In a series of recent writings, David Albert (1996, 2013, 2015, ms-a, ms-b) and Alyssa Ney (2012, 2013, 2015), amongst others, have introduced, clarified, and defended a radical understanding of quantum metaphysics which I label ‘high-dimensionalism’. According to this view, ordinary objects are the ‘shadows’ of high-dimensional fundamental ontology. This has been the subject of a number of criticisms (especially Maudlin 2007, 2010, 2013, ms), focused on high-dimensionalist connections between fundamental and non-fundamental. Perhaps the most interesting of these criticisms concerns ‘ghosts’: alternative constructions from the fundamental ontology that are alleged to have the same credentials to be material objects as the ‘shadows’, making high-dimensionalist connections seem objectionably arbitrary. I argue that there is no in principle asymmetry between high- and low-dimensionalism here: low-dimensionalists have just the same kinds of ghosts to ponder.

1. Introduction

Call the space that the fundamental ontology inhabits ‘the fundamental arena’. It is what David Albert (ms-a, p.7) describes as “the totality of opportunities for things to be one way or another”. Specifying the fundamental facts is a matter of specifying everything going on in this fundamental arena.

This fundamental arena is standardly conceived as low-dimensional: the universe consists in some fundamental ontology (perhaps particles or fields) inhabiting four-dimensional spacetime (perhaps with a few extra string-theoretic dimensions rolled in). Call this standard view ‘low-dimensionalism’.

According to Albert (1996, 2013, 2015, ms-a, ms-b) and Alyssa Ney (2012, 2013, 2015), however, the success of quantum mechanics suggests a radical rejection of low-dimensionalism. They propose that the fundamental arena corresponds to what is, for the low-dimensionalist, the universe’s ‘configuration space’ (together with a temporal dimension). This arena has $3N+1$ dimensions, where $N$ is the number of particles. This allows the wavefunction to be straightforwardly interpreted as a field taking values at the points of this space, evolving through time according to a fundamental dynamical law. (Any further fundamental ontology also inhabits

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1 My usage differs slightly from Albert’s (ms-a): my ‘fundamental arena’ corresponds to his ‘Ur-arena’, his ‘fundamental arena’ refers to my fundamental arena at a time.
2 See also Loewer 1996, North 2013, Ismael (ms).
3 This is merely a heuristic: the number of dimensions is supposed to determine the number of particles, not vice versa.
this high-dimensional arena. For example, Bohmian mechanics is to be interpreted as positing a single ‘world-particle’.) Call this revisionary view ‘high-dimensionalism’.4,5

High-dimensionalism faces an obvious challenge: accounting for the low-dimensional world of our everyday experience. “The particularly urgent question,” as Albert (2013, p.54) puts it, “is where, in this picture, all the tables, and chairs, and buildings, and people are.”

Can high-dimensionalism meet this challenge? Several critics – notably Tim Maudlin (2007, 2010, 2013, ms) – have claimed that it cannot. They have alleged that high-dimensionalism leaves a distinctive explanatory gap between its fundamental ontology and the ordinary world of material objects. Thus, for example, in discussing a high-dimensionalist view, Hawthorne (2010, p.149) writes that

…you should be able to see that there’s going to be an explanatory gap and that there will be no real hope of closing it.6

There are (at least) two concerns behind this criticism. One is that the connection between high-dimensional fundamental ontology and ordinary spatiotemporal ontology is not sufficiently scrutable. For one thing, this connection is too opaque: it is conceivable, logically possible, and a priori open that things are fundamentally as the high-dimensionalist says, and yet non-fundamentally the tables and chairs do not emerge as we expect them to. And for another, it is too indirect: the fundamentals fail to render the manifest image intuitively visualisable or straightforwardly comprehensible. Given the high-dimensionalist’s complete fundamental description of the world, one cannot easily read off where the tables and chairs are, or even whether they exist. Instead, highly non-trivial metaphysical codebreaking is required to unlock this kind of information.

