following the natural impulse of fighting and retaliating the chain is broken. At least this is the teaching that in theory is supported by our analysis of the consequences of WQT and GET in the sphere of moral acts.

It goes without saying that the real difficulty is less with the analysis than with the practical achievement of actually being able to act according to this insight. The history of Christianity on a collective level is a huge example of how difficult this is, since it presents us with a lot of obvious failures to act according to this insight. The faculty to act according to the understanding that an evil act and its consequences can only be broken by wilful positive actions on part of the victim is certainly none that comes for free. It requires, apart from the general understanding and will, also a capacity of the consciousness to attune itself to this general insight despite other and quite natural tendencies to retaliate or to fight in the face of evil done to oneself. It is no free lunch and requires training of consciousness and will. This may be the reason, why 2000 years of mental and moral teaching have still not been enough, as they have very obviously not reached the deeper layers of human consciousness. Perhaps an amalgam of Christian teaching and the practice of meditation, as was certainly embodied by the great Christian mystics, on a collective basis would help trigger the necessary cultural change.

In the same way as a wilful act of evil creates a system between perpetrator and victim, coupling the two of them non-locally, a positive intentional act will do the same, according to the model. It will allow a positive train of events to come into being and transmit its results. Hence most major religions' emphasising the importance of "purity of mind".

One final thought may be in order here:

For most of its part, in the Western tradition evil was seen as "privatio boni", a deprivation of good, and not as substantial being in itself. Along those lines, and using the outline sketched above, one could venture out to say that the common description of the overall system, the "kosmos", is the "good", or "bonum", while the description of all individuals who are perpetrators against this "good" of the whole, would warrant, at least partially, the description of evil in the sense that they are deprived or depriving themselves or others of this good.

If we accept that these two descriptions are complementary, then from the theoretical framework it would follow that all these individuals are non-locally coupled. This would give a quite naturalistic meaning to the "chain of evil" that reproduces itself, as long as it is not broken, following Schiller's sentence⁶³ "Das eben ist der Fluch der bösen Tat, dass sie, fortzeugend, immer Böses muss gebären - Such is the curse of evil deeds that they must continuously engender evil."⁶⁴ It would also show the only exit route: not "combating" evil, trying to "eradicate" it, or whatever militaristic metaphors are at the command of mostly fundamentalist attempts at doing so, will overcome evil. But only to remedy the privation in itself by aligning it with the larger good, by breaking the force of the coupling through willed actions not to use the logic of evil to retaliate, or continue along the same lines will change the situation.

In that sense the complementarity between good and evil, at least in a Western view and following a Leibnizian perspective, is not a final, irreducible or substantial one. It is an accidental one, but perhaps one that, metaphysically speaking, was and still is necessary for individuation. In that vein, what was called "evil" above in a moral sense is "individuation" in a meta-physical or ontological sense. It becomes "evil", if it fails to be integrated into the larger whole and if it insists on individuality, despite, or sometimes precisely because of the necessary complementarity with the larger community or communion of all individuals. Once individuation and individual development has achieved its goal of creating a unique individual perspective, an in-dividuum within a larger whole, insisting on this individuating tendency would result in evil, while acknowledging the complementary stance of

⁶³ F. Schiller, *Werke: Wallensteins Lager. Die beiden Piccolomini. Wallensteins Tod*, vol. 5.1. (Berlin: Spemann, 1890)

⁶⁴ Schiller, *Die Piccolomini*, 5. Aufzug, 1. Auftritt

being an individual in community or communion with other individuals and within a larger whole is nurturing the basis for the development both of the individual and the community.

In that sense, Nietzsche's reinterpretation of the original sin as individuation⁶⁵ is completely correct, if seen from the angle developed here. The difference is that it only becomes evil and counterproductive, if, as with any development, it insists on individuation and individuality as the one and only goal. For then it has to necessarily refuse its connectedness with the whole, or its integration with community, without which no individual could exist. Evil, then, is the insistence of individuation over communion, of individuality over community, beyond the point necessary for the formation of an individual.⁶⁶

We can see that the moral complementary pair of good and evil can be reduced to the ontological complementary pair of individual and community. This, we saw, is a basic complementary description which, following the formalism of WQT, would predict non-local coupling between the individuals belonging to one system or forming a community. This could, of course, hold at multiple levels and could be of different strengths depending on the systemic boundaries. Thus, it is to be expected that non-local couplings within families are stronger than within extended families, or nations, or the whole of humanity. Nevertheless, GET affords us with a mechanism of non-local coupling which is very similar in nature to, if not a modern counterpart of, Leibniz' pre-established harmony.

One final disclaimer is warranted here: How can one, in the post-modern age of relative systems, after the language turn in philosophy, after the impossibility of demonstrating the truth of philosophical systems has been shown, after the impossibility of final arguments is an accepted fact, try to revive old-fashioned metaphysical thought, as we seem to have done? There is only one argument in favour. What we have sketched out here, is not just a speculative idea, although it certainly is also that. It is a consequence deduced from an axiomatic theoretical framework that is open to rational debate, to improvement, and, eventually even to experimental testing. As was observed with QM and the empirical testing of quantum entanglement, this is the first time in history that meta-physics has turned experimental⁶⁷. Now the second step is in order, it seems. The theoretical framework

⁶⁵ F. Nietzsche, *Die Geburt der Tragödie: Schriften zu Literatur und Philosophie der Griechen*. Hrsg. u. erl. von Manfred Landfester. (Frankfurt: Insel, 1994)

⁶⁶ It is quite possible to reverse this analysis with communion over individuality being the source of evil. However, we refrain from elaborating, as it seems less prevalent nowadays in Western societies.

⁶⁷ H. Atmanspacher, "Metaphysics taken literally. In Honor of Kalervo Laurikainen's 80th Birthday" in *Festschrift in Honor of KV Laurikainen's 80th Birthday* (Vastakohtien todelisuus

has moved out of physics proper into a more general, systemic description. Nevertheless, it is open to experimental tests, perhaps not in the moral realm, but certainly in fundamental experimental designs. If these vindicate GET, we know that the further consequences derived from the theory of WQT are worth reckoning with. If not, we have a clear indication that this speculation is not worth the paper it was written on. This is certainly a big difference from, and in our view a great improvement on meta-physical speculation in itself.