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6. PLATO AND ARISTOTLE OF THE PRESENT

The Real

For Plato, "the real" was the world of *ideas*, to be reached by thinking. For Aristotle, "the real" was *the observable nature*. When these two opposite views are projected onto the present physics, the first impression is, that here we have, in germ, the controversy between *theory* and *empiry*. Thus, are the theoreticians Platos of and the experimentalists Aristotles of the present?

From the *ontological* point of view, the question is, whether the real is theoretical or empirical. Do the theoretical concepts represent the nature of reality better or more genuinely than the results of experimental research. Or vice versa?

From the *epistemological* point of view, the question is, whether "the truth" can be found theoretically, by thinking, or through observations, by empirical research. Do we reach the reality more genuinely through the experimental results, or does the theory reveal more deeply the nature of reality?

The meanings of concepts represent our conception of reality. The three basic elements of meanings¹, the empirical, the theoretical and the metaphysical one confuse the setup. It is not quite clear whether Plato's *ideas* correspond to theory, or concepts and conceptual structures, or should we rather understand them as the metaphysical mental images, the fictitious carriers of the meanings of concepts. They correspond to theory in the sense that they are results of thinking. Correspondingly, it is not obvious, whether Aristotle's *observation* should be interpreted as the ordinary empiry, i.e. observations and experimental results of research, or does it rather refer to *gestalts*, the meanings perceived through empiry. In this view the controversy looks rather tripartition: Is "the real" in theory, experimental results or in the metaphysical carriers of their meanings?

For instance, is "the table" real? Is just this table, our dining table, coffee table or my worktable, real?.

According to Aristotle, it clearly is. The properties of "this table" can be observed by looking, touching, knocking and listening and lifting it. "This table" can even possess a characteristic smell, which I am used to. But all my sensory observations together consistently convince me about its existence. My table is very real to me. This is the empirical point of view. What is essential, is the *gestalt* of "this table", formed through the consistent observations, the meaning created by all the observations together, which I interpret to indicate its existence. In principle, this is, however, a metaphysical mental image.

What then is the *idea of table*, which, according to Plato, possesses a more genuine existence than just "this table". Is it the class of entities of a certain type, defined by its purpose and by the structure suitable for this purpose? This, in fact tells much more about the "reality" of the "table" than one single table. At the same time, this point of view, adds one more element to the meaning of concepts, the *"technological meaning"*, which I didn't mention earlier on my lectures. It is born in the *technological process*, which belongs inseparably to the dynamics of perception and adds a practical purpose to the *gestalts*². This is obvious in the case of a table, because table, as such, is an artefact created by the technological process. But this concerns generally all *gestalts*. The technological process turns bodies into things and harnesses phenomena as working principles of methods or machinery.³

Then enters the theoretician, physicist, who says that, in fact, there is no table. There are only a great amount of atoms ordered in a certain way, or nuclei and electrons, or quarks and gluons, but in all, almost empty space. Or, going still deeper, he can say, that there are just strings of an 18-dimensional space, in other words nothing, because the strings are nothing but a mathematical abstraction. But all these are metaphysical ideas, fictitious carriers of some meanings – existent or not. They form a hierarchically layered set of mental images of different degrees, which, however, have nothing to do with the idea of table or the meaning of table.

In this ontological view the theoretician will scarcely get Plato on his side. Perhaps Plato's "idea" is, in the ontological sense, closer to Aristotle's "observation", or the mental image born with the support of empiry, than to the abstract mathematical ideas of the theoretical physicist.

¹ See the passage titled *The components of reality* of lecture 1. "*Structural perception*".

² See the passage titled *Dynamics of perception* of lecture 1. "*Structural perception*".

³ This terminology is clear in Finnish. I don't know, how it works in English. In this context, it can be taken as a definition: While "body" is any material object as such, "thing" is a "body" with a purpose.