Following Schaffer (2017), I think we should be comfortable with connections between the fundamental and the non-fundamental which are opaque; indeed, opacity seems to be the norm. For example, the claim that wholes are grounded in their parts is a paradigm case of such a connection, and yet mereological nihilism – according to which there are no composite objects, and hence this connection never holds – is conceivable, logically possible, and a priori open. Meanwhile, looking for reasonably direct connections may be a natural way to start our

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4 This view is usually called ‘wavefunction realism’. However, the name is misleading: opponents may agree that the wavefunction is real, whilst denying that its reality mandates high-dimensionalism; either because the wavefunction is non-fundamental, or because it does not inhabit a high-dimensional arena.
5 There is also a hybrid view which envisions both a low-dimensional and a high-dimensional fundamental arena – see Dorr (ms) for an exploration.
6 See also Allori (2013, p.69): ‘A new explanatory scheme is needed, and nobody has found one yet.’ And Chen (2017, p.351): ‘we are right to doubt whether there can be any principled way to close the apparent explanatory gap’.
fundamental theorising, but it is a preference that we should be willing to give up when pushed. The world’s true metaphysical structure may just turn out to be difficult to comprehend for beings with our (idiosyncratic) conceptual resources. The business of extracting the ordinary world from a true fundamental theory is likely to be far messier, more abstract and more involved than we might have hoped.

Of course, the scrutability concern deserves far more discussion than I have given it here. But I would like to focus instead on a second concern that seems to underlie explanatory gap criticisms: that the high-dimensionalist’s connections are objectionably arbitrary. The worry is that there is nothing to distinguish these connections from other equally natural alternatives in the vicinity. Why does the fundamental ontology give rise to this ordinary world rather than some other one?

The aim of this paper is to argue that there is no asymmetry between high- and low-dimensionalism here: they face just the same kinds of choice between alternative connections. The broader moral is that there is no distinctive, in principle explanatory gap on the basis of which high-dimensionalism can be ruled out. Instead, we should evaluate and compare the overall virtues of high- and low-dimensionalist fundamental theories.

Before I turn to the argument, I will present the kind of high-dimensionalist connections that are supposed to be objectionably arbitrary.

2. Grounded shadows

According to high-dimensionalism, the ordinary world is constituted by ‘shadows’ of the fundamental ontology, projected onto a low-dimensional space. The latter is a derivative space distinct but constructed from – that is, grounded in – the fundamental arena. The key to this construction is that each point in the fundamental arena is posited to correspond to an N-tuple of spacetime points – mimicking the mapping between points of 3N-dimensional configuration-space and the N particle locations in their corresponding configurations. Given a coordinatization of the high-dimensional fundamental arena, we can represent this correspondence perspicuously by coordinatizing spacetime in such a way that the point of the fundamental arena coordinatized as \((x_1, x_2, x_3, t)\) will be mapped to the N-tuple of spacetime points \(<(x_1, x_2, x_3, t), \ldots, (x_{3i-2}, x_{3i-1}, x_{3i}, t), \ldots, (x_{3N-2}, x_{3N-1}, x_{3N}, t)>\).  

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7 *Grounding* ideology is not standard in the existing debate. I intend it as a usefully generic term for the explanation-backing metaphysical determination of the less fundamental by the more fundamental, without importing any substantive conception of this relation.  
8 I am glossing over complications regarding the relativistic extension of quantum theories here, in the spirit of assuming that they won’t impact the core metaphysical issue that I am concerned with.
The resulting ‘configuration-space mapping’ from points of the fundamental arena to N-tuples of spacetime points can be used to define a converse mapping, $G$, from spacetime points to corresponding regions of the fundamental arena. $G$ maps the spacetime point $<a, b, c, t>$ to the region containing all points of the fundamental arena of the form $(\ldots x_{3i-2} = a, x_{3i-1} = b, x_{3i} = c, \ldots, t)$. Intuitively, $G$ maps each space-time point $p$ to all those points of the fundamental arena whose corresponding configurations involve a particle occupying $p$. The resulting region of the fundamental arena is a fusion of N $3N-3$-dimensional hyperplanes; the $i$-th of these hyperplanes corresponds (heuristically) to all those configurations in which the $i$-th particle occupies $p$.

