

# Gunk Mountains: A Puzzle

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## **Abstract**

This note points out a conflict between some common intuitions about metaphysical possibility. On the one hand, it is appealing to deny that there are robust counterfactuals about how various physically impossible substances would interact with the matter that exists at our world. On the other hand, our intuitions about how concepts like MOUNTAIN apply at other metaphysically possible worlds seem to presuppose facts about ‘solidity’ which cash out in terms of these counterfactuals. I consider several simple attempts to resolve this conflict and note they all fall short.

## **1 Introduction**

This note aims to point out a conflict between some common intuitions about metaphysical possibility.

In the first half of this paper I will point out that three robustly attractive intuitions about metaphysical possibility are incompatible with one another. On the one hand, it is appealing to deny that there are robust counterfactuals about how various physically impossible substances would interact with the matter that exists at our world. But, on the other hand, our intuitions about how concepts like MOUNTAIN would apply at other metaphysically possible worlds seem to presuppose facts about ‘solidity’ which seem to need to be cashed out

in terms of these counterfactuals. I consider several simple attempts to resolve this conflict, and note they all fall short.

In the second half of this paper, I will provide further motivation for (what might otherwise seem like) the least compelling of the above principles. I will show that a new cardinality paradox (different from those presented by Kaplan and Armstrong and discussed sections in 2.2 and 2.3 of *On the Plurality of Worlds* [7]) arises if we suppose that there are definite counterfactuals about how objects in metaphysically possible worlds very alien to one another would interact, and try to develop this intuition in a principled way.

## 2 A Puzzle About Mountains

In [4] David Lewis introduces the idea of ‘gunk’, a kind of matter which is indefinitely divisible. We can use this notion to bring out a tension in common ways of thinking about metaphysical possibility as follows.

Intuition 1 It is metaphysically possible for there to be a mountain made of gunk in a world containing only gunk.

Intuition 2 If something isn’t disposed to resist the motion of *our* hands, then it doesn’t count as a mountain, e.g., a mountain shaped cloud doesn’t qualify as a mountain.

Intuition 3 There is no fact about whether our hands (made of atoms) would be repelled by gunk existing at in an all gunk world.

The tension between these three premises is clear. Intuition 1 insists that there is a possible world containing a gunk mountain, but Intuitions 2 and 3 imply that it can’t be determinately true that the proposed world contains a gunk mountain.

To dramatize the difficulty of solving this puzzle, I will now consider some possible ways of responding to it. I will argue that significant sacrifice and/or philosophical work would be required to adopt any of them one.

I don't think Intuition 1 is particularly controversial, so let's begin by considering the costs of rejecting premise 2. I will argue that Intuition 2 is strongly motivated by intuitions about cases. Specifically, it's hard to deny that mountain shaped clouds in our world do not (literally) count as mountains<sup>1</sup>, and we seem to need something like premise 2 to explain this fact.

For example, we might instead try to explain this fact by saying that being a mountain requires being disposed to resist the touch of (and otherwise play a mountain-role towards) some *possible agents*. But this doesn't seem strong enough to do the necessary work, as it seems conceivable that there could be cloudy agents who would be suitably repelled by the mountain-shaped clouds in our world. Nor can we say that it is a necessary condition for mountainhood that there there are some agents *in the world containing the purported mountain* who would be impeded by it. For, surely, there are possible worlds which don't contain anything we would recognize as an agent, but still contain mountains

Alternately, one might suggest that it's necessary for an object in a possible world  $w$  to count as a mountain that it repel the bodies of some of the agents living in  $w$  *if there are any*. Or one might say that a candidate mountain must (in some sense) be disposed to repel most of the 'material' in  $w$ . But we can counterexample these suggestions by considering a possible world closely mirroring our own, but with the addition of cloud people (or dark matter people) who ski on cloud (dark matter) mountains. Even if the cloud stuff in this world acts like a solid with respect to other cloud stuff, and even if there is more cloud stuff in this world than atomic stuff, it seems intuitively clear that as long as

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<sup>1</sup>We might speak metaphorically about mountains of coins which Scrooge McDuck can swim in or mountains of spices. But we would not count these when asking how many mountains the world contains.

