Looking for Levels

0. Abstract

Levels-of-reality talk is common among practicing scientists and philosophers of science, yet such talk of levels has been criticized by Jaegwon Kim, Amie Thomasson, and Angela Potochnik, which I analyze into three objections of increasing strength. The first requires abandoning only some of the wilder claims about levels, while the second prunes off many biological uses, and the third poses serious challenges even for metaphysicians. Metaphysicians who wish to save realism about levels must be prepared to make serious revisions. I argue for a novel approach which carves up levels using a neo-Aristotelian answer to the question of fundamental mereology which takes substances as the tiles of the world and uses metaphysical priority aconformities these generate in the mereological graph to identify levels. This emergentist account of levels is more coherent than varieties less connected to mereological structure, and places fewer constraints on that mereological structure than views like van Inwagen's. While starkly revisionist, it fares better in recovering historical levels discourse than competitors like material atomism and priority monism. Further, the most painful revision is treating much of the biological levels discourse as representation and metaphor, but Potochnik argues that such talk was never a good candidate for metaphysics.

1. Introduction

The paper begins in section 2 by surveying some of the history of scientific levels discourse and the philosophical and scientific work that levels of reality are supposed to do. In section 3, I analyze three arguments of increasing strength against scientific levels. The first requires abandoning only some of the wilder claims about levels, while the second prunes off many of the uses put to levels by actual biologists, and the third poses serious challenges even for sober philosophical accounts of levels. In section 4, I advance a novel metaphysical solution to the problem, beginning by listing criteria for success and then evaluating contrasting approaches using those criteria. Finally, I conclude in section 5 by discussing what work remains to be done.

2. Levels Talk

Ernest Rutherford spoke for a certain strain of physics-imperialism when he divided human intellectual endeavors into "physics and stamp collecting" (Bernal, 1939). On this view, physics studied genuinely natural kinds and universally applicable principles while other fields were limited by the scope of human interests. If natural science is supposed to deliver realist knowledge, then Rutherford's view is eliminativist about natural sciences beyond physics. Erwin Schrödinger shared this view, holding that biology involved no new physical, non-physical, or super-physical laws and could be explained by nothing more than quantum mechanics (Schrödinger, 1944).

While progress of biochemistry and particularly molecular genetics did undercut vitalist impulses which sought new physical, non-physical, or super-physical laws proper to biology (Mayr, 1998), biologists were generally unmoved to accept an imperialism of physical explanation. Instead, they gradually developed a theory of *levels* which granted mereological reduction (organisms have no ultimate non-physical parts), but insisted that different levels of complexity and organization exhibit unique phenomena with irreducible explanations and even ontology (Needham, 1936; Novikoff, 1945). Accounts which characterize subatomic, molecular, cellular, multi-cellular, and ecological levels in this way are ubiquitous to the point of hegemony in biological texts (Potochnik & McGill, 2012). Nonetheless, levels-theorists differ among themselves on the nature or justification of the

irreducibility: Needham (1936) and Novikoff (1945) cite what Jessica Wilson (2021) calls weak emergence (non-reductive physicalism) while Feibleman (1954)'s more systematic characterization insists on strong emergence (downward causation).

In the postwar period even reductionists strongly opposed to emergence generally found mereological levels talk appropriate in objective hierarchies of explanation. Oppenheim and Putnam (1958) propose six natural scientific levels and consider it "utopian" to suggest that reductive accounts could successfully skip over any of them rather than proceeding exclusively in terms of adjacent levels. Ernest Nagel (1961) allowed that biologists were right to insist on a hierarchy of unavoidable levels of explanation, even as he himself insisted that such levels could in principle be mechanistically reduced to lower levels by appropriate bridge laws. More recently, Kenneth Waters (2009) has suggested that the lessons of contemporary biology should move us "Beyond Theoretical Reduction and Layer-Cake Antireduction." Nevertheless, in Waters' telling both opposing views come with a world sliced into tranches, namely classical and molecular genetics: where they differ is in claims of reducibility and assignments of fundamentality. Even Waters' own preferred more pragmatist or instrumentalist focus doesn't deny that molecular genetics "helps to explain causal regularities of classical genetics at a lower level of organization." Both practicing biologists and philosophers of science with a wide range of views on the reduction – emergence question seem to make ubiquitous use of levels talk. Levels therefore have a *prima facie* role to play in our inventory of the world.

3. The Case Against Levels

3.1 The Adjacency Stricture

Despite its ubiquity, levels talk has its dissenters. One class of concerns has to do with the structuring work that levels are supposed to do, given mereological reduction. Both Feibleman (1954) and Oppenheim and Putnam (1958) require that all of the proper parts of a whole at level *n* exist at level *n*-1. Potochnik and McGill (2012) follow Guttman (1976) in generating a host of biological counter-examples to that requirement. Given that parthood is a partial order, with levels imposed as a foliation, this is quite a strong requirement and perhaps we should not be surprised that it often goes unsatisfied. Certainly as in Figure 1, generic posets may have what look like natural-looking foliations, but generic posets will not be foliable in a way that respects the adjacency stricture.

