

ONTOLOGY, REDUCTION, AND THE UNITY OF SCIENCE

To use a currently popular philosophical term, I conceive ontology as **supervenient** on science. That is, if the differences between two ontological systems don't reflect fundamental differences in the results of scientific research, then we can forget about them. As terminology already suggests, physics comes first, metaphysics afterwards - and not the other way around.

Understood in this way, the ontologist's task would be greatly facilitated if science were a single, homogeneous, neatly constructed system - something like a *Bauhaus* building. Then, we would concentrate on the foundations of just this building to find out what the stuff of reality is and how it can be categorized. This is the reason why the idea of the **unity of science** is so attractive **also** for ontological matters. The unity of science would still not imply the unity of being but it would make plausible a single system of what there is, a unique ontology. If science were a *Bauhaus* building, then we would have a guarantee that the question of Being would have a definite answer - whatever Heidegger's ghost might still grumble...

Unfortunately, we all know that science is **not** a *Bauhaus* building. There are hundreds of different theories - each one of them with its own ontological commitment.

Nevertheless, the presence of many different theories in really existing science is not, by itself, a deadly blow to the unitarian ontologist, it just makes his/her task somewhat harder. His/her endeavour may still be saved by means of a magical remedy: **reduction**. If all those hundreds of theories, even those having apparently different ontological commitments are found to be step-by-step reducible to a single theory, then the unity of science would be restored and with it the underlying unique system of Being. But even if there is no such single theory reducing all the rest, the unitarian ontologist should not immediately give up his/her hopes: there might be several fundamental theories reducing the rest but if they are not mutually incompatible, then we might still construct a single ontological system of reality where the ontological categories are extracted from the ontological commitments of the several fundamental theories. Reality would be then definable as the disjunction of the domains of several fundamental theories. All of this admittedly sounds rather metaphorical and fuzzy, and it is so. Let's try to be more precise.

There are at least four terms of the problem needing urgent clarification: "ontological commitment of a theory", "reduction", "fundamental theory" and "compatibility of theories". To this end, a bit of formal semantics might help.

A theory is something uniquely associated with a class of models. If the theory purports to say something about what there is, then at least some of its models have to be regarded as more or less good representations or "theoretizations" of a given domain of our experience. This means that some of the experiences you have when seeing with the naked eye or through a telescope, a microscope, or any other device of the sort, can be subsumed under one of the models of the theory in such a way that some predictions you make really fit, at least approximately. (The process of subsumption of a bit of experience under a theory's model is a quite involved and ill-understood matter but this need not worry us at present.) Once you have successfully subsumed your experience under a theory's model, you are entitled to say that your experience confirms, or makes plausible, or gives some justification to the claim that real things are the way the theory says they are. And the things that really exist, are those and only those included in the model(s) representing your experiences. They are the theory's ontological commitment - and, insofar as you take the theory's claims literally, they are also **your** ontological commitment.

Let's clarify this general point by means of an example. Suppose there were just one theory - call it "the theory of dots", T_d - under which **all** of your experiences could be subsumed. That is, whether you get wet when raining, or you lose your money playing at the stock-market, or you go through a sleepless night after quarreling with your neighbour - all of these experiences, and any other you may have, can be successfully represented by picking out particular models of T_d . Suppose, moreover, T_d has a simple structure: its models have the form

$$\langle D; \rho_1, \dots, \rho_n \rangle$$

where D is a non-empty, finite set of entities (you call them "dots" but, of course, you could give them any other name), and ρ_i are relations defined over D satisfying some axioms $\alpha_1(\rho_1, \dots, \rho_n), \dots, \alpha_m(\rho_1, \dots, \rho_n)$. In such a case, you would be entitled to say that the world ("your world") just consists of dots. To be is to be a dot. That is, to be is to be the value of a bound variable running over the elements of D . Presumably, a traditional ontologist would still show up and ask strange questions like: "But what is the hidden being (*verborgenes Sein*) behind a dot?", or "Isn't it the case that dots are essentially constituted by nothingness?", or similar ones. However, as an obstinate analytical, pre-postmodern ontologist you have to stick to your scientifically-oriented ontological system and make clear that the only justified ontological commitment is the one with dots. All you can say about Being is that it is to be a dot.

