

Sunday, June 27 AM 9:00-12:00, Room 140

Session 3 (room 140): **20th Century Philosophy of Science II**

Daniela Bailer-Jones, “The Neglect of Models from 1900 to 1950”

Henk W. de Regt, “Scientific Realism in Action: Molecular Models of Boltzmann’s Bildtheorie”

Matthew D. Lund, “Toward a Conceptual Meteorology: Finding the Laws Governing the Cloud of Conjecture and Confusion”

Torsten Wilholt, “Lost on the Way from Frege to Carnap: How the Philosophy of Science Forgot the Applicability Problem”

Michael Heidelberger-Chair

“The Neglect of Models from 1900 to 1950”

Daniela Bailer-Jones

The goal of this paper is to analyse why, despite their practical importance in 19th century science, models did not receive any (favourable) attention in philosophy of science during the first half of the 20th century. The almost total disregard of the role of models for a period of 50 years needs explaining. I begin by considering the role attributed to theories, which usually implicitly included the opinion that good theories rendered models theoretically and practically redundant. As a hangover from the early days of philosophy of science, even now, ‘model’ very often still implies that a chosen description is in a merely preliminary version, to be confirmed and to be transformed into a theory later. ‘Theory’, in turn, has the connotation of being well established, i.e. free from the many failings and inaccuracies of models.

At turn from the 19th to the 20th century, theories were mostly taken to have axiomatic form and were reconstructed according to the ‘hypothetico-deductive method’. Pierre Duhem, a proponent of this notion of theory, also reached notoriety for playing down models as a tool for lesser minds. One important issue is that ‘model’ in this period exclusively referred to physically built models. Models of the more theoretical variety, as we use the term today, were referred to as analogies (James Clerk Maxwell, Ludwig Boltzmann, Pierre Duhem). Another issue that led to the disregard of models is the Logical Empiricists’ emphasis on the context of justification, rather than the context of discovery. Issues that arose in the discussion of the early ‘modellers’, such as Ernest Hutten and Mary Hesse, have to do with *actual thinking*, while they do not much contribute to the ‘rational reconstruction’ of theories. Thus, models were quite naturally of no interest to Logical Empiricist philosophers because models were not thought to contribute to the successful application of a theory (Carnap 1939, p. 68).

Interestingly, the reference frame of the early modellers, in particular Richard Braithwaite, but also Mary Hesse, seems to have been operationalism. Models provided one response to the question that stood out so prominently in operationalism, the question of linking theoretical postulates to observational evidence. I recapitulate the early arguments in favour of the importance of scientific models in their historical context and end by highlighting how the early discussions of models, mainly those by Mary Hesse

and Ernest Hutten, raised many of the issues that still govern the philosophical consideration of models: models for the purposes of interpreting theory; how scientists use models; models as incomplete and ‘not literal’, i.e. as leaving out things and potentially being misleading; models as aids for visualisation; models as relating to the familiar; models as providing descriptive vocabulary; models as guides for experimentation; models as tools for thinking and theory development.

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“Scientific Realism in Action: Molecular Models of Boltzmann’s Bildtheorie” Henk W. de Regt

This paper analyzes the interaction between the scientific work of Ludwig Boltzmann and his views on the epistemological status of scientific theories. Its general thesis is that the epistemological views of scientists themselves are relevant to the philosophical analysis of science, and to the realism issue in particular. This is substantiated by a case study which shows the interplay between specific epistemological goals of scientists and their scientific results.

The case study concerns the attempts by Maxwell and Boltzmann to solve the ‘specific heat anomaly’, which was a serious problem for the kinetic theory of gases in the 19th century. The anomaly consisted in a discrepancy between the theoretical predictions and the experimental values of the ratio of specific heats for particular gases. It appeared impossible to construct a realistic molecular model that accounted both for the anomaly and for other known properties of gases. In 1876 Boltzmann advanced a solution in the form of a molecular model (the ‘dumbbell-model’) that defied straightforward realistic interpretation. Maxwell rejected this proposal: he advanced specific objections to the model, but these were fatal only on strongly realist assumptions. Boltzmann did not abandon his model: his mitigated realist ambitions allowed him to advance and defend the model. Later he developed his epistemological views into a sophisticated form of realism, the so-called ‘Bildtheorie’.

Analysis of the relation between Boltzmann’s scientific work (the ‘dumbbell-model’) and his epistemology (the ‘Bildtheorie’) shows that it is not a unidirectional cause-effect relation but a mutual interaction. Interestingly, Boltzmann’s ‘Bildtheorie’ has similarities with Ronald Giere’s constructive realism, according to which a model should be similar to reality in specified respects and degrees. Giere’s account provides an explanation for the current role and status of the dumbbell-model: the model is still used because, even though it fails to be similar to reality in important respects (which can be explained quantum-mechanically), it remains similar to reality in other respects. Accordingly, there is no need to abandon realism per se; only a more flexible relation between model and world is required. Such a flexible kind of realism was already defended by Boltzmann around 1900.

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“Lost on the Way from Frege to Carnap: How the Philosophy of Science Forgot the Applicability Problem”

Torsten Wilholt

The Applicability Problem (i.e., the problem of how to explain the applicability of mathematics in the empirical sciences) was regularly addressed in the philosophy of science up to the early 20th century. It had been made a central issue in philosophy of science by Kant, but with the crisis of intuition (in mathematics as well as in physics) beginning in mid-19th century, many started to find Kant's own answers wanting and therefore to look out for new ones. Nevertheless, the applicability problem has almost vanished from the discussion in post-war philosophy of science. In this talk, I will present one possible explanation of how this came to be.

I will argue that the decisive circumstance that obliterated the Applicability Problem from the agenda was the fact that post-war Logical Empiricism considered it solved. The solution was taken to consist in the Analyticity Thesis (i.e., the thesis that mathematics is a body of analytic truths) that the Logical Empiricists had adopted from the Logicians. Interestingly, the Logicians themselves had a strong interest in the Applicability Problem. I will set out how Frege's philosophy of mathematics can in fact be understood as an attempt to solve it.

But the Analyticity Thesis and its relation to applicability underwent a change during the process of adoption by Logical Empiricism. This can be seen by a comparison of Frege's and the late Carnap's treatment of applied mathematics. More precisely, the difference comes out most clearly with respect to their accounts of real analysis (even though Frege's account, in the aborted second volume of *Grundgesetze*, remains fragmentary). Carnap (as well as other Logical Empiricists) regards applied mathematics as a body of analytic truths employed as a *representational* tool. But this version of the Analyticity Thesis does not possess the explanatory power with regard to the Applicability Problem that Frege intended his doctrine of Logicism to have. Roughly speaking, while the Logical Empiricists' view explains how mathematics will be a *reliable* tool if it is useful, it does nothing to explain why it is *useful* in the first place. The latter question had however been a central concern for Frege and his ideas about how number concepts are *per se* related to ratios of physical magnitudes.

The comparison between Carnap and Frege brings out the shortcomings of a bare appeal to the analyticity of mathematics as a response to the Applicability Problem. It thus shows that the Applicability Problem is an issue that was not really resolved, but rather forgotten in the course of Logical Empiricism's temporary hegemony.

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