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BETWEEN METAPHYSICS AND METABIOLGY: THE CONCEPT OF INFORMATION IN EVOLUTIONARY METATHEORY

In the work of Aristotle "metaphysics" is just a title for his explanations of those items and structures which are entirely beneath (i.e. "meta") the physical things. His metaphysics deals with the reason of "Being" itself, regardless how the being is physically maintained. According to him those foundation of being as being is due to a "substance", which categories are explicated by himself to be primordial. A modern anthropological analysis, however, shows especially the human mind being a structure which seems to be "meta" with respect to physics in that very sense.

In modern times "metaphysics" is a term designating a set of so-called "theories" which are not deduced (pseudo-induced) from or at least related to empirical facts, but are in contrary related to purely mental considerations. Such a method is based on some of Plato's work, e.g. his cave allegory, with which the states that the empirical facts are at most shadows of the reality, but by no means the reality itself. Due to his opinion the reality can only be, at least partially, recognized by the mind of wise humans, and thus the set of all possible empirical facts must be incomplete indeed. The reason why Plato argued in that way was, of course, due to the fact that he was due to his main interest a politician rather than a philosopher (which part, in reality, took Socrates). Namely, a theory which cannot be proved by anybody's practical experience, but is only due to the wisdom of the governors, suits well as a legitimization for any dictatorship. Indeed, all Platonic dialogs end aporetically. This may be a reason why such modern metaphysics is often found with societies acting repressively upon its members, and even upon other human beings by psychological means. Those activities are by no means less than criminal acts.

In contrary, the serious and profound results of the scientific disciplines, being in agreement with empirical experience, are cast into theories, which are more or less closed (thus describing a well-defined type countable quantity of

empirical facts) and/or even axiomatic. With an axiomatic system together with a finite set of preconditions, all those infinite possible empirical facts can even be deduced; and it is then the correctness and even beauty of such a (often even aesthetically acceptable) small system that it is in agreement with facts of a potentially infinite number. In order to avoid modern confusions one must urgently state, that those theories, although often constructed deeply symmetrically, are by no means comparable with the Platonic symmetries, which are not connected to the real perceivable world, but are of deliberate contingency. [The symmetries of the five Platonic bodies are just due to the three (!) finite subgroups of rotation of the $SO(3)$, that is the whole story!]

By the way, it is interesting to note here that the inherent contingency of quantum facts can be shown (due to the work of von Neumann) to not (!) be governed by "hidden variables" delivered from a principally unperceivable world. This is done by just presupposing the extremely simple axiomatic system of quantum theory with which no contradiction to facts had been found up to now, but in turn even explains real facts which are completely against human mind evidence (e.g., the Einstein-Podolsky-Rosen-paradox).

Due to the incredible strength of such modern theories it is certainly well done to look more intimately upon their construction, and which formal principles they are governed by. This is indeed an epistemological approach, being by definition metatheory upon theory. Such a metatheory, if constructed well, may in turn stimulate the construction of new better, i.e. more definite and/or more general, theories. In that very sense, metaphysics is an important branch of philosophy and science as well.

Some people ask whether science may once come to an end, whence all possible facts are explained in that way. Without discussing this question here further, it is obvious that when approaching to such a Last Theory its metatheory has to be included in itself (otherwise the question would not be solved how exactly the human mind acts on the material facts). Thus an important goal is to explain the actions of mind and brain just in terms of matter which, of course, is a completely anti-Platonic attitude.

The same as for such a serious metaphysics, or even more, is true for a metabiology. Namely, there are many doubts that biology itself is constructed in that very way being able to explain the onset of life, or even the existence of life itself. It seems obvious that biology can not be just the sum of physics and chemistry, or more precisely: The laws of physics together with the laws of chemistry alone does not seem sufficient to explain "life". However, there is a term, namely "evolution", which is used to explain what there may be more in biology, additional to physics and chemistry. This term should be made responsible for the onset of life, its development genetically as well

as phenomenologically, too. Although by no means well defined, any people "believe" in Evolution like others – or sometimes even the same people – believe in God. In both cases there is apparently a mystery responsible for life – and thus creationism and evolutionism are both obscure systems, because they are far from being theoretical systems in an axiomatic sense. As a consequence, it does not seem astonishing any more that even modern theory of evolution appears to be insufficient to explain its own subjects. But how should it, without any sound foundation?

