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SHORT COMMUNICATIONS

The Problem of Understanding of Nature in Exact Science

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In this short inquiry I would like to defend the statement that exact science deals with the explanation of models, but not with the understanding (comprehending) of nature. By the word 'nature' I mean nature as *physis* (as a self-moving and self-developing living organism to which humans also belong), not nature as *natura naturata* (as a nonevolving creature created by someone or something). The Estonian philosopher of science Rein Vihalemm (2008) has shown with his conception of phi-science (φ-science) that exact science is itself an idealized model or theoretical object derived from Galilean mathematical physics.

Some authors have rightly stressed that mathematical natural science (i.e. exact science) grasps *empirical repeatability* and because of that it cannot "see" the *nonrecurrent*, the *unique*. The nonrecurrent cannot be idealized, quantified, or generalized. The unique is scientifically unintelligible. For exact science, the real is the repeatable. For exact science, the real does not include the original, it is always already reproduced. In exact science there are reproductions without an end. The knowledge of the repeatable by exact science makes it possible to control objects. But to control is not to understand. To understand nature as *physis* demands a knowledge of the unrepeatable what exact science, constructing models about reality, ignores and must ignore because the aim of the scientist is to discover law-governed regularities. The scientist discovers the so-called 'laws of nature' which are also idealizations—that is, they are the relations between idealized objects, not the relations between natural phenomena. The 'laws of nature' are formulated in mathematical equations and confirmed by experiments

(or by observations as quasi-experiments). The natural phenomenon, however, simply *is*, while its being remains beyond lawful regularity. The 'laws of nature' are purely exterior relations. The reality (nature, society, cosmos), however, is entirely complex and exhaustible and because of that the laws of reality (the relations between the natural phenomena) would be also very complex, but they could not be well and easily defined. The reality is not only the order, it also contains chaos. Because the reality is primarily and mainly the quality, in doing science the scientist meets resistance to recurrence. Quality must be ignored when the scientist tries to model the object by using idealizations.

Therefore, the scientist must *ignore* the human experience of uniqueness and unrepeatability, of contingency and inexplicability. The scientist finally gives us a system of abstract idealizations and this is an explanation of a model, not understanding the reality. The reality contains many phenomena that in principle cannot be idealized.

Methodology of science embraces only explanation. Understanding is intuitive and does not belong to the methodology of science. In exact science intuition is not recognized. Explanation grasps nature only in the Humean-Cartesian-Kantian meaning, as a pure nonevolving extremely ordered entity (without any chaos), but not as the Aristotelian *physis*. (Aristotle looked at nature, a sublunar world, as a big living organism to which humans also belong.)

A process of explanation is deduction only, not induction. A logical structure of explanation is the same as a logical structure of prediction. Since idealization contains features which contradict the known reality, it is by definition not falsifiable. Since idealizations are false we must say that truth is not necessarily a condition for explanation.

Idealization has its limits on use. Edmund Husserl opposed the application of idealization to the study of the mind, to the study of mental phenomena. Nancy Cartwright (1989) said that Galilean idealization presupposes capacities in nature and because of that it is possible to extrapolate beyond the ideal case. There is also a philosophical concern about the laws created through idealization. The laws as idealizations describe only the behaviour of ideal bodies. These laws can be used to predict the behaviour of real bodies when a number of factors have been eliminated or ignored. Laws that account for a greater number of factors are usually more complicated and not easy or even possible to discover.

The nature of understanding (comprehending)

Knowledge of something is not understanding if it comprises ignorance. Understanding is a process, a human movement toward wisdom, toward seeing the unity of diversity, including the unity of contradictions. Seeing various facts in relation to a general principle is the essence of understanding.

Already thirty years ago I introduced the contrast of 'organization' and 'self-organization', using Ilya Prigogine's and his co-workers' research in nonlinear nonequilibrium thermodynamics (the theory of dissipative structures). I have shown that the philosophical category of organization describes all classical exact science and the exact (mathematical in ideal) part of nonclassical science (theories of self-organization). The philosophical category of self-organization describes the understanding of historical and self-organizing reality. This understanding is possible only beyond idealizations. If we want to understand the reality, what one is, what is historical and self-organizing, we must try to combine the sciences by the 'unity of history', not by the 'unity of laws'. Ilya Prigogine and his collaborators Paul Glansdorff, Grégoire Nicolis, René Lefever and so many others discovered the part of the world that is really *complex*. They are scientists who understood that matter is not inert masses and indifferent interactions, but the states of reality are time-oriented. The states in far-from-equilibrium have properties that are emerging. To describe these states, physicists began to use 'correlations' which measure the kind of togetherness among randomly interacting individual components. As Ilya Prigogine's collaborator and co-author Isabelle Stengers (2004, pp. 92–99) has stressed, for scientists, exploring models where constituents are defined as active and sensitive, the problem is no longer one of *deduction* but of *wondering* what is relevant and how. Besides having a model, scientists researching far-from-equilibrium physical reality are able to *address* a wide diversity of *natural situations*. As Isabelle Stengers (2004) has stressed, the task of scientists exploring complexity is not to *explain* but *to go from opposition to coherence.* Complex systems are characterized by features which in exact science were traditionally eliminated. Now the scientists in nonclassical exact science (which embraces self-organizing systems and their history) researching complex systems know how to address these features. Thus, the task of nonclassical exact science is not to eliminate what is only subjective, what the model had no need to take into account; the scientists must address these subjective features to the realm of understanding the corresponding natural phenomena.