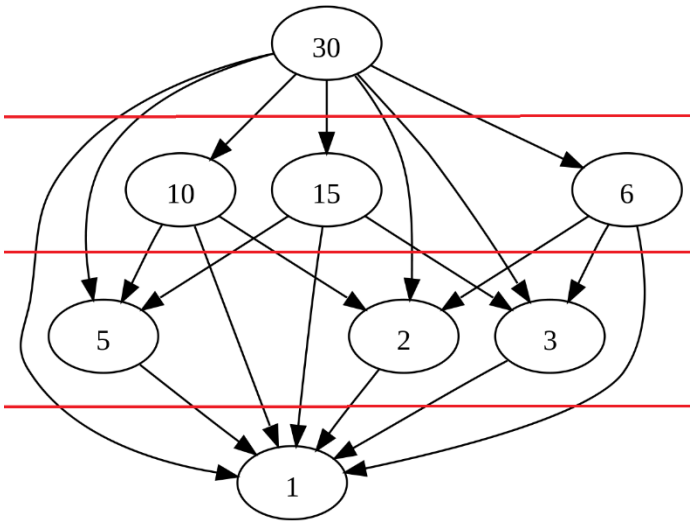

Figure 1: Generic poset with foliation

While an account of levels without the stricture of a bijection between parthood-adjacency and level-adjacency is obviously weaker than one with such a stricture, the requirement does not seem

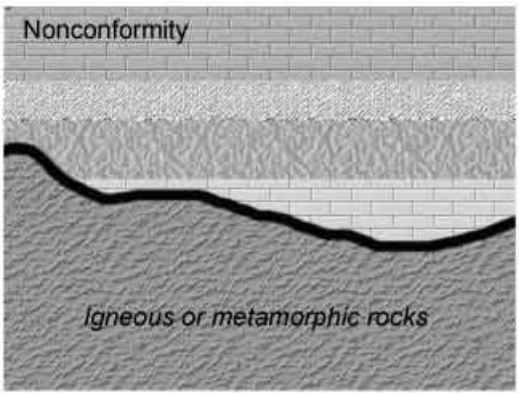

Figure 2: Geological Unconformity

inherent to the concept of levels or its scientific application. Computer scientists treat file systems as hierarchical data structures where folders exist in levels with the files as ultimate (leaf) nodes and the top-level as a root, but do not insist that files can only exist in lowest-level folders or that all folder hierarchies must have the same depth. Geologists identify rock layers while allowing that unconformities exist which bring ordinarily non-adjacent levels into contact (Figure 2).

Nor does the adjacency stricture seem critical for the uses of levels talk canvassed in section 2. If chemical concepts are somehow ineliminable when reducing biological to physical theories, that may remain true even if on certain occasions biological systems have immediate physical proper parts. On the other hand if levels are defined by families of weakly- or strongly-emergent properties or behaviors, that also fails to entail the adjacency stricture. The adjacency stricture therefore seems like a bit of excessively tidy theorizing whose failure says nothing about general applicability of levels talk.

3.2 The Stability Stricture

Potochnik and McGill (2012) raise a second concern, following Kim (2002), that no preferred foliation exists which draws non-contextual equivalence classes. In their example, a squirrel and an oak tree might both be considered at the same level, that of individual organisms, but the difference in physical and temporal scale is so stark that most interactions are really between an oak tree and a whole population of squirrels. Foliations by scale and by organizational complexity are both valid for certain important scientific purposes, but they will yield importantly different levels, so there is no preferred foliation and levels are merely contextual or instrumental. In Jaegwon Kim's version, the problem is how to classify an android which for functional purposes and as an emergence base for mentality classes with organisms, but unlike organisms is wholly characterized without recourse to biology. In the limit, Angela Potochnik (2021) worries that "An individual sodium ion (etc.) may even change level over time. This, I take it, is a counterintuitive outcome."

Again, however, neither the general concept of levels nor their application in philosophy of science suggests that levels are merely instrumental, nor that an entity changing levels is problematic. To return to the file system example, a folder may be moved from a lower level up to the root while remaining the same folder—but this does not imply that at any one time the level of the folder is not an objective fact. Similarly, a certain file may be found at one level on one computer's filesystem and at a different level on another—the level of the file is certainly relative to the filesystem context, but this does not make it merely instrumental rather than objective. Similarly in geology layers are

literally foliations by depth (the law of superposition), but such foliations are broken by faults (Figure 3). While shared depth is an important local characteristic of rock layers, it is not a global characteristic. Globally, layers are rather "formally defined by rock characteristics (e.g. fossil content, geomagnetic polarity, isotopic events, etc.)" (Hounslow, 2021).

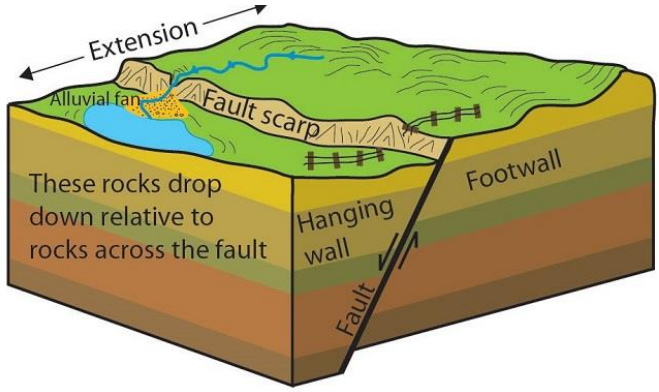

Figure 3: Geological Fault

The fact that a layer which is at one depth in one location is at a discontinuous depth in another location only implies that the foliation is not smooth, rather than casting any doubt on its objectivity. Similarly, in an erosion and sedimentation event the very same bit of rock can move from one layer to another, even acquiring new fossil content, geomagnetic polarity, etc. This again does not impugn the objectivity of geological layers.