Even more dangerous: This situation marks a fundamental crisis in modern science and even culture as a whole: Many people do not trust in the work of scientists any more, and they instead do escape into several kinds of obscurantism.

In this situation it seems to be appropriate to look more intimately into the metatheory of all sciences, which indeed is an epistemological approach. Doing this we discover quickly that we have to distinguish between the sciences of the "Being" and those of the "Becoming". Recognizing the first ones, there is a well established set of metatheories: Concerning the structure of any set of affirmative statements about facts and theories dealing with "being" (i.e. not explicitly and irreducibly time-dependent) matters, they are connected by classical logic. Aristotelian logic was considered over some thousand years as a constitutive element (*causa formalis*) of whole the world; the scholastics even refined this system to extreme standards. It was Kant who discovered that these logical categories are no means of a constitutive, but only of a regulative, or even epistemic, character of our explanations. It is so that our brain is equipped with these regulative measures for good survival reasons, because it makes sense to calculate most probable expectations for what may come, deduced from former experiences, in order to optimize the survival probability of the carrier of that brain. This very calculation system structure indeed is classical logic, because it conserves and handles accumulated information about the human environment in his mesocosmos best, as can be formally shown. But by no means this system can make any meaningful affirmations concerning the constitution of the world. Namely, when casting our advanced experience concerning the microcosmos (the atoms) or the macrocosmos (the universe) into classical logic many contradictions in adjecto appear – we are just not biologically selected for acting in micro- or macrocosmos, but only for the mesocosmos. Even in our world logic produces nice contradictions, namely if it comes to self-reference or consecution.

Later on Boole showed that Aristotelian logic is indeed tautologic, however, is a closed set of formal statements, axiomatized in algebra as a distributive modular complementary lattice. Thus it only transforms truth values, being not capable to handle real "becoming". Becoming is a consecutive process which

irreducibly produces new informations by its result not present in the beginning, also not in the sense of deterministic laws and sets of conditions.

As von Neumann (1955) showed, however, all those sets of logical statements are properly connected together by this Boolean logic if, and only if, a conservation law would be valid: Namely the conservation of the quantity "information" I (which is, precisely, the logarithm of the inverse probability of the "esse" of actual things the statements deal with, relative to their "posse" due to governing eternal, i.e. explicitly time-independent, laws). Thus all real development, meaning that its results are not completely determined by its preconditions, cannot be handled by this system. A more close inspection (Krueger 1984) even exhibits that the set of all empirical affirmative sentences precisely conserving I , thus precisely obeying the rules of Aristotelian logic, is empty! Consequently, the term "being" can only serve as a tool for an approximation to the real world. Thus logic at the first glance looks like a proper metatheory of all the "beings", if any. But a strict logical empirism would eject exactly that, because any empirical act constructs a certain actuality (esse) out of a set of possibilities (posse), and thus enlarges the quantity I in the system under consideration at that very time. So only as an approximation, all statements dealing with stable things or processes being stationary (implicitly time-dependent only), can be connected together within the formal set of this (Aristotelian, i.e. Boolean) logic.

Epistemologically, it is important to note that at least all classical physics and chemistry are constructed in that Aristotelian manner, that the onset of new information is structurally neglected. In other words: There seems to be an eternal information in the laws of physics and chemistry (like dedicated by an universal demiurge), plus a totally contingent temporary information in the sets of start- and limit-conditions, thus leading to a schizophrenia, i.e. a paranoid perception of the reality divided into the eternal and the secular objects.

What is, however, a real scandal is the fact that even biology being the science dealing with life is constructed in that way. At least there is no doubt about one important part of the definition of life, namely that life is due to systems accumulating information. Recognizing the metabiology, i.e. the epistemic structure of biology, which is indeed based on classical logic, as a proof for the fact that its subject – biology – can only properly deal with information conserving objects, "biological science" in that sense is a real *contradictio in adjecto*. Thus it is not astonishing that biology can not explain, but only describe several features of its own subject – life. By the way, also explanation theory is a part of epistemology. The classical form of explanation deals with the well-known Hempel-Oppenheim scheme (Hempel 1966); it "explains" information conserving facts, or strictly speaking: it explains nothing. An appropriate explanation scheme for information gaining systems is the Ramsey scheme.