*our* hands would effortlessly pass through a mountain shaped cloud, it wouldn't qualify as a mountain.

Similarly, we can't say that it's a necessary condition for mountainhood that all agents in the same world as the candidate mountain be unable to pass through it. For surely discovering the existence of ghostly agents who could pass through Mt. Everest wouldn't stop us from counting it as mountains.

So it looks like Intuition 2 can't be given up easily.

What about Intuition 3? One could also avoid paradox by accepting Intuitions 1 and 2 and rejecting Intuition 3 (i.e., by maintaining that there *is* a definite fact whether our hands would pass through some particular form of gunk).

To see how this approach runs into trouble, let's begin with a little unpacking. Intuition 2 plausibly says something with the following form:  $\Box\forall x$  mountain( $x$ ) then 'were we to touch  $x$ , our hands would be repulsed by  $x$ '.<sup>2</sup> And in Lewisian terms, this amounts to something like: for any object  $o$  in a possible world, if  $o$  is a mountain, then the closest possible world  $w'$  (to the actual world) in which a counterpart of one our hands touches some counterpart of  $o$ , is one in which the mountain-counterpart repels the hand-counterpart.

Thus, accepting premises 1 and 2 (and thinking about metaphysical possibility in broadly Lewisian terms) plausibly requires us to say that there is *some* possible world  $w_1$  containing a mountain-shaped chunk of gunk which is disposed resist our hands. And presumably, on pain of unprincipledness, we also want to say there's a similarly mountain-shaped chunk of gunk at some other

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<sup>2</sup>One might instead say 'x is disposed to repel our hands' and say that the truth of this dispositional claim requires more than the truth of the above counterfactual. For instance Lewis gives the following analysis in [5], and the related literature, "Something  $x$  is disposed at time  $t$  to give response  $r$  to stimulus  $s$  iff, for some intrinsic property  $B$  that  $x$  has at  $t$ , for some time  $t'$  after  $t$ , if  $x$  were to undergo stimulus  $s$  at time  $t$  and retain property  $B$  until  $t'$ ,  $s$  and  $x$ 's having of  $B$  would jointly be an  $x$ -complete cause of  $x$ 's giving response". I will ignore these further refinements because (so far as I can tell) they make no different to my argument.

(phenomenologically and structurally very similar<sup>3</sup>) possible world  $w_0$ , which has the opposite disposition (i.e., is disposed to pass through our hands).

Now, consider, the question: what grounds or explains the difference between all-gunk worlds which do and don't resist our hands. It is very natural (if not logically required) to think that there must be some intrinsic difference between gunk worlds  $w_0$  and  $w_1$  which explains why the mountain-shaped chunks of gunk found in possible world  $w_1$  are disposed to interact with our hands so differently from those in  $w_0$ <sup>4</sup>. For, note that the scientifically useful and explanatory laws within each gunk world say nothing directly about disposition to interact with our kind of matter (after all, the physical laws of our world preclude gunk, and the laws of a gunk-only world preclude atoms). And (more generally) note that we cannot appeal to phenomenological facts about what experiences creatures in these gunk worlds have, or structural facts of how physical properties are instantiated in these worlds to explain their respective interaction dispositions (for, by supposition, the phenomenological and structural facts about these worlds are identical).

It may seem that the obvious answer is to say that there are different essences (or fundamental physical properties) instantiated in  $w_0$  and  $w_1$ , and that the different intrinsic nature ('quiddities') of these essences grounds and explains why similar mountain-shaped chunks of gunk in  $w_0$  and  $w_1$  are disposed to interact with our hands so differently. Positing such quiddities is already somewhat un-

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<sup>3</sup>By saying that  $w_0$  is phenomenologically and structurally similar to  $w_1$  I mean that similar experiences are had by creatures within these two worlds, and that structural facts about how physically natural properties apply within them are similar i.e., even if different physically natural properties are instantiated in  $w_0$  and  $w_1$  the same Ramsey sentences saying that there are *some* physically natural properties which bear a certain relationship to one another and more observational properties (as considered in [6]) will be true in  $w_0$  and  $w_1$ .