Similar points can be made for the uses of the layer concept in philosophy of science discussed in section 2. In the reductionist accounts of layers, the claim is that the concepts do crucial explanatory work, but this need not imply that the same entities or properties do the same explanatory work everywhere. Precisely because of Fodor (1974, 1997)'s points about multiple realization—which Potochnik strongly endorses—an entity or property might be a realizer of one theory, and hence play an explanatory role at one layer, and then a realizer of another theory, and play an explanatory role at another layer. In the reductionist account theories do the crucial work, so layers would be layers of qua-objects, entities qua realizers of theoretical roles. Alternatively, it might turn out that with levels as sparse as Oppenheim and Putnam (1958)'s, theories might only range over very narrowly defined sets of objects (physics might range over the particles of the standard model, chemistry over the elements of the periodic table, etc.) which do not overlap. In that case, level membership would be defined by immutable formal characteristics, with scale playing only the same heuristic role that depth does in geology. That the heuristic fails to be extensionally equivalent with the formal definition is not a strike against the objectivity of the formal definition or the utility of the heuristic—merely an exhortation to keep the two appropriately distinct.

Matters resolve similarly in the emergentist case. "Interaction with oak trees" is not a good candidate for the kind of characteristic which reduces degrees of freedom in weak emergence or exhibits novel powers in strong emergence. After all, everything from solar flares to soil molecules to human environmentalist culture has an impact on oak trees. Similarly, while Kim's android might have its mentality as an emergent property, and non-mental biological properties may also be emergent, neither of these claims has any bearing on the level of the android's physical properties. That the android, like primates, can serve as an emergence base for mentality plays the same role as depth in the geological case—a heuristic which might sometimes lead to similar treatment, but irrelevant to the formal characteristic which delineates the levels. If the same entity exhibits an emergent

property at one point but not at another, then it will change levels, just like the eroded and redeposited rock or the moved file.

Where Potochnik is on stronger ground is with the much denser set of levels found in biology textbooks, which list not only the physical, chemical, biological, and social layers common in both reductionist and emergentist philosophy texts but also intermediate levels like cells and tissues—perhaps even organelles, organ systems, and food webs. It's not clear that these supposed levels have their own laws, let alone laws which are ineliminable parts of reductive explanations. They are rarely posited as exhibiting novel powers in the way that strong emergentists often claim for organisms and minds. These dense biological levels might be reasonable candidates for weakly emergent reductions in degrees of freedom, but even that presumes they can be assigned invariant formal characteristics and have their behavior well-characterized by empirically confirmed theories. The more instrumentalist tenor of much recent work within philosophy of biology casts doubt on that proposal. But this, note, is merely a question of *which* levels exist—surely an empirical matter—and does not cast doubt on the levels concept as a whole, especially since most general philosophers of science do not list such intermediate levels in their accounts. It would not be unusual for a concept to have a general, heuristic usage among practicing scientists and a more specific use among careful philosophers of science—see terms like law, theory, cause, and explanation. In none of these cases should we doubt the objectivity of the concept merely because careful usage would rule out many instances of the term in the scientific literature, as long as the ones which remain are useful and paradigmatic.

3.3 The Emergentist Stricture

A more serious concern is Kim (2002)'s point that levels talk only makes real sense for emergentists. Oppenheim and Putnam (1958) call the prospect of doing away with levels "utopian" but why should this be on their account? Recall that for them theoretical reduction occurs when the reducing theory explains *all* the observational data with *greater* systematization. If chemistry can explain all the data of biology with greater systematization, and physics can explain all the data of chemistry with greater systematization, then how could it be that physics would fail to explain all the data of biology with greater systematization? Similarly micro-reductions occur when wholes at one level are decomposed entirely into parts governed entirely by the theories operative at a lower level. Since parthood is transitive, micro-reductions will be, too. This is why Oppenheim and Putnam's notion of reduction as *reduction of scientific vocabulary* might be better understood as eliminativist in the contemporary context—there are no identities in view. Perhaps their worry of utopianism should be understood to suggest that only *partial* reductions of branches of science are envisaged—mere baby steps on the way to unity of science—and that because the reductions are partial the levels cannot be eliminated. Then, though, levels will exist just to the extent that reduction *fails*—they are a merely *prima facie* feature of our scientific discourse. Then, though, they will be merely heuristic and instrumental, just as Potochnik suggests. Bridge-law accounts of reductionism *a la* Nagel (1961) seem to suffer a similar fate. If bridge laws can define the terms of one science in those of a lower science (or replace the terms of a higher science with more empirically adequate ones which can be so identified), then there is again no role for levels as identity is also transitive.

