

# 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 note that some otherwise attractive principles about metaphysical possibility turn out to conflict with each other. 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. Indeed, I’ll argue that unexpectedly, the concept of MOUNTAIN involves the same kind of implicit rigid reference reference

to the actual world that Kripke (Kripke, 1972;135-6) famously observed occurs with WATER. I'll then consider several simple attempts to resolve the resulting 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. Specifically I will argue that positing definite *de re* counterfactuals about interactions between objects in metaphysically possible worlds very alien to one another (and the attempt to develop this idea in a principled way), leads to a cardinality paradox.

## 2 A Puzzle About Mountains

In (Lewis, 1991) 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.

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

Principle 2 Necessarily, if something isn't disposed to resist the motion of our hands as they actually are, then it doesn't count as a mountain, e.g., a mountain shaped cloud doesn't qualify as a mountain.

Principle 3 If there were a gunk mountain in a universe containing only gunk, then there would be no fact about whether it would repel our hands as they actually are.

The tension between these three premises is clear. Principle 1 insists that there is a possible world (of a certain kind) containing a gunk mountain, but Principles 2 and 3 imply that it can't be determinately true that the proposed world contains a gunk mountain.

However, I will argue that it is difficult to give up any one of these verdicts without sacrificing intuitive verdicts about metaphysical possibility.

As regards Principle 1, I take it to be fairly intuitive that that there could be mountains in an all gunk world. Relatedly (this will matter for the points below), I take it that the kind of mental pictures<sup>1</sup> which supports this judgment also motivates the stronger claim that such a world need not operate using our familiar microphysical laws. Indeed, the same considerations support the idea that some other property, e.g., a foundational notion of resistance to penetration, could replace charge in accounting for familiar phenomena of solidity (that is, the phenomena of some objects within this world not being able to pass through other objects in it). Thus, it seems that the laws of such a world could imply that no physical property plays (even approximately) the role which charge plays in the actual world – and thereby plausibly preclude the instantiation of charge.

Now what about Principle 2? I'll argue that we seem to need some such *de re* counterfactual to account for our intuition that dark matter 'mountains' in the actual world wouldn't be mountains .

For consider what we'd say if our universe turned out to contain a mirror 'world' of dark matter interacting with other dark matter<sup>2</sup> just as matter interacts with matter (e.g., via dark charge, dark gluons etc.) but passing through normal matter with significantly less interaction. I take it that we would (and should) not class such dark matter peaks as mountains, if we found that we could effortlessly pass through them. And I also take it that discovering facts about the distribution of such dark matter would (and should) not shake our confidence that paradigmatic mountains, like Mt. Everest, are mountains.

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<sup>1</sup>By this I mean, strictly speaking, the same methods of reasoning from mental pictures and background philosophical beliefs to conceivability and possibility judgments.

<sup>2</sup>Thanks to Peter Gerdes for the suggestion to use (a hypothetical version of) dark matter as inspired by (Baxter, 1997).

But this combination of verdicts is problematic for any ‘purely structural’ account of mountainhood of the kind above. For, consider a scenario where the dark and light matter universes are almost perfect copies, differing only in that the dark matter universe is shifted a mile in some direction. Because of the symmetry of the situation, no purely structural constraint could ensure in such scenarios that paradigmatic matter mountains were mountains while their dark matter clones were not.

In particular, if we characterize mountainhood by appeal to local structural facts (i.e., facts about how the stuff that makes up mountains must relate to itself), we can’t explain why the dark matter peaks in this world don’t qualify as mountains. So, for example, we can’t just say that being a mountain requires obeying some (particular selection) of the scientific regularities which govern mountains in the actual world<sup>3</sup>, e.g., regularities governing the rate and kind of erosion or changes in shape over time, because dark matter peaks would obey this as well.

And if we appeal to global structural facts (i.e., facts about how a putative mountain relates to the overall structure of the possible world containing it) to explain why the dark matter peaks don’t qualify as mountain we lose the desired verdict about paradigmatic normal matter mountains. For example, if we had recourse to some notion of agenthood, we could suggest that putative mountains must resist all agents or most agents, etc. Or we could say that being a mountain requires being disposed to resist the most common type of physical stuff in the world around you. But any version of these principles strong enough to rule out dark matter mountains in the symmetrical scenario above also seems to rule out light matter mountains.

Accordingly, it can seem that we need Principle 2 (or some other such appeal

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<sup>3</sup>Depending on how one conceives of such laws, this may require modifying them in the obvious way so notions like dirt and boulder refer to the appropriate analogs in this world rather than being restricted to accumulations of atoms.

to facts about how substances in our world would interact with substances at that alien world) to account for the pair of intuitions about mountainhood mentioned above<sup>4</sup>.

Now let's turn to Principle 3, which denies that there are definite counterfactuals about whether our hands (made of atoms) would be repelled by gunk peaks existing in an all gunk world (of the kind invoked by Principle 1).

I will argue that accounting for such *de re* interaction dispositions between between our world and the kinds of microphysically alien all gunk worlds discussed above creates a dilemma. We seem forced to choose between taking metaphysical possibility facts to be unattractively arbitrary (plus rejecting certain intuitive conceivability verdicts) and positing a kind of scientific discovery transcendent fact which many philosophers have been uncomfortable with.