The various high-dimensionalist proposals exploit this mapping to define projections of the fundamental ontology onto the newly constructed derivative space. Albert (2015, ch.6) describes four such projections: one for Bohmian mechanics and three for ‘GRW’ (named for Ghirardi, Rimini & Weber (1986)). My interest is in the general structure shared by these proposals rather than their particular details. Nonetheless, to have a concrete target in the arguments that follow, it will help to briefly introduce one of them.

In the case of GRW, unlike Bohmian mechanics, the wavefunction is not supplemented by any additional fundamental ontology. As Bell (1987, p.204) puts it:

> It is in the wavefunction that we must find an image of the physical world, and in particular of the arrangement of things in ordinary three-dimensional space.

One natural approach is to posit a non-fundamental ‘mass-density’ field on spacetime. This field can be imagined as being formed by superimposed particle configurations, with the ‘density’ of each configuration in the resulting spatiotemporal image being determined by the wavefunction’s amplitude at the corresponding point of the fundamental arena. This layering of particle configurations amounts to a pointwise ‘projection’ of what is going on in the fundamental arena onto spacetime. More formally, the mass-density at any given spacetime point $p$ is determined by integrating the wave-function’s squared-amplitude across the N $3N-3$-dimensional hyperplanes that constitute the region $G(p)$.

This describes a precise and systematic connection between the wavefunction in the fundamental arena and mass-density in derivative spacetime. The requisite ordinary objects are then formed out of the various clumpings of this mass-density, arranged in a suitably intricate manner. Tables, for instance, are table-shaped clumps of high mass-density.

Albert’s other proposals all share the same two-step structure as the mass-density proposal.

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9 See also Bell 1987, ch.22. Although the same issues arise for Many Worlds interpretations (see Saunders et al 2010, Part II), I don’t consider the extension directly here as it involves extraneous difficulties.
Firstly, they posit a precise and systematic connection between their fundamental high-dimensional ontology and some derivative spatiotemporal ontology, or ‘local beables’ (Bell 1987, ch.7), such as the mass-density field. Each of these connections exploits the mapping $G$ described above, extended in the natural way to take in arbitrary regions (fusions of points are mapped to the fusions of their images), so that what is going on at the spacetime region $R$ is metaphysically determined by what is going on at the region of the fundamental arena $G(R)$.

Secondly, they posit some further connections between the local beables and ordinary objects, replicating the connections posited by their counterpart low-dimensionalist theory. For example, suppose this latter theory posits a connection of the form:

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\begin{align*}
&\text{[table at spacetime region } R]\nonumber \\
&\text{[local beables arranged table-wise at spacetime region } R]\nonumber \\
&\text{[high-dimensional ontology arranged table-wise* at region of fundamental arena } G(R)]\nonumber 
\end{align*}
$$

where $table-wise^*$ is a place-holder standing for however it is that the high-dimensional ontology has to be arranged at $G(R)$ to give rise to local beables arranged table-wise at $R$, given the posited connection between the high-dimensional ontology and the local beables (the first step). Since this latter connection is made perfectly precise on each proposal, $table-wise^*$ will be no sketchier than $table-wise$ is already.

What motivates the posited connections in all these proposals is the promise that the resulting low-dimensional world behaves exactly as it should. As a mathematical matter, such connections will, by design, replicate the predictions of their low-dimensionalist counterparts. Whenever the low-dimensionalist says that the local beables ground a pointer pointing up, say, the high-dimensionalist agrees, merely adding that those local beables are in turn grounded by some fundamental high-dimensional ontology.
But empirical adequacy alone seems insufficient to fulfil high-dimensionalism’s obligation to accommodate the manifest image. The high-dimensionalist’s connections shouldn’t leave an explanatory gap; and in particular, they shouldn’t be objectionably arbitrary.

3. Groundless ghosts

The arbitrariness concern centres around ‘ghosts’: alternative constructions from the fundamental ontology that are alleged to have the same credentials to constitute material objects as Albert’s shadows. The question is: what privileges the shadows over these ghosts? Why aren’t the ghosts also material objects? Or if they are, how can’t we see them or interact with them – how come, more generally, they don’t seem to have the same significance for us that the shadows (allegedly) do?