This focus on emergentist accounts of reduction changes the dialectic in important ways. As Kim (2002) notes, for the emergentist the wholes relevant for the foliation will be the ones which exhibit emergent properties. This can either be accomplished by restricting composition to emergent wholes, in the sense of Peter van Inwagen (1981) or nearly equivalently by defining a certain class of wholes as the important ones for which levels are a meaningful attribution. This approach has been explicitly embraced by weak emergentist levels realists like William Wimsatt (2007, p. 207). In one

way, this makes the task of imposing a foliation on parthood easier: we need not assign levels at all to mere mereological fusions without emergent properties. In another way, it makes the task harder, because the problem of levels becomes entangled with the general problems of emergentist metaphysics. Emergence, as Jessica Wilson (2021) reminds us, is autonomy with dependence. But not only are there at least two kinds of autonomy (corresponding to weak and strong emergence), there are also at least five varieties of dependence (Calosi, 2020). If all of these are relevant, we are unlikely to end up with a single preferred foliation, but what can justify choosing only one? Moreover, dependence is not guaranteed to be well-founded: according to intentionalists, consciousness and intentionality are mutually dependent, and according to Aristotle so are constitutions and polities. Clearly a layered model cannot reflect every kind of dependence.

In short, by picking out sparse wholes, emergentists become committed to answering van Inwagen (1995)'s special composition question: under what conditions does a whole exist? Presumably each successive constitution of an emergent whole will amount to a new layer, so the only remaining question is how to draw the foliation across "faults," placing emergent wholes into equivalence classes. Amie Thomasson (2014) phrases these two requirements as the joint demand that level-advocates answer "how layers are distinguished" and "what holds them together" by "examining the world." Some levels theorists, like Lynne Rudder Baker (2007, p. 236), simply deny that levels provide a global foliation. Emergent wholes are on a higher level than their parts, but since parthood is a partial order there is no general fact of the matter regarding whether two emergent wholes are on the same level. If this restriction is taken strongly, we seem to have a case where faults present between every horizontally adjacent pair or rocks, and we might seriously question whether the levels concept meaningfully applies. Thankfully, Baker need not restrict her view quite so sharply: she takes it that emergent wholes are defined by primary kind properties (Baker, 2007, p. 236), so at least where emergent properties fall into kinds a local foliation will exist. Particularly if emergent properties are relatively sparse, these kinds will be few, so the local foliations will be large enough to count as levels, even if "faults" (as those between complex biological and non-biological systems) prevent a global foliation.

While Baker (2007)'s view of levels seems to meet Thomasson (2014)'s demands, it remains an empirical question whether emergent kinds fall into levels. It might seem desirable for a metaphysical view to be empirically testable, but attention to a case-study casts doubt on whether views like Baker's can remain sharp enough to have empirical content while still yielding a plausible account of levels. Life is a prototypically emergent phenomenon, so its hallmarks, e.g. homeostasis, reproduction, and metabolism (Bedau, 2010), should count as emergent properties. One barrier to Baker's account is that these properties seem to come in grades rather than being sharply divided. Animal cells, enclosed in their protective membranes, exhibit homeostasis to a much higher degree than their organelles, but to a much lesser degree than the multicellular organisms to which they belong. Reproduction, likewise, occurs at genetic, chromosomal, organism, and population levels. Metabolism occurs ubiquitously as adenosine tri-phosphate hydrolysis, in specialized organelles as oxygen reduction, and in whole organisms as the process of gas exchange. Which of these wholes are supposed to count as possessing the emergent property constitutive of a new level? There may well not be, and is not likely to be, any single answer. Absent heavier-weight metaphysical strictures on the special composition question of the sort introduced by van Inwagen (1995), science alone probably cannot tell us which wholes should count as the genuinely emergent unities.

A second barrier to Baker (2007)'s view of levels is that the hallmarks of life famously come apart. Red blood cells exhibit homeostasis to a relatively high degree—they can be kept outside the body for extended periods in a fairly broad range of conditions without lysing—yet they lack any genetic

material or respiratory organelles. Mitochondria, by contrast, are the very metabolic engines of the organism and come with their own genetic lineage, but lack a similarly robust membrane. Not only would this account place a "fault" between red blood cells and ordinary somatic cells, it would seem to envisage *same-level* part-whole relationships, as mitochondria, cells, organisms, and populations all exhibit reproduction. Contrary to Baker's account, then, constitution would not be the level-building relation (see esp. Baker, 2007, pp. 32, 161, 177–178, 236) and emergence would have little relationship to mereological structure, a key element of levels talk. Perhaps Baker could respond that in her account it is only *primary* kind properties which are level-building (Baker, 2007, p. 236), and the above examples may trade on non-primary kind properties. Cells, which have membrane-enclosure as a primary kind property, nonetheless compose Portuguese Men O'War, which are colonial organisms bound by a membrane. Coral organisms, which have their role in evolution as a primary kind property (Benner, 2010), reproduce by budding individual somatic cells. Even the restriction to primary kind properties does not seem to guarantee that composition and emergence line up in the constitution relation. Worse, if brains exhibit thought or gametes exhibit reproduction then the organism would fail to exhibit those properties, since they would be proper to a lower level of composition. Mentality might then become an "intrusive" layer in geological parlance rather than a higher layer with organisms as its emergence base, even in the biological case. These difficulties threaten to vindicate Thomasson (2014)'s contention that levels-talk is a "jumble" which "leads us astray" or at minimum Potochnik (2021) view that levels are a contextual, instrumental feature of representations rather than a metaphysical feature of the world. Saving levels will require imposing heavier-weight metaphysics.