The role of the process

The key to knowledge is not in what we know or what we think we know about the reality, but it is in the way how knowledge is created – in other words, not in the product but in the process.⁴ This emphasises the epistemological point of view, that of search for "the real". Isn't this just what the pursuit of the scientific process for understanding means?

From this point of view the controversy between Plato and Aristotle corresponds more clearly to the dualism of theory and empiry. The "ideas" of Plato's "real" are reached by thought, i.e. through theory. Aristotle finds "the true" by observation, i.e. through empiry. This setup parallels to Galileo's two questions "how" and "why". To which one of these questions "the true" is the answer? Is "the true" in "how nature works" or in "why does it work as it does"? "How" represents empiry and corresponds to the Aristotelian view. "Why" represents theory and corresponds to Plato's view. Galileo's stand seems clear, when he says, that research of physics does not offer answers to the question "why", but just to the question "how".

The process of science and learning starts from the observation or from the question "how". But the hierarchically layered conceptual system, created by it, seems, in its progress, to answer more and more clearly the question "why". In this way, the problem of "the true" returns to the question: Is "the true" in the starting point of the process, or in its results, the explanation? Hence, the controversy of Plato and Aristotle gets reduced to the question about the direction of the process, assumed as the building principle of the world picture.

I, thus, arrive at the interpretation, that, in teaching and research, Aristotle and Plato are represented by the empiry-based perceptual approach and the theoretical approach, respectively.

Aristotelian process – perceptual approach

If "the true" is in the gestalts perceived through empiry, observations and experimental research are the key to reality. This view about reality can be crystallised into two basic statements:

1. *Intuitive conviction, according to which the surrounding world exists and we are part of it, is the strongest possible certainty about the existence of anything.*
2. *Perception created by intersubjective intuition gives the most sure possible experience about the reality.*

For us, there isn't, and there cannot be, any more genuine or more true reality. The intersubjectivity, which can be reached through the social process is the best possible objectivity to be aimed at in science, because complete absolute objectivity is impossible. From this the question follows: How far is it possible to extend this conviction about the observable reality, when the primary perception based on sensory observation is complemented by the experimental methods of science and it develops into "structural perception", where the conviction is maintained by "empirical compulsion"?

The structural perception process⁵, in its pursuit for reality, is not logical but *intuitive*. The empirical meanings and the empirical compulsion, which regulates it, are intuitive. Perception does not follow from any logic. The existence of the table we observe, the "meaning" of the gestalt "table" and the bindingness of its "empirical compulsion" cannot be deduced by any logic. Logic does not work as a procedure of the process, but it is an aim of it. The process aims at understanding, and tries to formulate it into a logical representation in terms of conceptual structures. Building of world picture is based, in all its details, on intuition, and a subsequent pursuit for logical formulation. It is an *inductive* process, which is proceeding in one direction, from observation to conceptual understanding, from empiry to theory, but it has a bidirectional dynamics, which consists of inductive and deductive elements, inseparably intertwined.

The conceptual system, thus created, is developing hierarchically in a way, where "levels of understanding" of different degrees can be distinguished. The next level is always built on the foundation created by the previous one.

The primary perception is followed by the subsequent macro and micro levels of concepts. Their empirical compulsion is still in concordance with the "elements of reality"⁶ born in the primary perception, and the conviction about their reality is not shaken. At the entrance gate of modern physics, we arrive at the next level, of atoms and quantum fields. There we encounter, due to empirical compulsion, the ontological crisis,⁷

⁴ Cf. K. KURKI-SUONIO: *Tuotteet ja prosessit*. Arkhimedes 2/2005, 21–25. An English translation: <http://per.physics.helsinki.fi/kurkisuo/6.2.D/98-ProductsAndProcesses.pdf>

⁵ Cf. Lecture 1. *Structural perception*. More closely the article K. KURKI-SUONIO (2011). *Principles Supporting the Perceptual Teaching of Physics: A "Practical Teaching Philosophy"*. Science & Education, 20: 211–243.

⁶ See lecture 4. *Meanings and their carriers*.