Let us refer to the possible ontological situation just depicted by this schematic example as "situation # 1". Another situation, however, is also conceivable. Not all of your experiences are such that you can always find a model of T_d to successfully represent them. Some stubbornly resist being subsumed under T_d . You conclude then that not all beings are dots, that to be is not always to be a dot. The unity of science, and with it the unity of the world, appears to be destroyed. You start looking for a different theory to determine the non-dottical part of Being.

Suppose, however, while you are worrying about these things someone else comes along and offers you a new theory T_{bs} - call it "the theory of beams and slices". T_{bs} 's models have the form

$$\langle B, S; \sigma_1, \dots, \sigma_p \rangle,$$

the σ_i satisfying certain axioms β_1, \dots, β_q .

Suppose T_{bs} has the following properties with respect to T_d :

- 1) D can be defined as a so-called **echelon set** over B and S , i.e. as a set constructed out of the application of the set-theoretical operations of power-set construction and Cartesian product; for example, $D \in \wp \wp(B \times S)$.
- 2) For any axiom α_i of T_d there are some particular conditions $\gamma_1, \dots, \gamma_h$ such that, when added to some of the axioms β_j of T_{bs} you obtain

$$\dots \wedge \beta_j \wedge \dots \wedge \gamma_1 \dots \wedge \gamma_h \mid \cong \alpha_i,$$

where the symbol " $\mid \cong$ " means that the conjunction to the left at least approximately implies α_i , i.e. it implies a statement which stands in a particular topological relationship with α_i .

If these two conditions are satisfied then we may say that T_d is **reducible** to T_{bs} . T_d is not a fundamental theory anymore; the **fundamental** theory is T_{bs} .

Suppose, further, T_{bs} would not only reduce T_d but would also be such that it has models successfully representing those experiences not covered by T_d . Then, we would have the unity of science and of the world restored. But we would have to say that there is not just one fundamental ontological category ("dots") but rather two: beams and slices. Of course, from a purely formal point of view, one could also restore the unicity of ontology by defining a set A , call it of "beam-slices", as the union $B \cup S$. But if we assume that the axiomatic characterization of B 's elements is definitely different from that of S 's elements, then the alleged ontological unity is spurious: From a material, ontological point of view we should still differentiate the elements of A satisfying the first set of axioms from those satisfying the second set. Nevertheless, though we have here two fundamental ontological categories we still have a unitary ontological system, since both categories pertain to just one fundamental theory. Let's call this kind of situation, where you have several ontological categories but only one fundamental theory reducing all other ontological categories and theories "Situation # 2".

Suppose, however, that you don't find a theory of beams and slices reducing your initial theory of dots but you find one or several other theories T_1, \dots, T_h , each one of them having some model that subsumes some of the experiences left out by T_d and none of them being reducible to the others. Here we have a set of several fundamental theories. Can we still speak of a unitary ontological system? The answer is: maybe. It depends on whether some of the theories in this set are **ontologically incompatible** or not.

Now I have to explain what I mean by "ontologically incompatible". Let me first say what I don't understand by it. That T and T' are ontologically incompatible does **not** mean that T contradicts T' ; since both T and T' are fundamental and are determined by different axioms, the entities of the respective domains of the models are different **things** and therefore what you say about one sort of things in one theory cannot contradict what you say about another sort of things in the other. What ontological incompatibility means is that the same sort of experience can be subsumed both under models of T **and** models of T' - T and T' being thereby assumed to be fundamental, i.e. neither is T reducible to T' nor is T' reducible to T , and of course they are not equivalent. Suppose, for example, that T only speaks about dots whereas T' only speaks about beams. And that dots and beams are really different things (and not just different names for the same thing) because different relations are established between them satisfying different axioms. Then, if the same experience E can be represented by both a model of T and a model of T' , this implies that E lends support both to the idea that being is just being a dot **and** to the idea that being is just being a beam. And this is a sort of contradiction - not a formal contradiction for sure, but an ontological one. On the other hand, T and T' would be ontologically **compatible** whenever this doesn't happen, that is, whenever they speak of different things **and** represent different ranges of experiences; or, still in other words, whenever each one minds its own business.