4. The Mereological Priority Unconformity Approach

4.1 Conceptual Desiderata

Angela Potochnik (2021) offers three desiderata for any helpful account of levels talk:

1. Provid[e] a basis for levels comparisons across entities.
    a. Show how some entity should be articulated into levels.
    b. Show across different entities (or properties, processes, etc.) how these levels boundaries align with one another.
2. Make judgments that at least loosely correspond to how levels of organization have customarily been understood.
3. Set aside any anticipated or desired implications that we can no longer reasonably expect to obtain in light of our conceptual refinement.

I take it that these three desiderata operate in decreasing order of importance. If (1a) and (1b) cannot be met, then as Potochnik rightly insists we are simply not dealing with levels-talk at all. She and Thomasson would be vindicated that our world is *not* organized into levels and such talk leads us astray. (2) is obviously a matter of degree. Any revisionary account will have to drop some features of the ordinary (scientific) language account if the latter is not fully consistent. The scientific image only recovers the manifest image once illusions are taken into account. On the one hand, being more common-sensical and less revisionary should count in favor of a view. On the other hand, insofar as Potochnik and Thomasson are successful in showing the failures of more commonplace views with respect to (1), the more revisionary we should expect any successful account to be. At the same time, Potochnik is surely right that if the new account is so revisionary that it doesn't recover any of the conceptual intuitions or philosophical/scientific applications found in extant levels talk, then the concept has been abandoned rather than revised for practical purposes. Nonetheless, we should be generous about this—concepts of laws, explanations, causes, etc. which only held for certain

exemplar theories in foundational physics would be weaker than those which could account for important special science uses of the terms, but might still be extremely useful. The bar only rises in the presence of competition, and the case for abandonment is only strong when even a modest bar cannot be cleared. The flip side of this commitment, however, is that (3) is surely fair. The utility of a heavily revised concept is only what it can be shown to be on its own terms, and those who proffer sharply revisionary accounts should delineate what usages they do not cover, which may be only contextual, instrumental, representational, metaphorical, or just plain mistaken.

4.2 Metaphysical Desiderata

In addition to Potochnik (2021)'s reasonable criteria for accepting an account as genuinely revisionary of levels-talk rather than a replacement, the lessons of section 3.3 suggest additional metaphysical desiderata. The fundamental difficulty with Baker (2007) and other similar emergentist levels accounts is that they assign levels to entities on the basis of both mereological and non-mereological properties, which are not guaranteed to line up. Increasing novelty and autonomy have no intrinsic connection to increasing mereological complexity. The two may tend to move together in a way adequate for heuristic representations in biology, but this will never prevent counter-examples from metaphysicians. If the mereological aspect of levels talk is ineliminable[1] (as distinguishing it from mere pluralism), then emergence must be representable directly on the mereological graph. Yet as Potochnik and Thomasson have made clear at length, mere composition cannot be the level-making relation. What sort of metaphysical constraints might do the work?

One option is Peter van Inwagen (1995)'s idiosyncratic proposal: there is only one class of wholes (organisms) and they are entirely disjoint. Because van Inwagen's own answer to the special composition question imposes significant mereological structure (no wholes overlap), it allows us to easily impose a global foliation on the mereological graph, namely between atoms and wholes. This metaphysical proposal neatly meets all of Potochnik (2021)'s conceptual criteria. Any entity is either a whole or a part (1a). All living wholes are at the same level and all physical atoms are at the same level (1b). Organisms and fundamental physical particles are two of the stock levels used by philosophers of science (2). All other levels talk is strictly false, not least because it attempts reference to non-existent entities (3). It looks like van Inwagen's answer to the special composition question has not only resolved the problem of material constitution (see Rea, 1995) but also resolved Potochnik's concerns about levels-talk. Those who are willing to embrace van Inwagen's account should fearlessly speak of levels in nature. Those committed to levels in nature should, given the severity of Potochnik and Thomasson's criticisms, consider whether they can live with van Inwagen's answer to the special composition question. Those of us who are committed to levels *and* unhappy at giving up, e.g., chemical and social levels, have the bar set for our own accounts. We need to add the features lacking in van Inwagen's account while providing equally strong answers to Potochnik's conceptual criteria.

One natural place to look for connections between mereology and emergence is questions of fundamentality. Autonomy and dependence are about fundamentality after all, and mereological structure is often associated with fundamentality via the priority of parts over wholes or wholes over parts. Jonathan Schaffer (2010) calls this "connection between the mereological order of whole and part and the metaphysical order of prior and posterior" the question of fundamental mereology. Priority monists like Schaffer take it that wholes are prior to parts (fundamentality follows

[1] Here Thomasson (2014) dissents, demanding that an adequate account of levels also account for abstract artifacts and other putatively-leveled entities without material parts. While such an account should definitely go on every levels-theorist's wishlist, I am dubious that it should be a requirement for meaningful levels-talk, since such levels appear on none of the classic accounts of levels discussed in section 2.

composition and the cosmos is most fundamental) while material atomists like David Lewis (1991) take it that parts are prior to wholes (fundamentality follows decomposition and the atoms are most fundamental).