⁷ See lecture 5. *The ontological crisis of modern physics*.

which puts this conviction to a severe test. On this level the "*elements of reality*" of the classical physics are *crumbled*. And with the further progress of the process the crisis gets still worse.

The 3-dimensional reality of our immediate experience is drawn away into the 4-dimensional space-time. The entities and phenomena are veiled into the wave functions. These "mathematical entities" behave, in themselves in a deterministic way concordant with the classical mental image of reality. However, they are linked to the observable reality only through probabilities, and they don't live in our 3-dimensional world but in the abstract mathematical space, so called *configuration space*, where the number of dimensions equals the number of degrees of freedom of the system represented by the wave function.

The mental image about reality "behind" the classical reality breaks into a discontinuous set of discrete momentary and local events, into a kind of "*twinkling reality*". The *idea of existence* is reduced to something, which could rather be called possibilities of existence or *potential existence*, ruled by some probability laws.

What is left of the heritage of classical physics is the conservation laws, as principles ruling the totality of the events. They are further reduced into *symmetries*, which can be treated in terms of group theory. Here, more abstract symmetries, ruling the fictitious particle species⁸ and the systematic of their properties, enter beside the geometric symmetries of space-time. On this path there is, as an intermediate stage, the so called *standard model* with its possible alternatives. Further, abstract, perhaps 18-dimensional, string structures are sought behind the thus arranged assortment of particle species, as the next deeper fictitious "explanation". According to authorities, who are better aware of the strings, there are millions of different string theories,⁹ but there are no predictions in sight, which would make possible any empirical testing in order to find out, how to pick the "correct" one as a candidate for the final "theory of everything".

Process à la Plato – theoretical approach

In relation to the progress of science, building of world picture by starting from theory is a *return process*, the inverse of the perceptual process. Its starting point is the *idea* of a fundamental basic law, a fictitious exact mathematical core of "the real".

"The real" of the perceptual approach is in, "how nature works", while, in the theoretical approach, "the real" is to be found in, "why nature works as I does". In its progress, science offers to the question "how" more and more general answers, which look as a train of more and more profound answers to the question "why". The starting point of the inverse process, the deepest foundation of "the real", is correspondingly pushed gradually deeper and deeper. It is not at all clear, how much deeper it still is going to be pushed. In fact, there is no rational reason to believe, that there is a final bottommost level of the deepest explanation. If it exists, it is, in any case, still unknown. The basic fundamental law, "the theory of everything" is the great Utopia of the particle physicists, the modern "sorcerer's stone". Many theoreticians have a strong *faith* in it, they *love* it, and they *hope* to find it – *intuitively*, by means of mathematics.

The nature of this process, which begins from an unknown starting point, is, however, obvious in principle. It is an explanatory, deductive logical process, which proceeds in the structural hierarchy of nature step by step from the bottom towards the macro level. Each phase of it can be characterised as *roughening*, where the properties of the next-higher-level entities and phenomena *emerge*, appear to this level as characteristic properties belonging to this level. They are "new" properties in the sense, that they don't exist as properties of the lower-level – or if you wish, deeper-level – entities and phenomena, but they derive, in the roughening, mathematically from the laws representing the entities and phenomena of the lower level. Finally, all measurable properties of the table and of its materials emerge from the properties of the atoms and electrons and their interactions¹⁰, and ultimately, as is believed, from the basic fundamental law.

Two difference ideas about "the real"

"The real" of the empiry-initiated process is in the perceived meanings. The primary meanings perceived through observations develop under the empirical compulsion created by the experimental research of physics. The rational empirical and theoretical meanings are inseparably linked with the irrational metaphysical mental pictures. The mental pictorial element is the core, which gives the experience of "understanding". The mental pictures are experienced as "carriers of the meanings", as existent entities and phenomena. They link the meanings to "the real" or our conception of it.

When the intuitive conviction about genuine existence of the immediately perceived reality is complemented and rectified by the "empirical compulsion", a modern version of the Aristotelian "true" results. It consists of successive layers within each other.

