

## Against Potentialities, in Favour of Constraints

Carlos Romero

Postdoctoral researcher

Institute of Philosophy, Pontificia Universidad Católica de Valparaíso

There have been various proposals to the effect that an ontology of potentialities can be used to interpret one or another quantum theory (e.g. Boge 2019, Dorato & Esfeld 2010, Esfeld et al. 2014, Suárez 2015). I object to these proposals and suggest an alternative modal metaphysics.

First, I introduce the modal metaphysics of potentialism in its most sophisticated version, which I take to be Vetter's (2015). Then, I present the proposed applications of the ontology of potentialities to the three main (non-relativistic) quantum theories: the standard theory, GRW and Bohmian mechanics. Next, I object to quantum potentialism that it misconstrues the explanatory relation between constraints, potentiality and modality, thus misconstruing quantum ontology. I close by suggesting a successor modal ontology —*constraint realism*— that provides a neater account of the explanatory relation, and has the added benefit of being a fruitful ontology of physical modality.

By way of context, it has already been argued that potentialism cannot account for *supra-nomic necessities* — meaning necessary principles that go beyond the laws of nature. Paradigmatic examples of these would be the principles of conservation (Lange, 2017). Lange argued that potentialism misconstrues supra-nomic necessities as *coincidences*, resulting from the interaction of different potentialities, while physicists have taken them at various points as *constraints*. Supra-nomic necessities are constraints in the sense that they limit what possible fundamental forces and laws for them there could be. In addition, the restrictions allow explanations that appeal to physical impossibilities (*counter-nomic* situations), in which they are still valid, indicating that they have a broader degree of necessity than that of the laws (Katzav 2004). But potentialism implies that laws have the widest degree of necessity —*metaphysical necessity*—, since they follow from the essence of potentialities (Bird 2007, Ellis 2001). Considering only potentialities ignores the existence of supra-nomic constraints, unduly restricting the scope of physical theory.

In this talk, I will argue that there are not only supra-nomic physical constraints, but also *infra-nomic* ones. The infra-nomic constraints are those states that constrain the physical ontology, but which do not follow only from the laws or the supra-nomic principles. Infra-nomic constraints determine particular physical *situations* or *problems*: the particle in a box, or the hydrogen atom, for example. They result from the application of the nomic and/or supra-nomic principles *plus* special *initial* and/or *boundary conditions*. These infra-nomic constraints are not explained by the potentialities, either.

Time permitting, I will introduce and motivate my own view, which I call *constraint realism*. Constraints have recently been of interest in the philosophy of physics and in general

philosophy of science (Adlam 2021, Filomeno 2019, Hooker 2013, Juarrero 1998, Winning 2019), but I think that an exact, explicit ontology is still lacking. I aim to propose one such, put in the framework of contemporary modal metaphysics. This metaphysics is anti-Humean, in accepting primitive modality in Nature; but it is also anti-Aristotelian, in rejecting —against contemporary potentialist and essentialist ontologies of physics— that the modality in Nature can always be tracked down to individual things. Constraint realism accepts “unsourced” modality in this sense, which is going to be further specified in the talk, and doing so allows us to accommodate infra-nomic necessity in a swift way not available to the other currently most favoured metaphysical theories of physics.