It is worth getting clear, before proceeding, on what this question amounts to. The credentials to constitute material objects are, in a broad sense, exclusively dynamical: it is a matter of behaving, or being disposed to behave, in certain characteristic ways. Material objects move continuously through the space they inhabit, are relatively stable, interact with each other when they are close enough, do not tend to split or pass through each other, etc. Grant that high-dimensionalist connections succeed in recovering a dynamical structure that enacts material objects in this sense – the problem is not that it cannot be done, but rather that this kind of formal adequacy is all too cheap. Indeed, the objection goes, there are many other connections which would work just as well.

The challenge, then, is to steer between the horns of arbitrariness and overpopulation. On the one hand, the high-dimensionalist wants to avoid populating our world with many more material objects than we expected. Such overpopulation would open them up to charges of redundancy: positing far more table and chair-like objects than we need to explain our ordinary experiences of tables and chairs. On the other hand, the high-dimensionalist wants to avoid arbitrary stipulation. It shouldn’t turn out that the privileged status of the shadows in relation to the ghosts is a brute, unexplained metaphysical posit, or (worse) is merely indexical – merely a matter of being related to us in certain ways, as opposed (say) to being related to some other perfectly parallel beings in perfectly parallel ways.

Solving this problem requires justifying one of two policies towards these ghosts: either elimination – they don’t exist, or discrimination – they exist, but don’t deserve the status of material objects. But I will not be arguing for any particular solution. Instead, my strategy is to show that low-dimensionalism faces just the same kinds of ghosts; there is nothing distinctively high-dimensionalist about the issue. Thus, the high-dimensionalist can simply replicate whatever policy is adopted by the low-dimensionalist towards their own ghosts, and whatever justification

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10 I borrow this useful terminology from Albert 2015, p.154.
they provide for this policy. To demonstrate this strategy, I will consider three kinds of ghost which have featured in criticisms of high-dimensionalism.

3.1 Other-dimensional ghosts

Recall that all the proposed high-dimensionalist connections exploit a characteristic mapping between regions of the fundamental arena and regions of four-dimensional spacetime to describe how the goings-on at the former ground the goings-on at the latter. It is natural to wonder what privileges this particular mapping. After all, many other projections from the high-dimensional arena onto different derivative spaces are available. For example, instead of grouping dimensions of the fundamental arena into three N-tuples, as the high-dimensionalist’s characteristic mapping does, we could group them into N three-tuples, yielding an $N+1$-dimensional derivative space. So what distinguishes the four-dimensional shadow-world of spacetime from all these other-dimensional ghost-worlds?11

The answer is the dynamics: the four-dimensional derivative space (constructed as explained above) is uniquely privileged as the space inhabited by material objects, because of the dynamical laws. Call the space inhabited by material objects moving and interacting in their characteristic ways the ‘material space’.12 It is the dynamical laws (defined on the fundamental arena) which determine the nature of this material space, including its dimensionality. In particular, the spatiotemporal relations between points of the material space are identified by the nomic roles that these relations play, given the laws on the underlying fundamental arena. For example, spatial distance is the relation which correlates with the sizes of interactive forces like electromagnetic repulsion and gravitational attraction in characteristic ways; two regions of the material space are close to each other to the extent that they allow for significant electromagnetic and gravitational interaction between objects occupying them. It is these correlations, between the geometry of the material space and the dynamical interactions of its occupants, which allow for stable objects that bounce off or stick to each other, and which ultimately underwrite the macro-regularities exploited by perceptual systems like our own. In short, these correlations allow the objects within the material space to ‘formally enact’ (in Albert’s phrase) a material world.

The Hamiltonian in Schrödinger’s equation yields the three spatial dimensions of this material space: three orthogonal directions along which certain sorts of interactions change in certain ways – along which, that is, material objects can approach each other. More generally, the dynamics (on the fundamental arena) constrains the fundamental ontology in such a way that

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11 Hawthorne (2010, pp.152-3) raises this issue in the context of Many Worlds.
12 Albert refers to this derivative space variously as “the space of possible interactive distances” (1996, p.282), an “emergent geometrical space” (ms-a), and “the space of ordinary material bodies” (ms-b). See Albert (ms-a, ms-b) for a much fuller presentation of the ideas that follow.
gives rise to a material world distributed across three spatial dimensions and evolving through one-dimensional time.