⁸ See the passage titled *Ontology of discontinuous existence* of lecture 5. *The ontological crisis of modern physics*.

⁹ Here I have, as my source, a set of popularising lectures about the string theories. For myself this area is pretty unknown.

¹⁰ This is so called *weak emergence*. *Strong emergence* means, correspondingly, appearance of such properties, which don't derive from the properties of the structural constituents and their interactions.

We ourselves are living in the outermost layer. Its reality is a self-evidence for us. It is ruled by concrete mental images, rooted in the classical "elements of reality". The inner layers are justified by the empirical compulsion becoming step by step more abstract. In each layer the meanings involve their own metaphysical element, mental images of "the real" represented by them. Even the innermost layer, the mathematical core idea, if there is one, includes inevitably a metaphysical mental-image element, the meaning which ties it to our conception of "the real". Layer by layer, the "empirical compulsion" becomes, however, more and more difficult to construct, more and more interpretative and speculative, and the metaphysical mental imagery becomes more and more difficult to achieve. Finally, *mathematical mental images*, without any concrete equivalents, stay, as the only elements of reality.

The empiry-initiated picture of reality has a hard shell. Its inside gets more and more obscure towards the centre.

The theory-initiated process proceeds from the inside towards the surface. In its starting point, the idea of mathematical fundamental law, it seeks mathematical rigor, pure rationality, which would be conserved by the logical deductive nature of the roughening steps. Quantities and laws, characteristic to each layer, emerge rationally from the quantities and laws of the next inner layer.

The concepts of "roughening" and "emergence" reflect the nature of the picture of reality involved in this process. The former one implies, that the concepts of the outer layers are rough and inaccurate as compared to the concepts of the inner layers. The concepts of the outermost layer are the most indefinite ones of all. The latter concept implies, that the concepts of the inner shells give a more genuine representation of reality. Thus, particularly, the observable entities and phenomena – "the true" of Aristotle – would not be existent as such, but they "emerge" only as products of the "deeper-level" explanatory phenomena.

In this conception, the only "genuine reality" left, is the fictitious mathematical core idea of the innermost shell, which would be the exact representation of "the real". All those "elements of reality", which represent our most sure possible experience of reality, would be, to the contrary, just illusion created by our ability and need of perception.

The theory-initiated "reality" has a hard core, and it gets more and more obscured towards the surface.

The basic problem remains, that this hard core, the all-explaining mathematical basic law is not known, and will most probably remain unknown. It is just a matter of faith.

The problem of meanings

The empiry-initiated process is based on perceived meanings and their development under the empirical compulsion. In the roughening steps of the theory-initiated process quantities and laws are "derived" rationally from the quantities and laws of the lower-level quantities and laws. It is, however, unclear, how the derived quantities and laws could be provided with meanings which would link them to the experimentally observable properties. From where would appear, in the theoretical process, the entities and phenomena, the properties of which the quantities and laws should represent?

The meanings don't emerge. The entities and phenomena of every layer have their own identities. The proton has the identity of a proton, the electron has the identity of an electron. The hydrogen atom is a particle species of its own, with its own identity. Although all of its observable properties emerge from the properties of the constituents, the identity of a hydrogen atom does not emerge from the identities of the proton and the electron. Similarly, the identity of the water molecule does not emerge from the identities of the hydrogen and oxygen atoms, and the identity of water does not emerge from the identity of the water molecule.

The perceived meaning of "table", which gives the table its "true existence", is different from the meanings of the atoms, which gives them their "true existence". The meaning of "table" is born from the observations of the properties of the table and not from the observations of the properties of its atomic constituents. True, all measurable properties of the table emerge from the properties of the atoms and their interactions, but the meaning of table does not emerge from the meanings of its atoms. .