If metaphysical priority were not merely an ordinal relation but quantifiable and indeed quantized, this would solve our difficulty. Simply foliate the mereological graph into equivalence classes by level of fundamentality, counting down from the top if you are a priority monist and up from the bottom if you are a material atomist. This account even yields the adjacency stricture discussed in section 3.1 as a simple model where every parthood relation counts for one quantum of fundamentality. Unfortunately for the view, the adjacency stricture is false and giving a simultaneously rigorous and more sophisticated account of fundamentality quantization seems implausible. Perhaps an account could be gerrymandered together from a known mereological graph and a preferred set of levels, but it would be extremely brittle to changes in the structure of the mereological graph and holds no hope of answering Thomasson (2014)'s challenge to answer "how layers are distinguished" and "what holds them together" by "examining the world." These would be merely pre-chosen representational layers, with metaphysical suppositions cut to fit.

Without far-fetched or gerrymandered attempts at quantizing fundamentality, though, even an ordinal approach to priority yields a simple view of layers: the minimally fundamental, the maximally fundamental, and the intermediate. After all, classical atomistic mereology gives you atoms which are parts but not wholes, a universe which is a whole but not a part, and other nodes which are both wholes and parts. Again, if you are a priority monist simply count down from the top: cosmos, ordinary objects, atoms,[2] and if you are a material atomist go in reverse. Metaphysically, this has obvious advantages over van Inwagen (1995): we get three layers rather than two, and we needn't drop ordinary composed objects from our ontology. Conceptually, it does well on Potochnik (2021)'s first criterion: entities other than the cosmos should be divided into two levels (composed parts and atoms) and all composed parts and all atoms are at the same level. Unfortunately, it is a disaster on Potochnik's second criterion: the cosmos does not appear on any of the classic lists of levels, and worse molecules, organisms, and human societies all end up at the same level. Van Inwagen's proposal bore even greater costs in simply eliminating such entities, but his proposal was both intended to be radical and justified that radicalism by giving an answer to the problem of material constitution which *wasn't* revisionary with respect to identity. Priority monism and material atomism might add to our ontology by universal fusion and our ideology by metaphysical priority relations, but they aren't meant to undermine them in a radically revisionary way. This view lack's van Inwagen's ability to meet Potochnik's third criterion by justifying the superiority of it's revised account of levels. If entities don't exist, then there is a good reason not to assign them to levels. Here, though, the objects do exist but seem to be misclassified.

Interestingly, a wrinkle in Schaffer (2010)'s discussion of priority monism provides another route to a simple layered ontology. Perhaps, Schaffer says, metaphysical priority runs *down* the mereological graph from cosmos to atoms, but then *up* the mereological graph from atoms to ordinary composed entities.[3] As before, we can begin our layer account with the most fundamental entity, the cosmos. Again, the atoms will end up counting as a distinct layer. In this case, though, the atoms are special not because they terminate the chain of priority (as least fundamental—which in this version they are not) but because they are the mereological entities at which an unconformity of metaphysical

[2] The possibility of gunk is an important aspect of Schaffer's argument, but here I presume that we are foliating an atomic actual world. This both allows simplicity of presentation and makes Schaffer's account more parallel to the material atomist's.

[33] Claudio Calosi (2020) defends the coherence of this version of priority monism.

priority occurs. They are prior to some of the wholes they compose (fundamentality follows decomposition) but posterior to another, the cosmos (fundamentality follows composition).

Less discussed in the literature is that another unconformity of metaphysical priority occurs at the least fundamental level, those composed entities which are proper parts only of the cosmos (the maximal proper parts). These are posterior both to the whole they compose (the cosmos, most fundamental by stipulation in priority monism) and their proper parts (more fundamental by stipulation in this variant). The ordinary composed entities between these and the atoms, by contrast, all exhibit three-way unconformity: they are posterior to their parts, prior to the non-cosmic wholes they compose, and posterior to the cosmos—in an atomistic classical mereology every entity is an immediate proper part of the cosmos, because it and its complement which fuses just those atoms it does not fuse (guaranteed to exist by universal fusion) together fuse to the cosmos (since by atomistic extensionality every whole is uniquely identified by the atoms it fuses, and the cosmos fuses all the atoms). Thus we end up with a four-layer picture: the cosmos (which fuses all the atoms), the *n* atoms, the ordinary composed entities which each fuse 2 to *n* - 2 atoms), and the maximal proper parts (which each fuse *n* -1 atoms).[4]

How does this account fare by Potochnik (2021)'s criteria? Each maximal proper part can be divided into levels: itself, its composed proper parts, its atoms, and the cosmos (1a); a global foliation creates equivalence classes of atoms, ordinary wholes, and maximal proper parts (1b). The second criterion seems to cause more trouble, however. Just as in the ordinary variant of priority monism, all of the ordinary composed objects which populate classic lists of levels end up at the same level. The fourth level doesn't help, because the maximal proper parts are all the fantastical trout-turkeys of universal fusion, which lack any application in science or philosophy of science. Schaffer (2010)'s twist on metaphysical priority creates more interesting aconformities than the basic model (where ultimate priority and ultimate posteriority can be treated as trivial aconformities), but not in an adequately rich way to preserve levels talk.

