

Heisenberg's Ladder Didn't Fall. Types, Aims and Uses of Models in the History of Quantum Theory

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Abstract:

The conclusion of Wittgenstein's *Tractatus* (6.54, before he recommends silence for the unspeakable, published 1921 in *Annalen der Naturphilosophie*) suggests a theory of knowledge generation that necessarily dispenses with older forms of knowledge, although they were instrumental to reach the new results, in order to "see the world rightly."

While many historical descriptions of the "quantum revolution" seem to match this contemporary picture, both classical physics and the old quantum theory did not become obsolete when quantum mechanics was established as both were still necessary to formulate, to guide and probably also to understand the procedures of quantum mechanics as well as also to explain, visualize and popularize the new theory.

In my talk I will first try to sketch this wider context of a classical tradition within quantum mechanics, in particular as far as it was related to models of various kind:

- models as simplifications in order to find quantum analogues (oscillator)
- models for formal mathematical analogies (Hamilton; micro/macro; invariants; Umdeutung)
- models as falsifications (e.g. celestial mechanics, Pauli hydrogen ion)
- models as visualizations, didactic tools and popularizations (Bohr, Sommerfeld ... H.E. White)

Then I will analyze the role of select three-dimensional physical models for these purposes in some detail, asking when they were introduced, what changes their status underwent and when, if at all, they were withdrawn from the physics discourse.

Finally, I discuss the example of H. E. White's mechanical device of 1931, which, when photographed in motion, provided pictures of quantum mechanical electron clouds. (To some extent it was motivated to give some consolation to those still in want of a mechanical model). This mechanical modeling of genuine quantum mechanical phenomena points in yet a different way to the fact that it is rather an illusion that Heisenberg's ladder could have been thrown away.