A Middle Way: A Non-Fundamental Approach to Many-Body Physics by Robert Batterman: From Scales to Levels

The quotidian life of humans unfolds on the scale of meters. The biological cells that make us up occupy 10^{-5} m. The COVID virus is 10^{-7} m wide. Atomic nuclei span 10^{-15} m, and the Planck scale on which we expect new fundamental physics is on the order of 10^{-35} m. Stable patterns of interesting physical phenomena unfold on each of these scales. There are also interesting patterns of dependence and independence between the phenomena that occur on each of these scales. The structure of the galaxy cluster that we inhabit depends on the mass distributions of the galaxies that make it up, but not on whether that mass distribution derives from dust or human society. Human affairs have recently depended sensitively on the distribution of the COVID virus, but the distribution of the COVID virus is insensitive to the intricate details of the QCD interactions that bind together the protons and neutrons of which the viral particles are composed.

In *A Middle Way*, Robert Batterman correctly points out that none of this had to be the case. The phenomena could have been distributed across different scales, and the world could have exhibited a wildly different dependence structure between phenomena on distinct characteristic scales. There might not have been relatively long distance structures over which one could successfully generalize at all, and there might have been delicate dependencies across all scales. The fact that the world consists of phenomena distributed across the particular scales that it does, with the particular dependence structure that they exhibit, is an empirical fact which cries out for explanation. And it is this explanatory task which Batterman faces up to in *A Middle Way*.

Much of the book is concerned with a particular collection of methodologies employed in condensed matter physics. One of the contributions of *A Middle Way* is to provide a detailed treatment of these central aspects of scientific practice which have been long neglected by philosophers of science. These methodologies are of interest because in many cases they provide the resources to answer the following question, which is central to Batterman's broader explanatory project:

> AUT: How can systems that are heterogeneous at some (typically) micro-scale exhibit the same pattern of behaviour at the macro-scale? (Batterman, 2021, p. 31)

This question will be familiar to those who are acquainted with Batterman's previous work on the renormalization group explanation of the universality

of critical phenomena.[1] Discussions of that work, however, have focused on the epistemic status of the idealizations that the renormalization group embraces, and whether they are in some sense indispensable. I expect that *A Middle Way* will provide further fuel to those debates. But this book leverages attention to the renormalization group and other condensed matter methodologies for what strike me as new and importantly different purposes; namely, to use the successes of multi-scale modelling to guide commitments about the metaphysics of levels.

Contemporary discussions of levels in the philosophy of science can be traced back at least to Oppenheim and Putnam (1958), and there already commitments concerning levels get linked directly to theoretical reduction. This linkage runs through the literature, and Batterman urges that this is a mistake. He argues that the bottom-up methodologies employed in the reductivist program don't provide the required resources to provide a compelling answer to AUT. For this reason, it is not clear that the reductivist has the resources required to produce an adequate account of the observed levelled structure of our world. Middle-out methods provide us with the right tools to provide answers to AUT, and hence function as the basis of Batterman's account of levels. He largely eschews talk of emergence and instead focuses on the concept of autonomy as the relevant one for delimiting the cases where distinct levels arise.[2]

This isn't how Batterman expresses it, but you might think of his argument going as follows. Scientific realists of a certain stripe infer from the success of their theories to the reference of that theory's central terms. When this inference is applied to fundamental theories, it yields grounds for belief in the reference of theoretical terms which are very remote from the realm of what is directly observable. But when this pattern of inference is applied to the success of the middle-out methodologies that Batterman is concerned with, it yields a rather different conclusion. In particular, he argues that it shows the mesoscale variables employed in these successful theories to be natural kinds. Moreover, one might go a step further and conclude that the dependence structure that middle-out methods establish between the scales in the problem track the dependence structure that is actually present in the world. From the success of middle-out methods, we can conclude that our theories latch onto the real levels in the world.

If this is a fair reconstruction of Batterman's argument, it should be clear that his target is not just the reductivist program in the philosophy of science. His arguments also bear directly on the tenability of numerous positions

[1] See, for example, Batterman (2001).