In general, priority unconformity approaches based on classical mereology, whether priority flows from the cosmos or the atoms, fall victim to Kim (2002)'s concern that they cannot model layers because they inadequately reflect emergence. They reflect dependence, but not autonomy. In Lewis (1991)'s material atomism, composed entities are guaranteed to exist by universal fusion, but by weak-composition-as-identity add nothing important to our ontology—just the opposite of autonomous emergent entities which are so important that they beg us to add levels to our metaphysics. In Schaffer (2010)'s priority monism, duplicating the cosmos duplicates all of its parts, and submergent autonomy of those parts is metaphysically impossible.[5] One might characterize Schaffer's view as weak-decomposition-as-identity. Identity relations between levels are how Jessica Wilson (2021) characterizes reduction, in contrast to the autonomy characteristic of emergence.

Nonetheless, the priority unconformity approach has promise for a layered metaphysics, as long as it is mated to a suitably emergence-friendly mereology which denies either universal fusion or (more likely) extensionality (Miller, 2019). Unlike approaches to emergence conceived independently of mereology, it is guaranteed to meet Potochnik (2021)'s first criterion due to the well-foundedness of fundamentality, without restricting composition as sharply as van Inwagen (1995) in contravention of science and common-sense. The main question is how well such an approach can perform on Potochnik's second criterion of recovering a useful fraction of scientific and philosophical levels-talk.

[4] Fundamentality is assumed to be well-founded, so there must be a finite number of atoms (Cotnoir, 2013).
[5] See Claudio Calosi (2017) for a contrary perspective.

4.3 The Neo-Aristotelian Proposal

The neo-Aristotelian proposal goes as follows. Take a set of non-overlapping wholes which jointly overlap all the parts of the cosmos.[6] Call these the *substances*. Take it that priority flows down the mereological graph from the substances to their parts and up the mereological graph from the substances to the wholes they compose (up to and including the cosmos). This fundamentality gives substances the autonomy appropriate to emergent wholes. Sara Bernstein (2021) calls this *middleism* and defends it as a coherent alternative to priority monism and material atomism. Looking for priority aconformities, we get five levels: the substances, the ordinary wholes they compose (let's call them *groups*), the cosmos, the composed parts of wholes (let's call them *homonymous parts* for reasons that will become clear later), and the atoms (if any). A group has substances, homonymous parts, and atoms as its sub-levels (where the order is by mereological decomposition rather than by priority). The well-foundedness of fundamentality allows Potochnik (2021)'s first criterion to be easily satisfied: all groups, substances, homonymous parts, and atoms are globally foliated into equivalence classes.

How does the neo-Aristotelian approach fare against Potochnik (2021)'s second criterion? Certainly better than van Inwagen (1995) or the priority monist and material atomist approaches. The substances will likely be the paradigmatic objects of natural science: organisms for biologists, extra-vivo molecules for chemists, extra-molecular fundamental particles or entangled sets of particles for physicists. These form groups (good for population biology, stoichiometry, and decoherence) and have parts (good for physiology, the study of molecular structure, and perturbation theory). Substances will be at a different level from their homonymous parts and the groups they compose (good for common sense). Empirical revisions to the mereological graph (see Caulton, 2015) may cause us to revisit which wholes are substances but need not jeopardize the coherence of the overall picture. Already the neo-Aristotelian picture fares well against the alternatives, and deserves a hard look by advocates of levels.

Moreover, this neo-Aristotelian picture is, well, Aristotelian—its informal origins go back to the origins of the emergentist view itself, which the Peripatetics defended against reductionist Parmenidean monism and Democritean atomism. After all, Aristotle famously held that parts "cannot even exist if severed from the whole; for it is not a finger in any state that is the finger of a living thing, but the dead finger is a finger only homonymously" (*Metaphysics* VII.10.1035b23-4, 1984b).[7] Substances are prior to their parts in the sense of modal-existential dependence: necessarily, if the part exists, then the whole exists.[8] This also avoids the strongest form of Potochnik (2021)'s equivalence-class worry, that e.g. "An individual sodium ion (etc.) may even change level over time." Sodium atoms may be substances when studied extra-vivo by chemists and parts of substances when studied in vivo by biochemists, but no individual sodium atom can move from the level of substance to the level of homonymous parts or vice versa.[9]

Nonetheless, the classical *bona fides* of the approach are challenged by the weaker form of Potochnik (2021)'s equivalence-class worry, that "Individual sodium ions, waste particles, and all the

[6] Schaffer (2010) calls this the "tiling constraint."
[7] This is true for all parts of substances, including the homogeneous ones (*Parts of Animals* I.1.641a, 1984f, *Generation of Animals* II.1.734b24-7, 1984a, *Meteorology* IV.12.389b30-390a19, 1984c; for extensive analysis see Miller, 2018).
[8] See Oderberg (2023), who calls this "reverse mereological essentialism"—parts are essentially parts of the substantial wholes of which they are parts. The close connections between existence and essence talk are reflective of Aristotle's broader metaphysical framework.
[9] For a defense of the plausibility of this counter-intuitive conclusion, see Miller (2020).