Rein Vihalemm (2008, pp. 416–417) has said in his book, published in Estonian, that the way of cognition of phi-science (i.e. exact science) is paradoxical: the objectivity is subjective—it is achieved by a specific activity of the subject. The way of cognition of exact science and the technical world which interacts with it have *limits*, which we can clearly see in the ecological crisis. Vihalemm stresses that the subject-free world begins to demonstrate its objective link with the world that contains the subject. The ecological crisis makes it clear that the reality, the objective world is unit, man is not outside of it and the existence of this world does not depend on the existence of man, but the existence of man depends on whether man adapts his activity with the objective unity of the world or not. Therefore, from the philosophical position there is *one* real world and potentially an infinite number of real 'world-versions'. And there are no Kantian 'things-in-itself'. This is a meaningless term because it marks the phenomena where the subject is not embraced. The world opens for *us* through the social-historical practice.

From the logical point of view, exact science as an idealized model (or theoretical object) functions (predicts and explains the phenomena) according to a simple categorical syllogism. The understanding of nature is compatible with, but irreducible to physical-mathematical explanation or prediction. If representatives of exact science want to speak about the understanding of nature they have to use the 'personalistic understanding' developed by Nicholas Maxwell or cooperate with humans who are more experienced in personal understanding. Nicholas Maxwell opposes 'physical explanation' as a knowledge-inquiry to 'personalistic understanding' as a wisdom-inquiry. About personalistic understanding, which he has also called 'person-to-person understanding', Maxwell (2001, p. 103) says: "Personalistic explanations seek to depict the phenomenon to be explained as something that one might oneself have experienced, done, thought, felt." While many scientists characterize personalistic understanding negatively as "folk psychology", Maxwell writes:

> Physical understanding [i.e. explanation—*Author's note*] is (a) objective, (b) impersonal, (c) factual, (d) rational, (e) predictive, (f) testable, and (g) scientific […]. Personalistic understanding, by contrast, may be held to be (a) subjective, (b) personal, (c) emotional and evaluative (and thus nonfactual), (d) intuitive (and thus nonrational), (e) nonpredictive, and (f) untestable. (Maxwell, 2001, p. 109)

While representatives of the so-called 'standard empiricism' claim that personalistic understanding is an intellectual disaster, Maxwell believes that in

cooperative activities personalistic understanding is more fundamental than physical explanation. Personalistic understanding may be characterized as *wisdom*, because wisdom can realize what is of value in life, for oneself and others. In his book in Estonian, Rein Vihalemm (2008, pp. 418–419), following Maxwell, has said that in personalistic understanding man uses himself/herself as a model for understanding the other and others in (co)acting in the real world. It must be added that Maxwell has also mentioned the tradition of hermeneutics and even used the term 'empathic understanding' as a synonym for the term 'personalistic understanding'.

In the following, I briefly discuss why idealizations have been created and what are the goals of scientists for using idealizations. Many philosophers of science (Nancy Cartwright, Ernan McMullin, Leszek Nowak, William Wimsatt, Michael Weisberg, and others) have written about the importance of idealization in scientific inquiry. I have already said that truth does not belong to the goals of scientists. Usually these goals are to achieve accuracy, precision, generality, and simplicity. If a theorist strives to achieve high degrees of accuracy, precision, generality, and simplicity, he will need to construct multiple models. But these models should not be confused with reality itself. Sometimes scientists use various models for the purpose of maximizing predictive power. In chemistry, the synthetic chemist or engineer may try to find a set of idealized models that is maximally useful for creating new structures. Sometimes the goals are pragmatic: scientists focus on prediction and structure construction; sometimes the goals are to create explanatory and nonpragmatic models.

Many representatives of exact science (Steven Hawking among them) believe that human beings are not conscious beings; they are incapable of empathy, incapable of making their own decisions based on free will. The fact that exact science sees only 'laws of nature'—that is, physical or scientific laws—does not mean that there are no other aspects (qualitative and quantitative) in reality. Nicholas Maxwell (2007, p. 282) is very right when he claims: "The very distinction between 'the physical universe' and 'the world of human experience' is, as it were, an artefact of our understanding rather than something that exists in reality." There is only one real world and "[it] is only through the means of practice that the objective world can really exist for humans." (Vihalemm, 2011, p. 50)

Concluding remarks

As using idealizations means ignoring the natural features of reality, it is not justified to name this activity 'understanding'. Understanding cannot include ignorance. To understand is to comprehend, and to comprehend means 'to take in' or embrace, but not to eliminate or ignore. An understanding is a generalized meaning. Explanation in science does not include generalization (as induction), explanation is only deduction. The exact science as an idealized model or theoretical object explains or predicts, but does not understand or comprehend. Understanding begins beyond idealizations. Where exact science ends, understanding begins.

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