<sup>4</sup>In more Lewisian terms, there should be something about  $w_1$  which (together with facts about the actual world) helps ground and explain the fact that possible worlds where (counterparts of) the peaks in  $w_1$  repel (counterparts of) our hands are closer to the actual world than any worlds where counterparts of these peaks pass through our hands (if there are any of the latter type worlds). And, analogously, there should be something about  $w_0$  which grounds and explains why the mountain-shaped peaks in  $w_0$  have the converse disposition.

popular, in view of general reluctance to posit ‘extra’ metaphysical facts about the actual world which are in principle undetectable and scientifically redundant<sup>5</sup>. But, in the next section, I will show that a more concrete problem arises (about how many such essences there are supposed to be) if we try to develop this solution in any principled way.

### 3 Essences to the Rescue?

Consider what I’ve called the traditional account of the difference between the all gunk world  $w_1$  (whose peaks would resist our hands) and the all gunk world  $w_0$  (whose peaks would not): saying they differ from one another in something like which essences (or physically fundamental properties) are instantiated in them. On this picture, all metaphysically possible objects (or at least all fundamental objects like electrons and pieces of gunk) have an essence<sup>6</sup>, which is shared by all counterparts of that object and helps ground the truth of counterfactuals regarding that object’s interactions. So, for example, a single essence  $e$  is instantiated by all electrons in the actual world. And the intrinsic nature of this essence helps ground/explain the fact that these electrons are disposed to repel each other. It also combines with facts about the essence of (actual)

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<sup>5</sup>For example Hawthorne writes, “The best case for thinking that the causal profile of a property exhausts its nature proceeds not via the thought ‘Well otherwise we wouldn’t know a whole lot of what we do know’ but rather via the thought ‘We don’t need quidditative extras in order to make sense of the world.’ Let us return to negative charge. All scientific knowledge about negative charge is knowledge about the causal role it plays. Science seems to offer no conception of negative charge as something over and above ‘the thing that plays the charge role.’ If there were a quiddity that were, so to speak, the role filler, it would not be something that science had any direct cognitive access to, except via the reference fixer ‘the quiddity that actually plays the charge role.’ Why invoke what you don’t need? Unless certain logical considerations forced one to suppose that properties are individuated by something over and above their causal role, then why posit mysterious quiddities?” [2] Perhaps one could take the gunk mountain problem to point out a way in which (rather than logical considerations) natural language, core metaphysical possibility intuitions and non-arbitrariness considerations ‘force’ one to posit quiddities.

<sup>6</sup>We might instead say that they all instantiate a physically fundamental property which is shared by all counterparts in close possible worlds and behave as specified below. Since nothing in the argument depends on this choice, so I will talk in terms of essences for the rest of this paper without loss of generality.

protons to ground and explain why these electrons are disposed to be attracted to these protons. And it combines with facts about the essences of objects in other metaphysically possible worlds (including essences that can be instantiated in radically different all-gunk worlds) to ground/explain robust counterfactuals about how our electrons would interact with objects in these worlds, i.e., determine whether gunk with a certain essence could pass through atoms with some other essence.

This picture accounts for the possibility of distinct all-gunk worlds  $w_0$  and  $w_1$  (while avoiding treating our world as special) by positing a range of different essences. We posit multiple atom-type essences, which differ from another in how they ground dispositions to interact with objects that have other essences (e.g., different types of gunk), and multiple gunk-type essences, which function analogously. So we have a kind of abundance or plenitude of different essences (in what follows, I will assume that no essence  $e_i$  can play both the gunk and the atom roles <sup>7</sup>). But now we can ask: how many (and what different kinds of) essences are there supposed to be? And here trouble arises.

First note that it's not enough to say that there could be objects with atom-type essences *in some world* which are disposed to pass through some objects with gunk-type essences. What we need to vindicate the truth of premise 1 and 2 (and thereby solve the paradox above) is for *our* atoms to be disposed to pass through peaks of gunk in some possible worlds.

