Committee II
Theoretical Empiricism:
A General Rationale for Scientific Model-Building

draft
for Conference Distribution Only

DISCUSSION PAPER

by

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on

Camilo Dagum's

Scientific Model-Building:
Principles, Methods and History

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Some remarks on the Unity of Science in relation to the Scientific Model Consortium. by Georg Süssmann, Munich, Germany

Last year in Chicago, in a conversation with professor Wold, I said to him that to my mind the unity of the sciences should be more than the common denominator of the scientific method. His answer was that he would like to see the background of my contention, and he invited me, a physicist, to his planned committee on Scientific Model-Building. I readily accepted this honorable invitation,and later on professor Wold allocated my comments to the paper of professor Dagum. So let me begin with some remarks more closely related to Dagum's paper.

In most respects I agree with the Theoretical Empiricism of professor H. Wold as it was explained to us by professor C. Dagum. I certainly prefer this two-dimensional approach to the one-dimensional positions of pure rationalism on one side and pure empiricism on the other.

There are only minor points where I would prefer a different formulation. Let me mention these four points: Dagum's interpretations of Democrit's and Kant's philosophies (on the pages 5 and 8 respectively), and the definitions of a general system and of a general space (on page 30 of professor Dagum's paper). As to the first pair of points: According to my understanding, Democritus, who postulated unseen atoms and a real vacuum, was not a radical empiricist; and Kant, who explicitly denied the idealistic philosophy, was not a radical rationalist either. As to the second pair of points: According to mathematical

vocabulary, a relation is not defined on a Cartesian product, but is just a subset of such a product , a relationship being a class of relations; and many important spaces(A) are homogeneous and thus do not show off a distinguished element, or point(a of A). It should not be too difficult in most cases to agree upon some more refined formulation. But not being a philosopher, methodologist, or social scientist myself I will not elaborate on these details. Instead let me concentrate on a few observations arising from my perspective and experience as a physicist.

My remarks will be mainly concerned with the idea of an ontologically based unity of science. Most physicists, including myself, feel they have good reasons to accept the physical universe not only as an imaginative idea(a formally collecting notion), but as a realistic entity(a substantially comprehending concept). There is, we think, this one world, inherently whole and thus a genuine cosmos, all its numerous differentiations notwithstanding. Therefore, there should be a unity of the sciences.

Here the term unity is not to be taken too literally, of course it need not mean that we will be able to establish one and only one ultimate principle like the water of Thales or the nous of Heraclitus, or the abstract one of Parmenides. What "unity" does mean here is an integrity and solidarity which does not allow for definitive separations like that between the mind and the matter of Descartes. It is not necessary to define life in opposition to physics nor humanity in opposition to biology. None of these distinctions can be denied, and they all are important

enough, but they do not exclude a connecting continuum. To derive biological physiology from physics and chemistry or human sociology from biology and psychology need not be a category mistake. The reasoning may be teleological as well, as is exemplified by the anthropic principle of recent years. According to this postulate, the astrophysical structures are chosen so as to allow for organic life, and the biological structures are chosen so as to allow for human spirit.

These considerations are supported, I think, by the history of the natural sciences, especially well by the manifestly unifying trends in physics. To mention only a few examples: Acoustics have been genuinely reduced to hydrodynamics, thermodynamics to statistical mechanics and cosmology, electricity and magnetism as well as optics to the unified electrodynamics, and chemistry to physics via quantum theory. The remaining problems of the initial conditions vs. the laws of motion, which are sometimes raised up in this context, are not at all alien to our present concept of physics; so they do not involve any new or irreducible feature which could separate chemistry from physics or physiology from chemistry. I admit an interesting polarity here, the dichotomy of the contingent vs. the necessary aspects of the universe. These are evidently related to the empirical vs. the rational elements of a sound methodology. (You see now a main reason for my endorsement of Theoretical Empiricism.) But this polarity does not imply any fundamental split in the physical and mental nature of the universe. They only mean that we have to deal with both: with accidental existence as well as with symmetric essence. Their close interconnections became even

stronger in the last decade through our studies of the so called broken symmetries, where the contingent and necessary features of the fundamental fields and particles are intertwined in a very interesting manner.

An important contingency besides that of the initial(or final) conditions is the indeterministic or stochastic aspect of quantum theory. Its equations of motion are deterministic, but in a formal sense only as they do not predict(or postdict) the factual events but merely the probabilities of these facts. This structure is much more open than the Pythagorean or Eleatean philosophy would have it. It allows for a plurality much richer than a rigid rationalism would permit.

On the other hand, we have found a surprisingly simple set of fundamental laws which are identical all over this huge universe. This fundamental simplicity is not a result of our wills or wishes only. They are more and often surprising, sometimes even unwelcome accomplishments. In some cases they came about in an entirely unexpected way. Let me remind you of Einstein, who disliked quantum theory even though he had made crucial contributions to its evolution. That kind of simplicity which we have encountered in quantum theory did not satisfy the epistemological or ontological tastes of Einstein, but we could not deny its physical validity. To be sure, we have not yet arrived at the foreseen unified fundamental theory but we have come, I think, a good deal closer to this goal during the last years.

When speaking about the essential unity of science and the wholeness of this one world, or creation, I am not calling it fundamentally material nor fundamentally mental. Neither the so called objective mor the so called subjective pole can claim, I think, metaphysical priority. Quite the contrary: The substantial coherence of the physico-mental universe implies, among other things, the impossibility to disentangel its material aspect from its mental one. This is one of the important lessons we have learned from the quantum theory of particles and fields. The idea of a physical object is an approximation only; and its representation by our physical concepts would not make any sense without its fundamental relation to a conscious subject. The world is not a system of localized objects; it consists rather of phenomena. (Remarkably enough, Whitehead came close to such insights rather independently of quantum theory in the very years when Bohr and Heisenberg coined the quantum theoretical concepts of complemenarity and indeterminacy, and shortly before von Neumann provided his rigorous formulation of quantum theory.) This remarkable inseparability of physical reality has been clearly explained in non-technical terms by d'Espaquat in his most recent book. For example, because of Pauli's anti-symmetry principle we cannot sharply distinguish between two electrons even if they are miles apart from each other.

Much less can we separate a moving thing showing up from the conscious eye seeing it. This is not only an epistemological relation of the Kantian type: according to vonNeumann's thorough interpretation of quantum theory a much more dynamic

physico-mental correlation is taking place. This is not Berkeleyan nor Platonic idealism - much less solipsism - in the sense of a metaphysical priority of mind over and above matter; and it is not realism - or materialism - either. What it really means is the impossibility of a Cartesian separation of mind from matter. Von Neumann's position is, I feel, close in spirit to that of Leibniz.

Let me close by drawing your attention to professor Kaplan's most recent book*, expecially its first part, which consists of four chapters dealing with science. One of Kaplan's basic notions is that of a correlative concept pair. With this he expounds the fundamentals of meaning and reality in a way which can be, I feel, of great help in our endeavors toward a better understanding of the nature and scope of science, its internal unity, and its relations to other ways of understanding.

* M. Kaplan: "Science, Language, and the Human Condition" (Paragon House, New York 1984)