This dynamics will not yield material worlds in other-dimensional derivative spaces. To the extent that we can find any objects inhabiting such spaces at all, they will be passing right through each other, splitting, jumping around, and behaving in all sorts of odd ways. If indeed they exist, they are strange and unnatural, and certainly won’t merit being described as ‘beings walking around’\footnote{As Hawthorne (2010, fn14) imagines.} or anything like that.

The situation is identical for low-dimensionalist theories. They have their own other-dimensional ghosts to ponder; there will, for example, be myriad flattenings of the four-dimensional arena available too. We could take N particles inhabiting a three-dimensional space and construct, say, 3N particles inhabiting a one-dimensional space. And the fundamental arena can be expanded as well as flattened: we could also construct, say, a 3N-dimensional space containing a single particle (Albert’s ‘world-particle’).\footnote{Indeed, since low-dimensionalist theories also posit a wavefunction – whether as a law, a multi-field, or something else – all the same richness of constructions from it is (in principle) available to them.} Thus, the question arises of what, if anything, these constructions correspond to. And it is, in both the high- and low-dimensionalist case, the dynamics of the fundamental arena which privileges four-dimensional spacetime.

Note, in particular, that the low-dimensionalist cannot privilege four-dimensional constructions merely on the grounds that the fundamental arena itself is four-dimensional. The privilege in question, recall, is that of being the material objects. And we can readily imagine dynamical laws characterising fundamental ontology on a four-dimensional fundamental arena which would give rise to worlds in which nothing four-dimensional behaves anything like a material object. Indeed, we can imagine laws according to which it would instead be a certain two-dimensional flattening, and not the four-dimensional arena itself, that would seem to earn the status of material space.\footnote{For vivid thought-experiments along these lines see Albert (ms-b).}

There is no reason to assume that this material space automatically coincides with the fundamental arena. That is, to borrow a metaphor of Albert’s, the directions in which material objects can move need not match the directions in which the fundamental story of the world can develop. If anything, once fundamental arena and material space are carefully distinguished, their putative coincidence begins to appear just that: coincidental. And indeed, the core of the high-dimensionalist explanation of quantum weirdness is precisely the claim that they in fact (dramatically) come apart.\footnote{See Ismael (ms) and Albert (ms-a, ms-b).}
3.2 Displaced ghosts

Maudlin (ms, p.162) points out that in addition to Albert’s shadows, there are hordes of ghosts related to them by spatiotemporal translations. Take the translation which shifts everything “three feet to the North”. The resulting ghost-world conforms to the same structure – both geometrically and dynamically – as the shadow-world it is constructed from. For example, whenever ghost-billiard balls collide, they bounce off each other. Thus, unlike other-dimensional ghosts, these displaced ghosts have the dynamic credentials to enact ordinary material objects.

Now, prima facie, this is a problem for low-dimensionalism as much as high-dimensionalism: these constructions are available whether the fundamental ontology is low- or high-dimensional. And it can be solved the same way in both cases – by positing a substantive grounding connection describing how the material objects inherit their location from the fundamental ontology. That is, we should not posit that there are tables wherever there is anything ‘playing the table-role’ (where this is a purely dynamical constraint), but rather only where there is an appropriate table-realiser (a table-shaped arrangement of particles, clump of high mass-density, or whatever) playing the table-role. High- and low-dimensionalists disagree about what, fundamentally, the table-realisers are – but each is entitled to make use of them in their grounding story about tables.

This is contrary to some misleading suggestions of Albert’s and Ney’s to the effect that high-dimensionalism is (or ought to be) committed to some kind of purely functionalist understanding of material objects, according to which what it is to be such an object is understood in exclusively dynamical terms. Instead, I am proposing, high-dimensionalism (like low-dimensionalism) should embrace a hybrid role-realiser view, on which being a material object is in part a matter of behaving in a certain way (the role) and in part a matter of being a particular kind of construction from the fundamental ontology (the realiser).