However, at least one important part of modern physics serves as mother theory for accumulation of information in empirically accessible (not eternal) systems, which is quantum dynamics. Moreover, there is an axiomatized metatheory correctly describing the structure of the set of corresponding statements of affirmation which is quantum logic. In the limit of conserved information, and only here, it is identical with classical logic. Generally its algebraic structure is again a modular lattice, however non-distributive (with the exception of the above described sub-lattice) but an orthonormal one.

Thomas S. Kuhn has shown that the structure of scientific revolutions always exhibits as a change of paradigms, i.e. exactly the exchange of central dogmas in the related metatheory. Aristotelian logic is surely such a dogma. One of its consequences is the fiction of the "being" which may be true or false, independent on any action like observation, measurement, development, evolution, just outside the "becoming". When the mind is imprisoned by those dogmas, it is not astonishing that the "becoming" becomes a miracle. Then it happens that people ask: "What is the driving force of the 'becoming' in the universe?" [There are intratheoretical answers to this question, like in irreversible thermodynamics with which one can easily show (de Groot 1960) that open systems tend to self-complication by local entropy reduction.] Metatheoretically this driving force cannot be formulated at all due to the structure of logic.

If one looks more intimately into quantum dynamics and statistics which is the basis of the rules governing all matter, the fundamental principle is the "action", not the particle. Taking this serious one has to state that there is actually only "becoming" to be seen from fundamental principles rather than being. Consequently, the change of paradigms is best illustrated by reformulation the above question in the right way, namely: "What is the stopping force of the 'being' in the universe?" (There is, of course, also an intratheoretical answer to this question in quantum statistics which is related to the orthogonality of the Hilbert space.) Metatheoretically this stopping force can (!) be formulated due to the distributive sub-lattice (which is indeed Boolean) of quantum logic being not empty.

When it came to the contra-intuitive logic of quantum theory, Bohr said: "Physics is too difficult for physicists". Nowadays, one may add: "Biology is too difficult for biologists." Nevertheless, all developmental processes must be described in a way taking the time-arrow (more precisely: consecutivity) of all "becoming" in a serious manner. For instance, the commutativity law of subsequent affirmative actions in classical logic (i.e. independence on time-reversal) is completely invalid for all real developmental processes. Penrose (1994) has shown that at least mental processes in the brain, if not even all life, necessarily make use of quantum phenomena. This is also an ontological rather than only an epistemological aspect! – It is indeed a serious challenge

to the biologists to properly axiomatize their own science, rather than retiring to a decadent or even obscurant view upon the myths of life.

More explicitly: The mind and its brain cannot be understood as classical computer (even not with implementations of neuronal network software). Such a computer, even if equipped with parallel processors, acts like a classical Turing machine, which indeed is an information processing (not: gaining) system acting upon Boolean logic. And very much alike quantum mechanics cannot be reduced to Newtonian mechanics (but vice-versa can), brain action cannot be reduced to Turing machine action, as proved by Gödel's laws (but vice-versa can: men have constructed computers)! Generally speaking, reductionism is mega-out when constructing an advanced biology.

As a result we may state that quantum logic (which, of course, contains classical logic as a sublattice for the limiting "stable" cases) is proved to be a necessary structure – and thus metatheory – of science including biology. However, it is not proven to be sufficient as an axiomatized metatheory of evolution. It cannot be excluded yet that quantum logic itself is a sublattice of that lattice connecting all possible affirmations concerning evolution. However, there is no ontological hint whatsoever that epistemology has to be extended beyond that of quantum logic. Anyhow, it is easy to forecast that advanced biology will not (!) be a science with less mathematics than modern physics, but in contrary will be mathematized in an even more skillful, and for sure: algebraic, manner.

