

Simplicity as an Epistemological Value in Scientific Practice: A WORKSHOP

JANUARY 8-9, 2009 – IEA-Paris – 16-18 rue Suger 75006 Paris

The epistemological value of simplicity has long been taken as self-evident by natural scientists, and perhaps especially by physical scientists, but in this workshop we wish to examine the multiple meanings and values that have variously been attached to simplicity in the mathematical, physical and biological sciences – both as currently practiced and as practiced in the past.

Schedule: Friday, Jan 8

9:30 Welcome: EFK

9:45: David Wilson, History of Science, Iowa State University:
“Simplicity in the Copernican Revolution: Galileo, Descartes, and Newton”

Abstract: Even with no unequivocal empirical evidence that the earth orbited the sun, natural philosophers and astronomers had generally accepted Copernicanism well before the end of Isaac Newton's life in 1727. The three principal Copernicans of the preceding century had been Galileo Galilei, Rene Descartes, and Newton himself. Galileo's *Dialogue on the Two Chief World Systems* appeared in 1632, Descartes' *Principles of Philosophy* a decade later in 1644, and Newton's *Mathematical Principles of Natural Philosophy* four decades after that in 1687. To be sure, Galileo's early-century telescopic observations had provided pathbreakingly new empirical evidence. But Galileo's unsuccessful trial in 1633, among other things, reflected that evidence's failure to establish the Copernican system. Why was it then accepted? Galileo, Descartes, and Newton all employed simplicity in their arguments. However, while physical scientists may pursue simple theories, historians generally find satisfactory explanations to be complicated. Therefore, the question for this paper is: can the historian provide a properly complicated account of simplicity's role in the Copernican Revolution?

11:00-11:30: Coffee Break

11:30-12:45: Jean Gayon, IHPST, Université Panthéon-Sorbonne:
“Simplicity in the biological sciences”

Abstract: There are two common uses of the notion of simplicity in scientific methodology: syntactic simplicity and ontological simplicity. Syntactic simplicity is about the number and content of hypotheses: a simpler theory has fewer principles, and these principles are as "simple" or "elegant" as possible. Ontological simplicity is about the number of entities (either things or processes) postulated by a theory (*entia non multiplicanda sunt*). The biological sciences are concerned with these two notions of simplicity in their daily practice in relation to the particular hypotheses that they make on particular subjects. However they are rather problematic from both points of view. Syntactic simplicity is questionable because most often biological theories are not demonstrative in the ordinary sense of the word. Ontological simplicity or "parsimony" is also problematic because of the huge diversity of living beings, which leads in practice to a pluralistic view of a number of higher level categories such as "gene", "organism", "species", "life", "variation", "selection". This does not mean that biologists are not attracted by "simplicity". They are. But, in comparison with other natural sciences, the price for simplicity in biology is a huge lack of precision and predictive power. The theory of natural selection is a good example of this. Reversely, biological theories may be quite operational and predictive, but then simplicity is lost. The example of the modern molecular definition of the gene used in genomics illustrates this situation.

2:45-2:30: Lunch

2:30-3:45: Evelyn Fox Keller, IEA and MIT:

“Simplicity as an ontological value in Physics and Biology”

Abstract: There is a long tradition in the physical sciences, from Galileo to the present, that attributes not only heuristic but also ontological value to simplicity: As Feynman put it, "You can always recognize truth by its simplicity." What is the basis of this assumption? What, if any, place does such an assumption have in the biological sciences? I argue that these questions are lent particular pertinence by the recent influx of many theoretical physicists into Biology.

3:45-4:05: Coffee Break

4:05-5:20: Annick Lesne, CNRS, LPTMC & IHES:

“Simple models in physics and biology”

Abstract: Simple models have been much fruitful in physics for understanding principles of emergence and collective phenomena; universality of the ensuing behaviors basically mirror underlying statistical laws (central limit theorem and its generalized versions, or self-similar situations when long-range correlations are present). In biology, additional feedbacks of emergent properties onto the state space and dynamics of the elements are essential. Biological systems thus ask for different modeling approaches, situated either at the level of the elements but accounting for their embedding in a whole (“reductionism in context”) or at a systemic level where general principles can be unraveled, e.g. the architecture of regulation. I will discuss the role of genericity arguments respectively in physics and biology and its relation to simplicity. My main point is that co-evolution by natural selection of the different elements and organisation levels of a living systems may lead its structure or dynamic regime in a very narrow and peculiar region of the possible space, corresponding to non typical situations, e.g. stabilization of bifurcation points or thresholds.

5:20- 6:20: Round table (commentators): David Ruelle, Karine Chemla, and Jacques Ricard, Nadine Peyri ras

DINNER: 7:30

Schedule : Saturday, Jan 9.

9:30 – 10:45: David Rabouin, Director, REHSEIS (SPHERE, CNRS & U. Paris Diderot):
“The Difficulty of being simple : Leibniz on simple notions”

Abstract: It is well known that Leibniz once had the dream of reducing all knowledge to an “alphabet of human reason”, a repertoire of simple basic notions from which any complex judgment could then be derived as in a computation of simple numbers. What is less well known is that Leibniz expressed very early on serious doubts about the possibility of actually arriving at simple notions. In this talk, I will briefly recall these doubts, describing the strategies elaborated by Leibniz for overcoming the difficulty of arriving at simple notions and showing their importance in his mathematical practice.

10:45-11:15: Coffee Break

11:15- 12:30: Jeremy Avigad, INRIA – MSR, Orsay, and Carnegie Mellon University:
"Simplicity in abstract algebra and number theory"

Abstract: Developments in mathematics often serve to simplify our reasoning, for example, by providing shorter proofs, easier calculations, or streamlined solutions to problems; and such developments are often highly valued for that very reason. And yet we still do not have a firm philosophical understanding of the nature of mathematical simplicity. I will discuss reasons that such an understanding is important, consider examples from algebra and number theory that illustrate the phenomenon, and try to draw out some common features.

12:30-2:00 Lunch

2:00-3:15: Andrew Arana, Kansas State University:
“Simplicity and elementary methods”

Abstract: A simple question like “How many primes are there up to x ?” deserves a simple answer, one that uses elementary methods rather than all of these methods of complex analysis, which seem rather far from the question at hand.” There seem to be two ideas regarding simplicity tangled together in this passage. One is that “simple” means “elementary”, which in this context means “provable without complex analysis”. The other is “simple” means “close to the problem at hand”. These are two quite different ideals of proof, however. As I will show, however, Granville's tangling of the two is quite common. I will make some suggestions about why mathematicians so commonly tangle them together, and explain why they should be untangled.

3:15-3:45: Coffee Break

3:45-5:00: Jean-Jacques Szczeciniarz, Director Departement HPS U. Paris Diderot & REHSEIS (SPHERE, CNRS & U. Paris Diderot):
“Investigating once again the Kantian antinomy simple/compound”

Abstract: I want to investigate once again the antinomy of the *Critique of Pure Reason* by E. Kant, in the Transcendental Dialectic, antinomy between Simple and Compound. I want to use it in order to investigate certain properties that defines the modern complexity. I will discuss in this frame some analyses by John Gribbin (*deep simplicity*).

5:00-6:00: Round table (commentators): Karine Chemla, Sébastien Gandon et Ivahn Smadja