So, instead, we want a stronger principle which guarantees the existences of essences witnessing a range of different ways to interact with certain *specific other essences* like the essences realized by electrons in the actual world (but

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<sup>7</sup>Rather than gunk type essences and atom type essences, in the argument below we could instead talk about self-attracting essences (i.e., essences  $e$  such that for any two objects  $o_1$  and  $o_2$  instantiating  $e$   $o_1$  will tend to attract  $o_2$ ) and self-repelling essences, or essences that require having other other objects with the same as proper part (and so, necessarily satisfying some of the the gunk axioms) vs. essences that forbid this (as perhaps the essences of actual electrons do).

doesn't privilege our essences). Informally this principle seems to let us reason to the existence of infinitely many different gunk-type and atom-type essences as follows.

- There is at least one atom-type essence, namely the essence had by electrons in the actual world. Call this essence @. There are two incompatible ways which an object with a gunk type essence can interact with objects instantiating another essence: resisting it and not resisting it.
- Therefore there are at least two distinct gunk type essences (call them  $y_1 y_2$ ), such that  $R(@, y_1) \wedge \neg R(@, y_2)$  if  $R$  stands for 'is disposed to resist'.
- Therefore there are actually at least four distinct types atom type essences corresponding to different possible relationships to these witnesses  $y_1$  and  $y_2$ . One kind is already instantiated by @ and we can choose witnesses  $x_2, x_3, x_4$  for the other four combinatorial possibilities so that we have:  $R(@, y_1) \wedge \neg R(@, y_2), R(x_2, y_1) \wedge R(x_2, y_2), \neg R(x_3, y_1) \wedge R(x_3, y_2), \neg R(x_4, y_1) \wedge \neg R(x_4, y_2)$ .
- Therefore there are actually at least  $2^4 = 16$  distinct kinds of gunk type essences corresponding to different possible relationships to @,  $x_2, x_3, x_4$  only 2 of which we have considered before (when we divide up our original typology of kinds of gunk according to their dispositions to interact with various other kinds of atoms  $x_2, \dots, x_4$ ) we can chose witnesses for the rest  $y_3 \dots y_8$ .

So it seems we should accept that there are at least a countable infinity of different types of gunk (aka essences which can play the gunk role) and a countable infinity of different types of atoms (aka essences which can play the atoms role). Now in itself, perhaps this profusion of different essences isn't so bad. But the things get worse. For the underlying intuition that let us infer

the existence of multiple types of gunk is would seem to be most naturally formulated something like as follows.

- **Full Plenitude Principle:** For any set  $S$  of essences playing the gunk (atom) role and function  $f$  from  $S$  to a set of possible interaction dispositions (e.g., to resist penetration, both disappear, both explode), there is an essence  $e$  playing the atom (gunk) role such that  $e$  has interaction disposition  $f(i)$  with any  $i \in S$

But this yields a contradiction. If the gunk-type essences have cardinality  $\alpha$ , then this principle implies that the atom-type essences must have cardinality  $2^\alpha$ . For there must be different types of atoms corresponding to all possible combinations of interaction dispositions toward each gunk essence. But then applying this principle again to the distinct atom-type essences tells us that that there must be  $2^{2^\alpha} \neq \alpha$  types of gunk. Contradiction<sup>8</sup>

Now obviously we can weaken the above Full Plenitude Principle by limiting the size of the sets of essences considered to be  $<$  some cardinality  $\kappa$ . Of these options, perhaps  $\kappa = \omega$  is most attractive (i.e., the saying that the above plenitude principle only holds for finite sets of essences). But even this can seem rather unprincipled.

Alternately one can try to avoid this cardinality problem by metaphysically privileging the actual world, as follows. One could say that all objects at other possible worlds definitely have (or lack) a property like “solidity” which grounds definite counterfactual facts about their disposition to repel or pass through the stuff that makes up the actual world, but then *deny* that that there are analogously well defined facts about how objects at *arbitrary* pairs of possible

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<sup>8</sup>Note that this cardinality problem for *essences* is different from Forrest and Armstrong’s cardinality problem for *possible worlds* and Kaplan’s cardinality problem for *propositions* which Lewis considers in 2.2 and 2.3 of [7], and not fixed by just endorsing the constraints what propositions it is metaphysically possible to express and when (so to speak) some collection of possible worlds can be combined to form a larger one which Lewis advocates there.

worlds would be disposed to interact with one another. However, adopting this view involves some bullet biting. We must reject some intuitive verdicts about the truth conditions of people’s use of “mountain” at macroscopically identical words made of some non-gunk-type substance different than our fundamental particles. For it would seem that *their* claims about the possibility of a “mountain composed of atoms” in an all gunk world could not be (definitely) true, because (we would be conceding that) there are no definite counterfactuals relating *their* hands to mountain-shaped things in other metaphysically possible worlds with very different physics<sup>9</sup>.