Let us now look more precisely to the quantity I (information) which we have recognized as the central concept of metatheory, and thus of a future evolution theory as well. At least we have to distinguish between four aspects: the numeric, the syntactic, the semantic, and the pragmatic aspect. The first and second aspect is already present in and describable by classical logic, the third and fourth, however, are not yet carefully treated.

Namely, the first and second aspect are not contextual; they deal only with information as such being a conserved quantity of a stable system.

(1) In principle any stable system (if there is at least one which really exists!) can be treated as a unique superposition of independent states of the smallest undividable substates, and thus the reality of each substate determines a certain probability to be realized out of the set of possibilities. Thought to be independent from each other the probability of the reality of the whole system is just the multiplication product (Poisson's law) of all the single probabilities. The inverse ratio is proportional to the information, and the sum of all single subsystem's informations is the total system information. The only non-trivial solution of this functional equation is just the logarithm, and thus the information is proportional to the negative entropy (Boltzmann's factor being the linear coefficient) of the system.

(2) The rules acting upon a given (and just fixed) amount of informations represented by an ordered set of truth values (t – true or f – false) by the "and", "or", and "not" are due to the syntactic aspects of the information. This finite number of rules is named classical logic, and they are valid for all affirmations concerning conserved information items, totally regardless of their content. What is interesting with those rules, beyond their mere tautology, is the handling of affirmations upon potentially infinite classes. This leads to a totally unempirical behaviour, namely: If a sentence states that all (of unlimited number) certain class items possess the property A, this sentence is false (f) if there is only one example member of that class not possessing A. But how to verify such a sentence practically, if not examine all (infinite by number) possible examples? It was Popper (1976) who discovered that science theory is not constructed within the lattice set of Aristotelian logic: Propositions using "all"-quantors over a potentially infinite set can only be "false", or "corroborated", – never "true".

Additionally, there is an easy proof, just deducible from the duality of lattice sets, what had been explicated by Krueger (1984), that in turn propositions using "existence"-quantors over that infinite set can only be "true", or "doubtful", – never "false". This is of course not the syntactical behaviour of classical logic, however, can be described in the framework of quantum logic for sets of incommensurable facts, as shown by Atmanspacher and Krueger (1991).

Now we have to deal with the contextual aspects of information which are the semantic and pragmatic ones:

(3) From semiotics, a necessary basis of any semantics, we know that a sign is a necessary, however not sufficient, item to transport information. One bit is the fundamental alternative, and thus the "atom" of information. 1 and 0, t and f, + and –, may be the signs or the designation of what alternative is realized. A letter being a byte, for instance a,b,c,..., or a (desoxy-) ribonucleotic codon, or an amino acid is a combination of more than one bits: An ASCII byte contains 8 bits, a nucleotic codon 2 bits, a triplet of those codes or an amino acid, which byte has 6 bits. Nevertheless, receiving just a bit sequence does not make any "sense" to the receiver. He does not know the context, the code; and so there are ancient American scripts with letters and apparent information, we do not understand up to now.

+ or – may, for instance, mean that a spin component of an electron has been measured as being +1/2 or -1/2, respectively. Thus the context is due to a certain level of the universal evolution (a lower one), namely the elementary particles, which provides the "meaning". Or: + or – may mean, a certain person had been examined in hospital to be alive or dead, respectively. Now the context is due to another level of the universal evolution (a higher one). If, by

any evolution process e.g., elementary particles recombine to atoms, or atoms recombine to molecules, another – relatively higher – degree of evolution is considered, and thus the total amount of information included in the atoms is certainly higher than in the sum of their building blocks, the elementary particles, and so on. But the semantics of elementary particles provide the information structure of describing the atoms, the semantics of atoms provides the information structure of describing the molecules, and so forth.

Thus semantics is the epistemology of the (via language man-made) stratification of the evolved universe, and only its information structure makes the universe understandable to us! (For instance, the semantics of chemical formulae is the epistemics of the evolutionary context between atoms and molecules.) Semantic information is concerned with the conditions of sub-systems forming a system. Although this is the onset of the human causal description of the world, it appears to be only conditional!