Specifically, accepting such definite *de re* interaction counterfactuals creates pressure to posit multiple deeply (structurally and nomically) similar all-gunk worlds which differ only in how objects within them are disposed to interact with specific forms of alien matter. If we accept the existence of a possible world  $w_1$  containing gunk peaks disposed to resist our hands, then it seems that it would be arbitrary to not also accept a structurally identical possible world  $w_0$  containing gunk peaks disposed to let our hands pass through. For hand-permeable gunk seems just as conceivable as hand-resisting gunk. And saying  $w_1$  exists but not  $w_0$  makes the space of possible worlds seem deeply arbitrary.

So we seem forced to posit a pair of worlds  $w_1$  and  $w_0$ , with the following features. The internal structure and pattern of events taking place with  $w_1$  and  $w_0$  are exactly the same. But if you tried to climb one of the mountain-shaped peaks in  $w_1$  you'd succeed, whereas if you tried to climb one of the mountain

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<sup>4</sup>It might seem at first attractive to say that a world made of substances which we are disposed to pass through could count as containing a mountain. However, this move is in tension with the intuition that dark matter mountains aren't genuinely mountains, as an intrinsic duplicate of the supposed permeable mountain instantiated in our world would presumably also fail to be a mountain.

shaped peaks in  $w_0$  you'd (sink through the mountain-shaped peak and thereby) fail.

Accordingly, we seem forced to posit some kind of hidden natures associated with various possible worlds that transcend what scientific investigation of our world and/or these alien worlds could possibly teach us. For, plausibly, the laws of physics discernable within  $w_1$  will just describe how different physically possible (with respect to  $w_1$ ) types of matter could interact. So they plausibly *won't* say anything about how the types of matter and properties in  $w_1$  would interact with other types of physically impossible (with respect to  $w_1$ ) matter and properties, such as the charged particles that make us up<sup>5</sup>.

Now we can take this difference in the counterfactual behavior of gunk in  $w_0$  and  $w_1$  to be fundamental, or take it to be grounded in some intrinsic 'non-structural' feature [(i.e. a feature that could distinguish  $w_0$  and  $w_1$  even if both involve the same pattern of gunk distributed through space and time) that differentiates  $w_0$  from  $w_1$ ]. For example, one might say that the chunks of gunk in  $w_0$  and  $w_1$  have different essences ( $gunk_0$  or  $gunk_1$ ), which explain their different dispositions to interact with us. Or one might take properties like mass and charge to have essences which necessitate certain interaction dispositions with all other metaphysically possible fundamental physical properties<sup>6</sup>. But, in ei-

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<sup>5</sup>One could, in principle, reject Principle 3 while avoiding commitment to this kind of deeply science transcendent fact if one said that all gunk mountain worlds  $w_1$  which falsify Principle 3 (by having definite dispositions to interact with us) had to instantiate some property like charge which explains why our hands don't pass through mountains in the actual world. For one might then say that ordinary scientific laws about how charged objects interact with one another within the actual world and  $w_1$ , suffice to ground counterfactuals about how our hands would interact with the relevant gunk peak – without supposing that there are undiscoverable facts/scientific laws governing how the matter in  $w_1$  would interact with *arbitrary* metaphysically possible properties (including ones that the laws of  $w_1$  say can never be instantiated). But this strategy saves the letter of Principle 1 at the cost of denying the spirit. For (as noted on above), the same reasoning from mental pictures that motivates principle one also motivates the claim that there could be gunk mountains in worlds that don't permit the instantiation of charge or any of the other microphysical properties that ground solidity behavior in the actual world.

<sup>6</sup>Or one might take our world to have laws which constrain not just how all physically possible states of affairs would evolve forward in time, but also specify how our fundamental physical quantities (like mass charge etc) would interact with all other metaphysically possible quantities (including ones that are physically impossible relative to our world).

ther case, we are positing an extra, deeply scientifically undetectable, fact which distinguishes between  $w_0$  and  $w_1$  – something which strikes many philosophers as deeply undesirable<sup>7</sup>. Thus rejecting Principle 3 is also hard.

### 3 A Cardinality Problem

In view of the motivations above, rejecting Principle 3 might seem like the easiest way to avoid paradox. But I will now argue that, if we take this route, the same anti-arbitrariness considerations which lead us to introduce the gunk worlds  $w_1$  and  $w_0$  lead to an explosion of essences and, perhaps, paradox. I'll phrase my point in terms of essences, but it will become clear that an analogous argument can be made for all other ways of grounding the difference between  $w_0$  and  $w_1$  discussed above such as physical laws.

Let 'repels(a,b)' abbreviate the claim that things with essence  $a$  are disposed to resist things with essence  $b$ . As we argued above, if there's a  $gunk_1$  s repels( $atoms_{\textcircled{a}}$ ,  $gunk_1$ ) then there should also be a  $gunk_0$  such that  $\neg$ repels( $atoms_{\textcircled{a}}$ ,  $gunk_0$ ). But unless something special about  $atoms_{\textcircled{a}}$  or the actual world is being invoked here (see below) it would seem that, by the same token, there should also be multiple atom-type essences grounding different possible dispositions to interact with  $gunk_1$  and  $gunk_2$ .