Water is real, the water molecules are real, the oxygen and hydrogen atoms are real. The table is real and its atoms are real etc. The 8th symphony of Anton Bruckner is real. The meaning, which makes this symphony, in a convincing manner, an important part of "the true" of mine, does not emerge from the zeros and ones of some of its digitalised presentations, even though all the measurable acoustic elements of the presentation emerge from them on the basis of their arrangement. Also the zeroes, the ones and their arrangement are real and have their meanings, but their meanings are a matter of complete indifference to me, when I am listening to a real presentation of the symphony.

The meanings do not only represent the reality. They are "truly existent" in the sense I interpret Aristotle to have meant it. The theory-initiated process à la Plato does not reach this Aristotelian reality, which is the starting point of the empiry-initiated process, and the existence of which is a matter of absolute intuitive conviction for us.

Reductionism and holism

The concept of emergence couples the controversy of *holism* and *reductionism* to each step of the hierarchically proceeding process of science.

The *reductionist* believes, that the weak emergence covers on each level all properties of the entities and phenomena of that level. Then, in fact, all observable phenomena of nature could be reduced, without remainder, step by step to the deeper levels of explanation and, perhaps finally, to the innermost all-explaining mathematical idea.

According to the *holistic* thinking "a whole is essentially more than a sum of its constituents". Then, on each level properties of entities and phenomena occur or may occur, which cannot be explained on the basis of the next deeper level. Strong emergence is one possible interpretation of such possible properties.

In the Aristotelian observation-based picture of reality one can see a holistic tone. In "the true" formed by ideas, born through the thinking of Plato, one can correspondingly note, at least, a hint to reductionism.

The research of physics is strongly bound to the reductionism, but not necessarily to the extreme-reductionist belief on its all-coverage. Already the starting point of the perceptual approach, perception of "pure phenomena" in the chaotic whole of natural phenomena, isolation of them for separate studies, and the endeavour to understand the whole as a combination of pure phenomena, is reductionist by nature. In principle, this does, however, not involve the idea, that everything could be explained exhaustively by this principle.

In physics, the principle of reductionism has worked well! This is clearly seen in the realisation of the hierarchical structuring principle in the arrangement of the matter in the universe. In the progress from the macroscopic bodies and matter through atoms and electrons to baryons and further to quarks, the next successive layer of constituents has always succeeded in offering a deeper explanation to the properties of matter. This far, at least, physics has succeeded in explaining all measurable properties of matter by this principle of weak emergence. The success has tended to strengthen the belief of the all-coverage of the principle and on the basic fundamental "theory of everything" hiding on the bottom.

The problem of materialism

There is one more essential problem following from the inverse direction of the theoretical process. It is due to the fact that the Aristotelian process starts from the middle of the structural hierarchies of nature. More generally, science always starts from the middle. This is an inevitable consequence of the impossibility of absolute objectivity. *There is nothing, which could be, à priori, logically necessary as such.* Every assertion, result or knowledge is based on some initial assumptions. An assertion can be true only conditionally, on the condition that its background assumptions are defined to be true. Therefore, *science starts from the middle and proceeds in two directions*, forward, building further on the basis of its assumed foundations, and deeper, questioning the justification of the assumed foundations and searching for new, more fundamental bases.

This is seen in the way, how research has made us conscious about the structural hierarchy of the material world. We have started from the structures of man's own order of magnitude, macroscopic matter and of its observable physical and chemical basic phenomena. Progress is made in two directions, towards large cosmological structures and towards the small constituents of matter.

Here, attention has been centred on the latter process, by which the reductionist is seeking the bottom-most basic mathematical idea. The theoretical process goes through the phases of this process in the opposite order. No problems can't even be expected, because in each stage the "explanatory properties" were, originally, "created" on the basis of the properties to be explained, just for them.

But, once this return journey has reached the starting point of the empiry-initiated process, it must be asked, whether the journey can be continued past the point, where the primary process started. Particularly, can we expect to be able to derive life, consciousness, the phenomena of the psyche and the social interactions with all their observable elements, and, for instance, the impressiveness of the 8th symphony of Bruckner, from the constituents of matter and their interactions, on the basis of those laws, which science has attained through the process started from the study of simple physical and chemical phenomena?