[2] The notion of autonomy is importantly different from the explanatory autonomy appealed to in Woodward (2018). Woodward's view involves relativization to the aims of inquiry, whereas Batterman points toward a view of natural variables and autonomy that does not require such a complete relativization. For discussion see (Batterman, 2021, Ch. 7).

concerning the metaphysics of fundamentality, ordinary objects, and levels. These topics have been the subject of significant discussion in the metaphysics literature in recent years. Unfortunately, like many issues at the boundary of metaphysics and the philosophy of science, the two communities have not mutually benefited from one another to the full extent possible given how much their interests overlap. For this reason, it is worth emphasizing that the view Batterman articulates in *A Middle Way* is very directly relevant to these debates as well and I will try to establish these connections here.

On the fundamentality front, Batterman engages directly with Sider (2011).[3] For Sider, what is most fundamental is that which is perfectly joint carving. But as we have seen, for Batterman, what joints there are in the world is a notion that is to be naturalized. And once we take account of the methods that actually are effective at identifying the joints, it is not at all clear that we should expect there to exist a privileged collection of perfectly joint carving structures. Rather, on Batterman's view, it seems that "galaxy cluster" will come out just as joint carving as "Higgs boson". From an effective field theory point of view, which is very much of a piece with Batterman's, the Standard Model of particle physics captures a middle level between the Planck scale and the relatively long distance scale of atomic physics. The notion of a perfectly joint carving property or structure is an idealization which the actual practice of science provides us with no grounds for committing to the existence of.

Those that hold out hope for a fundamental completed physics whose structures are perfectly joint carving often are committed to eliminativism about ordinary objects. Roughly, this is the view that all that really exists are the items of the fundamental level, whatever a completed physics reveals them to be. This is to be contrasted with conservativism according to which ordinary objects, understood as the class of medium sized dry goods, also exist.[4] I think Batterman's view leads naturally to the conclusion that there is something right about the claim that tables and chairs exist in the same way that electrons do. Tables and chairs, are, after all condensed matter systems, and their properties will emerge as joint carving according to Batterman's story in the same way that the properties of electrons do. Eliminitavism and conservativism are also to be contrasted with the varieties of permissivism generated by countenancing as existing various combinations of the results of mereological parthood and fusion operations. For Batterman, how to think about such composition relations isn't going to be the sort of thing that we have any reason to think we can settle without empirical input.[5]

[3]There are, of course, many other metaphysical approaches to fundamentality. While I think that Batterman's arguments bear on their tenability as well, for reasons of space I will not discuss them further here.

[4]For recent treatments, see, for example, Baker (2007) and Korman (2015).

[5]For an account of what an empirically informed mereology might look like, see Needham

Lastly, and most centrally to the argument of the book, *A Middle Way* provides an interesting new approach to the metaphysics of levels. Recent discussions in the metaphysics literature have considered whether there is a fundamental level,[6] whether a middle level might be the most fundamental,[7] whether the universe in its entirety is the most basic,[8] and whether level-talk is altogether misguided.[9] For Batterman, again these are not questions that we should expect to be able to settle without empirical input. Given the contingent nature of the characteristic scales of the phenomena, and of the dependence relations between the phenomena on those scales, we should expect to need our best scientific methodologies for approaching these questions about levels. As far as I am aware, the metaphysical approach most closely aligned with Batterman's approach is the one developed in Wilson (2010). The question of how the views of Batterman and Wilson are connected is worthy of further investigation.

So, one way to read *A Middle Way* is as an effort to focus our attention on the methodologies that matter for articulating a fully naturalized metaphysics of fundamentality, objects, and levels. In making these connections, I have gone beyond what Batterman says in the book and in doing so I have likely stated his case more metaphysically than he will be comfortable with. I have taken these liberties because the book should be read by everyone with an interest in understanding why the world is structured in layers, and how to understand the dependence relations that obtain between those layers.

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[6] See Schaffer (2003).

[7] See Bernstein (2021).

[8] See Schaffer (2010).

[9] See Thomasson (2014).

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