Let's call a situation where you have a series of different but mutually compatible fundamental theories "Situation # 3"; and a situation where you have several fundamental theories some of them being incompatible with others "Situation # 4".

Now it seems to me that in Situation # 3 we would still speak of a unitary ontological system, and therefore of one world, and therefore of being. Being would be determined in this case by different categories. The categories would come some times from one and the same theory, some other times from different theories. But there would not be an essential ontological problem in this. Experience would some times support the claim that something that is, is a dot, sometimes that something that is, is a beam, sometimes that it is a slice, and so on. But as long as the experiences are different we can live with that. According to the experience we have, we categorize being in different ways. Surely, the resulting ontological system is less well-unified than in Situation # 1 or # 2, since we lack a unifying theory. However, it is still **one** big ontological system. There is just one Being of beings.

The picture changes drastically when we go over to Situation # 4. It doesn't make sense here to speak of one ontological system. Experience would tell us that we live simultaneously in fundamentally different, incompatible worlds. The notion of world itself would cease to make sense and with it the notion of Being.

The interesting question, of course, is what is really the case. Are we in Situation # 1, 2, 3 or 4? What does really existing science suggest that is the truth of the matter? Now it seems pretty clear that we don't live in Situation # 1. This is certainly not a logical truth, it is an empirical fact; but it is so obvious that it almost has the force of a logical truth. What about Situation # 2? Since Newton's times, the most brilliant physicists and natural philosophers have invested tremendous efforts to bring it about that Situation # 2 becomes realized. GUT is just the most recent example. And along with physicists, also chemists, biochemists, sociobiologists, etc. have tried to give good reasons to endorse the same world picture: reductionism. At certain times they seem to be on the verge of fulfilling the utopia of ONE THEORY - ONE WORLD. But, then, once and again some trouble-makers appear on the scene with other theories representing well other sorts of experiences and definitely **not** reducible to the pretended one big theory. The history of science of the last 300 years tells us that we should be rather cautious in expecting something close to Situation # 2.

At the present stage of our scientific worldview, the real issue seems to be posed between Situations # 3 and # 4. Whatever the fans of the "theory of everything" might contend, it seems obvious that we are confronted with **several** fundamental theories in the sense explained here.

Now, many people contend nowadays that at least two of the existing fundamental theories, viz. general relativity and electroweak theory are incompatible. Some people might also add thermodynamics, especially irreversible thermodynamics, to the list of mutually incompatible theories. If this were the case we would have Situation # 4 and, therefore, the idea of a general ontology would appear as quite problematic. However, it is not clear that people asserting the incompatibility of, say, general relativity and quantum electrodynamics understand by it the same intertheoretical relation I have called incompatibility here. Rather, it seems that what they mean is that neither the principles of general relativity are derivable from quantum electrodynamics nor the other way around, and that they have very different conceptual frameworks. But this still is no sufficient reason for asserting incompatibility in our sense. If the experiments and observations represented by the models of quantum electrodynamics (or electroweak theory) are clearly distinct from the portion of experience subsumed under general relativity, then we have Situation # 3 rather than # 4. The same goes for the experiments and observations for which irreversible thermodynamics has been designed. It seems to me that this is actually the more realistic interpretation of what is going on in present-day science. If this were admitted, then we still would be able to build up a single ontological system, though of course at the price of admitting that Being sometimes is said to be in the sense of general relativity, sometimes in the sense of particle physics, sometimes in the sense of irreversible thermodynamics, and perhaps in still other senses. There would still be one world but this world would be more

like a de-centralized federal system rather than like a centralized State. Whether this is a plausible interpretation of present-day science, however, ultimately depends on the results of a careful ontological analysis of the existing fundamental theories and their interrelationships. This still has to be done. The question about whether we **really** are in Situation # 3 or rather in Situation # 4 is still open.

Institut für Philosophie, Logik und Wissenschaftstheorie
University of Munich