Nonetheless, one might worry that there is an important disanalogy between the connections posited in the two cases. According to low-dimensionalism, tables are straightforwardly located where the particles are. This seems like a maximally straightforward and natural inheritance principle. According to high-dimensionalism, on the other hand, tables are located in some distinct space from the fundamental ontology that they ultimately inherit their location from. Positing that tables are located wherever the table-shaped clumps of high mass-density are doesn’t help – the real issue concerns what determines where the clumps themselves are located! High-dimensionalist location inheritance seems bound to be radically more abstract and more substantive here. The low-dimensionalist’s location inheritance principle seems the obvious choice in a way that the high-dimensionalist’s does not: since the high-dimensional fundamental

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17 See, for example, Albert 2015, p.129 and Ney 2012, p.545. This pure functionalism is explicitly renounced by Albert (ms-a) in a footnote addressing the issue of displaced ghosts.
ontology inhabits a distinct space, there seems to be no natural or obvious connection available, making any choice arbitrary.

This disanalogy, however, is only apparent. Spacetime is indeed a distinct space from the high-dimensionalist’s fundamental arena but crucially, it is not *metaphysically distinct*: it is a derivative space which is itself grounded in – which owes its very existence and nature to – the fundamental arena (together with the dynamical laws pertaining to it). Recall the mapping $G$ from spacetime regions to regions of the fundamental arena exploited by high-dimensionalist connections. This mapping – privileged by the dynamical laws, as outlined above – describes the construction of spacetime out of the fundamental arena. In particular, the region $G(p)$ grounds the spacetime point $p$; the topological and geometric relations holding between spacetime points $p_1, \ldots, p_n$ are determined by the relations between their corresponding regions $G(p_1), \ldots, G(p_n)$. According to high-dimensionalism, then, spacetime points themselves are derivative entities grounded in certain regions of the fundamental arena – namely, corresponding sets of hyperplanes.

Given this grounding connection, there is a natural and obvious location inheritance principle available to the high-dimensionalist: what is going on at a given point of the derivative space is grounded in what is going on at the region of the fundamental arena which grounds it. For example, the undulations of the wavefunction across hyperplanes of the form $(x_{3i-2} = a, x_{3i-1} = b, x_{3i} = c, T = t)$ ground a mass-density spike derivatively located at the spacetime point <a, b, c, t>. And similarly, the wavefunction’s table-wise undulations across certain regions of the fundamental arena will ground mass-density arranged table-wise (and hence, a table) at the corresponding derivative region of spacetime.

You may be thinking by now: perhaps high-dimensionalist connections are natural, but are they really as natural as the low-dimensionalist’s? After all, the low-dimensionalist doesn’t need to mess around with projections or derivative spaces at all – the connection between the locations of the fundamental ontology and the material objects is simply *identity!* It doesn’t get more natural and non-arbitrary than that.

Perhaps. But once it has been admitted that the high-dimensionalist’s connection is also natural, the objection from arbitrariness has lost its bite. There are further questions concerning whether and to what extent this connection is in some sense *less* natural than the low-dimensionalist’s; and if so, whether and to what extent we should take this into account when we weigh the overall virtues of these theories. If *this* is the kind of question that you are concerned with – and I think it should be – then the task of this paper has been accomplished.
3.3 Alternative local beable ghosts

Maudlin (2007, pp.3161-2) observes that there are alternative ways of deriving local beables from high-dimensional ontology. For example, in addition to the mass-density proposal detailed above, there is the ‘flash’ proposal, which maps the wavefunction’s jumps (given GRW’s stochastic dynamics) to unstructured events or ‘flashes’ at corresponding spacetime points, constellations of which are supposed to underwrite material objects.\(^{18}\) If both these mappings successfully enact material objects, then what could privilege one over the other?

One thing that certainly couldn’t distinguish them is any experiment. There are differences between the proposals, of course: for example, the mass-density field permeates spacetime, whereas the flashes occupy a region of measure zero. But these differences could not even in principle be detected by experiment because the proposals make identical predictions about the macroscopic positions of all pointers: with overwhelmingly high probability, constellations of flashes are located exactly where clumps of high mass-density are.\(^{19}\) So not only do these alternative local beables both enact material objects, but they enact objects which behave identically in all circumstances.