The *reductionist* doesn't necessarily take any stand. He just thinks, that life and consciousness must be somehow present in all layers of the reality. They may exist there as some still unknown and unstudied structural elements. He can, thus, ask, whether there are some sprouts or seeds of life and consciousness involved in or linked to the material constituents and their interactions? Are their, perhaps, life and consciousness of hierarchically different degrees? Is their, in the atoms and electrons, baryons and leptons, and finally in the strings, life and consciousness hiding in some elementary form? And in what way could they appear in the fictitious fundamental mathematical idea on the bottom of everything?

The materialistic belief, according to which this utterly daring *extrapolation* of the return process past its starting point, is rationally justified, is often offered with the title of scientific world picture. The *materialist*, thus, claims even that no new explanatory elements are needed. For him, life and consciousness are just

apparent properties, which follow from the complexity of structure. Although there are no signs in sight, that they could be explained in this way as properties of material entities emerging from the laws of the deeper structural levels of matter, he believes, that finding such an explanation is just a question of time.

To myself, a much more credible possibility is, that life, consciousness etc. are genuine "new" properties and phenomena. *The holist* says here, hurray, whole is more than a sum of its constituents. When shouting, he is, however, thinking about those "parts" we already have learned to know in our research of the physical and chemical phenomena. However, close is also the anti-materialistic idea, according to which these properties are completely different kind of "elements of reality", independent of matter and its laws – without any emergence-coupling to them –, somewhat like the way one perceived, in the classical era of physics, the fields as a new class of entities beside the material ones.

The rational and the irrational

In all, the question is about the controversy between *rational science* and *irrational intuition*. The questions of man in his search for reality are *intuitive*. They deal with the perceived meanings. Science tries to answer them "as well as it can". Answers are sought by "*asking the nature*", by compelling nature, by well designed experiments, to answer. For that purpose the questions must be operationalised, dressed in a rational form of experimental research problems. In this way, they are reduced into questions, to which science has the possibility to seek answers. Thus, *science answers its own questions*. To the reduced questions of science we get reduced answers, To make them, at least, to look like answers to the man's questions, they must be interpreted in the metaphysical language of the meanings involved in the original questions.

There is no science without intuition.¹¹ The progress of science is based decisively on the perceivable meanings with their metaphysical mental images as carriers. But the search for truth of science is always shackled to the sequence: intuitive problem => reduced question => reduced answer => intuitive interpretation. Therefore, it is not quite clear, whether science actually is searching for reality, or even, whether it has any possibilities to reach it. If, however, we wish to interpret science as search for truth, it is search for a reduced "rational truth", and the reality, possible for it to search for, is "reduced reality".

WOLFGANG PAULI spoke about reality beyond a veil. The reduction of the scientific world picture to the rationality is a veil, through which the genuine reality is not visible.

Let me illustrate my conception about science and its reduced reality with a mathematical parallel. The scientific knowledge is rational. We can think, that the rational numbers correspond to it. On each segment of line, separated from the real number line, there are an infinite amount of points. The length of the segment tells the measure of the set formed by these points. The measure of the whole real number line is infinite. But the measure of the set of points corresponding to all rational numbers *is zero!*¹² Correspondingly, if all scientific knowledge, possible in principle, corresponds to the set of all rational numbers, its measure is still zero in that "*God's reality*", represented by the infinity of the line. Scientific knowledge at any particular moment corresponds, in this parallel, to a finite subset of the rational points. Of course this subset is expanding and getting denser with the progress of science, but it can never reach even the infinity of the rational numbers, still with zero measure.

¹¹ See K. KURKI-SUONIO (2011). *Principles Supporting the Perceptual Teaching of Physics: A "Practical Teaching Philosophy"*. Science & Education, 20: 211–243.

¹² The length of such a fictitious segment of line, which would be formed, if all these points could be united into a continuous unified sequence.