Methodologies for the achievement of understanding in Quantum Mechanics: The case of Primitive Ontology

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Here I address two questions from the epistemology of Quantum Mechanics, namely: *can scientists achieve legitimate understanding of QM?* and if so, *how is this possible?* On the one hand, scientific understanding is a fundamental component of any successful scientific enterprise and it consists of building networks that successfully connect our scientific knowledge about the world. In addition, understanding is often regarded as both explanatory and factive -this is, the content of understanding can only include true propositions that are known to be so. This considered, it seems impossible to legitimately understand knowingly defective (partial, vague, conflicting, inconsistent, false and even impossible) theories. On the other hand, while we often say that QM is predictively successful, in recent years, the actual epistemic contribution of the theory has been put on trial. The main concern is that both the standard theory and its interpretations are defective in different senses, and therefore, they are not worthy of (strong) belief (Cf. Saatsi 2019, Hoefer 2020). The combination of these facts poses the following dilemma: either, pace traditional literature, we can legitimately understand defective theories such as QM (the standard theory and its interpretations) or such theories cannot be object of our understanding, and we have been mistaken by assuming that they are.

Here, I argue that we can legitimately understand the standard Quantum theory and some of its interpretations, even if defective, if we can recognize the theory's underlying inference pattern(s) and if we can reconstruct and explain what is going on in specific cases of the theories in question. To do so, I assume a Primitive Ontology-methodology and I contend that it (remarkably) enhances our modal understanding of both the theories and the world that they describe.

I proceed in four steps. First, I characterize the problem of achieving scientific understanding of defective theories, and I briefly discuss the case of QM. Second, I introduce the Primitive Ontology (PO) framework (Cf. Allori 2013, 2015, 2016) and sketch a PO-methodology that can be relevant for both the

satisfactorily scrutiny of the theories as well as for the achievement of understanding. Third, I briefly compare this methodology with Maudlin's Canonical Presentation method (2018), and I highlight the understanding-related virtues of PO. Finally, I illustrate how a PO-methodology can enhance our understanding of an interpretation of QM -namely, GRW matter density (Cf. Egg and Esfeld 2014) and I draw some conclusions.

References

1. Allori, V. (2013). Primitive Ontology and the Structure of Fundamental Physical Theories. In: D. Albert, A. Ney (eds.), *The Wave Function: Essays in the Metaphysics of Quantum Mechanics*, Oxford University Press: 58-75.

2. Allori, V. (2015). Primitive Ontology in a Nutshell. *International Journal of Quantum Foundations* 1 (3): 107-122.

3. Allori, V. (2016). Primitive Ontology and the Classical World. In: R. Kastner, J. Jeknic-Dugic, G. Jaroszkiewicz (eds.), *Quantum Structural Studies: Classical Emergence from the Quantum Level*: 175-199.

4. Egg, M., and M. Esfeld (2015). Primitive ontology and quantum state in the GRW matter density theory. *Synthese* 192: 3229–3245.

5. Hoefer, C. (2020). Scientific Realism without the Quantum. In: French, S. and J. Saatsi (eds) *Scientific Realism and the Quantum*: 19-34.

6. Maudlin,T. (2018). Ontological Clarity via Canonical Presentation: Electromagnetism and the Aharonov–Bohm Effect. *Entropy* 20, 465.

7. Saatsi, J. (2019). Scientific realism meets metaphysics of quantum mechanics. In A. Cordero (Ed.), *Philosophers Look at Quantum Mechanics*, pp. 141–162.