(4) The pragmatic aspect of information in the (man-made) stratification of the universe describes the finality of systems to a possible supersystem. So pragmatics corresponds to semantics in complementary way. This final determination (metaphysically stated as teleonomy) of pragmatics may also provide new information: If, for instance, the message on those in (3) examined person was: "dead", and we knew from other contextual information that he was a Negro incensed by German Fascists, the pragmatic information now is a social one: "Fascism is raising in Germany!" The items the information is acting on, are human beings; its pragmatic aspect, however, is due to a higher level, namely a super-system (social groups) composed of those items. Whether we will grant truth values to such inferences from single events, or not, is an improper question: Namely, truth cannot be assigned to pragmatic propositions, but merely is a syntactic item in affirmative propositions dealing with the information type (2).

Let us summarize: Within the ontic levels (strati) of the world, the epistemic structure of the information may be

- intra-level type: numeric and syntactic information;
- inter-level sub-strati type: semantic information;
- inter-level super-strati type: pragmatic information.

Thus any information is produced on a potentially infinite ladder of subsequent evolutionary processes, composed of elementary acts, from the real zero ("nothing", the total symmetry of all possibilities which numeric information is 0) by local symmetry breakings (events, with non-zero numeric information), however, under conservation of the global symmetries. The strati of our ontological view are stable or at least stationary clusters of such acts, un-

numerable "becomings" – however, producing to us the illusion (!) of "being"s, including ourselves.

Due to the non-Aristotelian logical structure of any evolutionary science, and due to the simply $m\bar{e}$ -ontological (the famous ontological difference is zero) "nothing" of the "being" world, the modes of reconstruction the world by information into strati by local symmetry breaking with conservation of global symmetries, which is indeed only another description form of information production, seem to us very contra-intuitive. However, with the evolution of more and more complex system structures not only the lower system symmetries are broken (free parameters of possibilities "slaved" to bound parameters of actualities, due to Haken 1977), but new types of symmetries are established in the new systems). By this very stratification all these symmetries are bound together via an entanglement of all the observables (i.e., the symmetry group elements), and these laws are the foundations of the truly "holistic" aspects of all evolution in a strictly scientific sense.

We should not end up before stating some ontological implications of this information metatheoretical approach. It seems to be clear now, that any substance ontology is incompatible with such a universal unitary approach, because "information" fundamentally does neither deal with the, ever already being, "hyle" composing the matter, nor with an inspired "pneuma" letting the matter mindfully act. For the information the interaction is primordial, and entities with which it acts are subsequent, namely just "created" by interactional (i.e., dual) information. For substance ontology, the matter runs exactly vice versa. Modern physics clearly showed, that there is no matter sui generis at all, but all "being" is the result of the interaction of two systems; in human understanding, for instance, the ontic system and its observer.

So, information is an extensive quantity describing intensive functionality rather than onticity. In Western civilization this was first seen by Nicholas Cusanus, however, in the attempt to explain the deity. The new paradigm of Copernicus then was the invention of the "system" (his planetary system), which System Ontology governed the German Idealism from Kant throughout to Luhmann. However, whereas the operating of systems can well be described by informational action within its functional (black-box-behaviour), structural (interconnection types), and hierarchical (sub- and super-systems) aspects, the autopoiesis does not fit into such an ontology. Needless to say that "autopoiesis" is the most important term in metabiology. Namely, although there are automatic systems which replicate themselves, reproduction of living beings towards more complicated and adapted species refers to an ontology beyond "system". Otherwise always either the demiurge or the engineer is needed to create the world or any system therein.

Only Structure Ontology can be fully compatible with an attempt to understand the onset of information out of the Nothing to the cosmos, and out of one system type to a more formidable one. The common goal of all sciences thus must be: Elucidating the structure of all entities governed by invariance principles which are symmetry groups (due to the famous Noether theorem) with local symmetry breakings (which is indeed information) with that symmetry globally conserved, "creates" more advanced symmetries each again governed by a new invariance principle, and so forth: All the way of the cosmic evolution, the ladder up from the Nothing (which at all is conserved!) to You reading this article.

Note added in proof. Recently we (Krueger & Krauße 1999) showed that the ancient Egyptian language is capable to construct quantum-logically connected affirmations. Thus the Egyptians, forming an early culture in human evolution, were able to properly deal with Information in their cosmogenic myths.

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