## 4 Conclusion

In this note I have tried to draw attention to a conflict between various common intuitions about metaphysical possibility. On the one hand, it appears that there could be mountains in possible worlds with radically different physical fundamentalia from our own (e.g., gunk mountains in all gunk worlds) and that being a mountain requires having robust dispositions to interact with actual human bodies in certain ways. But, on the other hand, it appears that there are no plausible grounds for such robust *de re* counterfactuals about interactions between objects from possible worlds with radically different fundamental physics (such as our world and an all gunk world). Indeed, even if we bite the latter bullet and accept a plenitude of essences with different hidden scientifically undetectable natures grounding such counterfactuals, we are forced to choose

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<sup>9</sup>Another strategy for rejecting premise 3, while avoiding this problem, would be to say that the existence of a single possible world can somehow ground the truth of two incompatible claims about metaphysical possibility (specifically: both the possibility of there being gunk which would resist our hand and gunk which wouldn’t resist our hands), just as David Lewis holds a single possible world can witness the possibility of my being one twin or another[7]. Perhaps if one does this, one can avoid the idea that there must two different gunk-type essences whose different natures explain the difference between two different all gunk worlds, and thus cut proliferation problems off even earlier. But it is, at best, extremely unclear how this proposal could be developed – even from a technical point of view.

between arbitrariness and incoherence when deciding how many different such essences to posit.

I won't discuss possible solutions to this puzzle here. But I think looking for such solutions is a valuable task for any friend of contemporary analytic metaphysics, because this puzzle threatens to reveal deep incoherence in a common package of ways assumptions and intuitions about metaphysical possibility which many of us are currently working with. Also note that, if my arguments for Intuition 2 succeed, they suggest that many ordinary-language concepts involve a kind of (hitherto unnoticed) 'implicit rigidified reference' to the actual world. For it has long been noted that 'water' applies to what is chemically similar to *the watery stuff* around here [3]. But if Intuition 2 is correct then 'mountain' (and presumably many other such ordinary-language macroscopic-object terms) will apply only to things *that would resist the motion of bodily stuff* around here. Thus, in David Chalmers' vocabulary, many more things will be 'twin earthable' than had previously been recognized<sup>10</sup>.

## References

- [1] David J. Chalmers. *Constructing the World*. Oxford University Press UK, 2012.
- [2] John Hawthorne. Causal structuralism. In James Tomberlin, editor, *Metaphysics*, pages 361–78. Blackwell, 2002.
- [3] Saul Kripke. *Naming and Necessity*. Blackwell, 1972.

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<sup>10</sup>As Chalmers puts it, "an expression E is Twin-Earthable if there can be a nondeferential utterances of E for which there is a possible corresponding utterance by a twin speaker with a different extension. So 'water' is Twin-Earthable since a nondeferential utterance of 'water' by Oscar (on Earth) may refer to  $H_2O$  while a corresponding nondeferential utterance by his twin Twin Oscar (on Twin Earth) may refer to XYZ. By contrast, 'zero' is not Twin-Earthable: while Burge's arguments suggest that twins in different linguistic communities might use 'zero' with different extensions, this requires that the utterances be deferential." [1].

- [4] D. K. Lewis. *Parts of Classes*. B. Blackwell, 1991.
- [5] David Lewis. Finkish dispositions. *Philosophical Quarterly*, 47(187):143–158, 1997.
- [6] David Lewis. Ramseyan humility. In David Braddon-Mitchell and Robert Nola, editors, *Conceptual Analysis and Philosophical Naturalism*, pages 203–222. MIT Press, 2009.
- [7] David K. Lewis. *On the Plurality of Worlds*. Blackwell Publishers, 1986.