rest can occur at different levels depending on what sort of entity they happen to compose." On the neo-Aristotelian account, "the substances" doesn't map neatly onto the presumed chemical, biological, etc. levels canvassed in section 2. Molecules would exist only as an extra-vivo local foliation, particles only as an extra-molecular local foliation, etc. This result is indeed counter-intuitive, but comes with advantages and can be justified in several ways. The main advantage is that treating these equivalence classes as global foliations into levels isn't obviously possible, given that the mereological graph is only a poset and the real world mereological graph does not seem to exhibit adjacency. We might like these stronger and more numerous global foliations in our levels concept, but if we can't have them without inconsistency then we should learn to settle for less, given the utility of the levels concept and the superiority to the alternatives discussed in section 4.2.

Furthermore, there are strong justifications for these substance-edge "faults" in the neo-Aristotelian framework. First and most generally, substances are the fundamental bearers of properties and thus the true objects of scientific study. They tile the world and we should expect "faults" between tiles.[10] More specifically, on accounts like Nancy Cartwright (1983, 1999)'s "dappled world" (or indeed other strong emergentist accounts with downward causation), the scientific laws which govern isolated substances simply don't govern parts, so philosophers of science who propose such an equivalence class are in error. Another approach with strong Aristotelian pedigree (*Generation and Corruption* I.10.328a10-11, 1984d) is to simply deny that substances have as parts even the *kinds* of entities which could be substances.[11] In this case the equivalence class would fail for metaphysical reasons similar to the revisions proposed by van Inwagen (1995): the relevant entities would simply fail to exist (though this would not be true of composed homonymous parts generally). In that case, like van Inwagen's, we should give some way of paraphrasing the erroneous level talk into something true. Bernard Lonergan (1992 [1957]) proposes paraphrasing this false entity talk into non-mereological levels of dependence among sparse properties defined by completed, irreducible scientific theories. Obviously these justifications have costs, as is to be expected for any constructive project so vast as Aristotelianism, and I will not attempt to evaluate them here.

Neo-Aristotelian approaches naturally save the autonomy of emergent levels in a way that material atomism and priority monism cannot, but what of their dependence? Is neo-Aristotelianism mere pluralism, or are substances dependent on their parts in some way that preserves scientific unity? The natural Aristotelian response is to invoke Claudio Calosi (2020)'s distinction between modal-existential dependence (which runs upward from homonymous parts to substances on this view) and *generic* modal-existential dependence: substances depend on some homonymous part of type *T*. Aristotle demands that animals, for instance, have organs as parts (*On the Soul* II.1.412a28, 1984e). Because of this mutual dependence, the organs and the organism have to come into being together (*Generation of Animals* II.1.734b24-7, 1984a).

The neo-Aristotelian approach of identifying the substances which tile the world, then using the metaphysical priority aconformities these generate in the mereological graph to identify levels, is reasonably successful. This version of emergentism generates a more coherent account of levels than varieties less connected to mereological structure, and places fewer constraints on mereological structure than views like van Inwagen (1995). While starkly revisionist, it certainly fares much better in recovering the historical discourse on levels than competing views like material atomism and

[10] For example, it's been proposed elsewhere that Aristotelians build up a notion of temporal passage from the distinct proper times of substances (Koons, 2020) or an account of quantum mechanics from wavefunctions associated with substances (Koons, 2021).

[11] Miller (2023) defends this for molecules, and a companion paper "Lonergan's Oddly Strong Theory of Emergence" (currently under review) makes the case more generally.

priority monism. Further, the most painful revision is transferring much of the biological levels discourse to the realm of representation and metaphor, but Potochnik (2021) argued that these were never good candidates for metaphysical stature in the first place. If they were not plausibly emergent to begin with, then ruling them out is no strike against a particular account of emergent levels.

5. Conclusions

Levels talk has a long history in science and philosophy of science. As with all scientific concepts of philosophical interest, rendering it coherent and empirically adequate involves separating the metaphysically acceptable uses from those which must be considered merely as representational or even metaphorical. The trick is to cleanly distinguish which uses are which, and to give an adequate theory for the metaphysical ones. Metaphysical levels must give up on adjacency (section 3.1) and global uniformity (section 3.2) while embracing emergentism (section 3.3). A coherent account of such emergent levels must give a global foliation (section 4.1) in terms representable on the mereological graph (section 4.2). The neo-Aristotelian approach does this by identifying substances which tile the world and are prior to their parts and the wholes they compose, generating metaphysical priority aconformities on the mereological graph (section 4.3). While the approach is certainly revisionary, it fares better than its competitors at recovering key, useful elements of levels talk.

The neo-Aristotelian proposal for finding levels in the world is fundamentally an empirical one. Its prospects depend on amassing evidence that middleism is more compatible with contemporary science than material atomism or priority monism. It also must respond to metaphysical challenges, both general concerns about emergentism like the completeness of physics and specific ones about the physical and metaphysical status of parts of substances. If we find a metaphysics of levels valuable and worth retaining, then this is work worth doing.

6. References

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