There are, I think, (at least) two attitudes one might reasonably take in response to this observation: a hard (staunchly realist) line and a soft (more deflationist) line. For hard-liners, the metaphysical structure of the world determines, somehow, which of these constructions are the real material objects: either the alternative construction doesn’t exist at all, or it does exist, but doesn’t correspond to the material objects. Such privilege may seem arbitrary from our perspective, but we needn’t always have epistemic access to the world’s metaphysical structure. Indeed, it seems hubristic to suppose that where we lack the means to decide between alternative metaphysics, the world itself fails to decide.

For soft-liners, since both constructions are equally credentialed to enact the macroworld, there is no fact of the matter about which ‘really’ corresponds to material objects. This is just one more kind of indeterminacy in our ordinary talk: just as talk of tables doesn’t precisely specify any spacetime regions or fusions of particles, so it doesn’t decide between ‘mass-tables’ and ‘flash-tables’.

Hardness and softness each have their distinctive disadvantages. Against the former, any asymmetry between the constructions seems hard to swallow; the latter, on the other hand, seems to unexpectedly double (or perhaps, over-determine) our world, by positing parallel, non-interactive material realms. This makes, I think, for an interesting conundrum. But the crucial

\(^{18}\) See Bell 1987, ch.22.
\(^{19}\) See Albert 2015, ch.4, for an illuminating discussion of experimental distinguishability.
point for our purposes is that it is not a distinctively high-dimensionalist conundrum. Perhaps the ‘larger’ the gap between fundamental ontology and material objects, the more ‘leeway’ there is for alternative connections, and the harder it becomes to decide between them. But the problem arises for many fundamental theories, whether high- or low-dimensionalist: there are often alternative, empirically equivalent connections available which seem equally viable.

To see this, consider a low-dimensional universe consisting fundamentally of some particles together with a gravitational field. How might we identify the material objects in such a world? The particle-construction grounds the objects in the particles’ trajectories; the field-construction grounds them in the contours of the gravitational field. These constructions are empirically equivalent: they necessarily agree on the macroscopic positions of all pointers. Again, a difficult choice looms, and there is a hard line and a soft line available: one might insist that only one of these connections holds, or one might concede that the material world is in fact enacted by both.

Perhaps this just shows that there is something objectionably redundant about such a theory, compared to a particle-free or field-free alternative. But we are at the mercy of the physics here; if the dynamics requires both particles and fields, then scrapping either may be unavailable or at least unattractive. Besides, there are more familiar metaphysical questions about the connections between low-dimensionalist fundamental ontology and ordinary objects. For example, suppose that fundamentally there are particles which endure – that is, which are wholly present whenever they exist. Then we can ask about the persistence of ordinary objects (assuming that they exist) – do they endure too, or do they persist in virtue of having temporal parts? These options correspond to alternative, empirically equivalent constructions from the fundamentals – mirroring the high-dimensionalist’s choice between alternative local beables.

In short, metaphysics has been hard long before high-dimensionalism came along. Low-dimensionalist connections also involve difficult decisions. Sometimes connections can be empirically adjudicated, but often extra-empirical virtues must be considered. And in some cases, a deflationist attitude may be warranted: there may not be any uniquely right way of identifying the material world.

Drawing the line between good and bad metaphysical questions is difficult. The present point is just that it seems utterly ad hoc to draw it between the issues raised by high- and low-dimensionalist theorising. If you think the question of whether tables are really mass-tables or flash-tables is good, then you ought to think the question of whether they are really field-tables or particle-tables is equally good. Whatever arbitrariness is involved in answering such questions, it afflicts high- and low-dimensionalism alike.
References


—— (ms-a). On the Emergence of Space and Time.

—— (ms-b). How to Teach Quantum Mechanics.


Dorr, C. (ms). Finding ordinary objects in some quantum worlds.


Ismael, J. (ms). What entanglement might be telling us.


