Gordon Belot
Geometric Possibility.
Oxford: Oxford University Press 2011.
200 pages
US$55.00 (cloth ISBN 978-0-19-959532-7)

There are two long-standing positions with regard to the nature of space. Substantivalists regard the structure or parts of space as fundamental, and the geometric relations that hold between material bodies as derived. Relationalists regard geometric relations holding between material bodies as fundamental, and the structure or parts of space as derived. A significant problem for relationalists is provided by the description of worlds that agree as to the matter distribution, but differ as to the spatial structure. If the structure of space is derived directly from material relations, then how can the distinction between such universes be held? We might, as relationalists, want to have a notion of spatial geometry ambitious enough to describe something akin to the large set of possibilities available to our substantivalist rivals. How can we construct such a notion? It is to exploring the intellectual landscape surrounding this thorny and important problem that Gordon Belot's *Geometric Possibility* is devoted.

In Part 1 Belot provides an overview of various types of mathematical object which some claim represent a possible spatial structure of the world. Part 2 then lays out the fundamental framework for the central argument of the book. If we are to assume that sentences such as 'space is finite' or 'space is *n*-dimensional' are given meaning by their truth conditions, then the substantivalist/relationalist dispute can be understood in terms of the contrast between the relevant proposals for such truth conditions. Whereas, for substantivalists, the obvious option is to define truth conditions in terms of constraints on the pattern of instantiation of geometric relations by the parts of space; for relationalists, there are two competing strategies: they can ground the truth of spatial statements either through conditions on actual material configurations, or through conditions on possible configurations of matter. This choice is taken to define a fundamental division between conservative and modal relationalists.

Belot thinks one should be a modal relationalist, and he offers his primary argument in terms of the difficulties that a conservative relationalist has in dealing with a world constituted by an expanding ball of matter. Further, in going modal relationalists, according to Belot, also gain access to a far more powerful descriptive toolkit: they can recognise as quantitatively distinct the same set of possible worlds as the substantivalists (in Belot's terminology the position can be 'ambitious'). It is claimed they can also hope to follow the conservative relationalist in obtaining equivalence between the specification of intrinsic geometric facts and material distance relationships (the position can be 'metric'). According to Belot, the notion of geometric possibility involved need not be assumed to be primitive: we may be able to base it in occurrent geometric properties and relations (the position can be 'grounded'). The rub, however, is that our modal relationalists can't have it all. In the final three parts of the book Belot argues that the three obvious strategies for constituting geometric possibility each conflict with one of

the three supposedly desirable characteristics.

The first option for geometric possibility is, accoding to the terminology introduced above, the grounded, metric, un-ambitious one. It is based on David Lewis' best-system approach to nomic possibility and has been expounded fairly recently by Nick Huggett ('The Regularity Account of Relational Spacetime', *Mind* 115 [2006]: 41-73). Broadly speaking, Huggett's approach considers the distance relations between material points as basic geometric facts of a world and then designates the ideal geometry for that world as that which is consistent with the geometric facts and gives the best balance between simplicity and strength (defined in geometric terms). We then obtain a notion of geometric possibility in terms of the set of ideal geometries relative to a given world. All in all, Belot finds the best-system approach fairly unconvincing, both in its nomic and geometric guises. This is chiefly on the grounds of his doubts as to whether the 'balance between simplicity and strength' is achievable in a sufficiently strong and coherently intersubjective sense. His arguments are generally quite convincing—not least on account of several nice examples—but in essence rely on backing his opponents into a corner of (supposedly) counterintuitive consequences. Most interestingly he contends that both Huggett and Lewis at best end up having to accept a species-relative notion of laws/geometry, and this amounts to their positions collapsing into something like a transcendental idealist thesis. To some this may not seem like such a bad thing, but to others such a reductio ad Kantium may be the clincher.

The second notion of geometric possibility considered follows the well-trodden path of nomic primitivism, and is taken to lead us to a variant of modal relationalism that is essentially ungrounded: there is no interesting sense in which, for a given world, facts about geometric possibility can be grounded in ordinary geometric facts. Rather, geometric possibility is mediated via a primitive equivalence relation on the space of possible worlds that tells us when two worlds share their spatial geometries. The focus of discussion is the potential ability of a primitivist modal relationalist to achieve the metricity and ambition that come with capturing intrinsic geometric facts in terms of facts about distances, such that we can still retain the descriptive capacity to parallel the substantivalist's set of possible worlds. As to whether Belot realizes his ambitions on this point, the discussion is, to my mind, not entirely satisfactory. It seems natural to expect that much depends upon what notion of substantivalism is involved, and the discussion of the so-called sophisticated variants of the position (which are arguably the most viable) is relegated to a footnote. This aside, it does seem that Belot is successful in putting together a coherent account of how a metric, ambitious notion of primitive geometric possibility can be viably melded with relationalism. Moreover, as the author points out, in the light of the various matter-free solutions to the field equations of general relativity, the potential for a primitivist to describe matterless worlds that differ with each other as to facts about geometric possibility, makes the position very attractive. However, the crux of the issue is surely within what kind of consistent metaphysical outlook this primitive modal notion can be set: What, ontologically speaking, do world-relative facts about geometric possibility actually amount to? And what does it mean to say that such facts can be instantiated differently in distinct matter-free worlds? Without some kind of answer to these questions it seems difficult understand how the primitivist notion of

geometric possibility could ever be invested with much metaphysical weight.

In this respect, the third and final option we are presented with has a notable advantage: investigation of the necessitarian version of geometric modality (which is ambitious and grounded) leads Belot to propose a new type of compatibility property that is held by material points in addition to intrinsic distance relations. The compatibility properties can be broken down and analyzed explicitly and, moreover, would seem to be explanatory in an interesting sense. In essence the idea is that just as nomic necessitarians take the laws of a given world to be completely determined by the fundamental (non-geometric) properties instantiated, geometric necessitarians take the geometry of a given world to be completely determined by the fundamental geometric properties instantiated. Clearly, for this approach to be tenable we need some non-trivial notion of what these properties can be beyond distance relations, and this we are given in terms of the notion of a compatibility property. These are such that, for a given world, they encode information about the class of materially full worlds with the same geometry.

After establishing the viability of the geometric position, Belot turns to whether the necessitarian approach (both nomic and geometric) should be considered 'super-grounded' in virtue of not depending upon modally tainted properties and relations. He argues that the necessitarian can do at least as well as the most tenable best-system type approach on this front: the advocate of a super-grounded best-system approach must accept either that there is no difference in the actual world between regularities born of metaphysical and physical necessity, or that there are non-modal essential properties which ground such differences. Whereas the first option is taken to be objectionable in principle, the second is taken to collapse the supposed advantage as to super-groundedness (since the necessitarian may then also follow the essentialist route to super-groundedness). However, it is not entirely clear that the first horn of this dilemma should actually be so unpalatable to the best-systems advocates. For, as far as the regularities of the actual world are concerned, they should not want to accept a fundamental difference between metaphysical and physical possible regularities in any case, since such a difference would be inimical to the Humean purpose of their enterprise. Thus, in the end, there seems little to choose between the best-system and necessitarian programmes for geometric possiblity at this stage of their development.

Geometric Possibility is recommended reading for philosophers of science and metaphysicians alike. It offers a well-motivated contribution to a philosophical debate of great historical significance. Although perhaps not a suitable introduction to any of the topics covered, it nevertheless should be accessible to advanced students and relevantly informed non-philosophers. Belot's project is a fascinating one, and there is certainly much valuable future work that could be done in extending and refining the ideas introduced in this book.

Karim Thébault
University of Sydney