For example, even though  $atoms_{\textcircled{a}}$  pass through  $gunk_0$ , it would seem that

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<sup>7</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?" (Hawthorne, 2001). 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.

there should also be another atom-type essence  $atom_1$  which grounds a disposition to obey all the scientifically discoverable laws that govern atoms in our world and resist penetration by  $gunk_0$ . Indeed, it seems that any possible way (repels, or  $\neg$  repels) of interacting with  $gunk_1$  and  $gunk_0$  should be realized by some atom-type essence<sup>8</sup>. Thus it seems like we should have atom-type essences corresponding to all all  $2^2 = 4$  options, i.e., we should have the following essences.

- $atom_{@}$  s.t.  $\text{repels}(atoms_{@}, gunk_1) \wedge \neg \text{repels}(atoms_{@}, gunk_0)$
- $atom_1$  s.t.  $\neg \text{repels}(atom_1, gunk_1) \wedge \text{repels}(atom_1, gunk_0)$
- $atom_2$  s.t.  $\text{repels}(atom_2, gunk_1) \wedge \text{repels}(atom_2, gunk_0)$
- $atom_3$  s.t.  $\neg \text{repels}(atom_2, gunk_1) \wedge \neg \text{repels}(atom_2, gunk_0)$ .

But then, by the same reasoning applied to possible ways gunk worlds could relate to these 4 atom worlds, it seems there should be at least  $2^4 = 16$  distinct kinds of gunk type essences (including  $gunk_0$  and  $gunk_1$ ) corresponding to different possible relationships to  $atom_{@}, atom_1, atom_2, atom_3$ . And so on. By iterating this argument we see that there must be a countable infinity of different atom-type and gunk-type essences.

In itself, an  $\omega$  sequence of different types of gunk and atoms might not be so bad. But it gets much worse. For it's not clear how we can avoid the following, inconsistent, doctrine in any principled way:

**Full Plenitude Thesis:** For any set  $S$  of essences playing the gunk (atom) role and function  $f$  from  $S$  to a set of possible interaction

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<sup>8</sup>One might try to resist this line of argument by suggesting that  $gunk_1$  might be disposed to resist any atom essence. However, if we say that this possible then it seems we should also say that, for all we know, our atoms ( $atom_{@}$ ) are disposed to resist all types of gunk. But this conflicts with the appealing idea (invoked above) that if there is a world  $w_1$  containing gunk that would resist our hands there must also be world  $w_0$  whose gunk we could pass through – and with the commonplace parity and conceivability reasoning that motivates it.



dispositions (e.g., to resist or not resist penetration), there is an essence  $e$  playing the atom (gunk) role such that  $e$  has interaction disposition  $f(i)$  with any  $i \in S$

To see that this principle is incoherent, let  $\alpha$  be the cardinality of gunk-type essences. Then (by the principle above) there is an atom-type essence corresponding to every function from the gunk-type essences to a set of size 2. Hence, the cardinality of the atom-type essences is at least  $2^\alpha$  (i.e., the cardinality of the set of all functions from  $\alpha$  to  $\{0,1\}$ ). But, by the same argument, the cardinality of the gunk-type essences must be at least  $2^{2^\alpha} \neq \alpha$ . This is a contradiction<sup>9</sup>.

Now we can weaken the above Full Plenitude Principle by limiting the size of the sets of essences considered to be less than some cardinality  $\kappa$ . That is, one might replace it with the weaker  $\kappa$  Plenitude Principle that begins as follows, ‘For any set  $S$  of essences playing the gunk (atom) role **with cardinality**  $< \kappa$  and function  $f$  from  $S$ ’. Of these options, perhaps  $\kappa = \omega$  is most attractive (i.e., saying that the above plenitude principle only holds for finite sets of essences). But making any choice seems unprincipled.

Alternately, one can try to avoid this problem by metaphysically privileging the actual world. 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 the atoms that make up the actual world, but then *deny* that there are analogously well defined facts

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<sup>9</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 (Lewis, 1986,:101-8), and it can’t be avoided by just endorsing the constraints on 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.

Also note that the cardinality paradox presented here can be formulated without any reference to Lewisian metaphysically possible worlds. For the argument above only involves quantifying over essences and can be rephrased without reference to the possible worlds they inhabit on a Lewisian picture.

about how objects at *arbitrary* pairs of possible worlds are disposed to interact with one another. However, adopting this view involves some bullet biting. It would require that we reject some intuitive verdicts about the truth conditions of people’s use of “mountain” at macroscopically identical worlds made of some non-gunk-type substance different than our fundamental particles. For consider people living in these worlds (containing some radically different third type of metaphysically possible substance). It would seem that the proposition expressed when they say, “there could be a gunk mountain in an all gunk world” could not be (definitely) true, because (we would be conceding that) there aren’t definite counterfactuals governing their bodies interaction with radically different metaphysically possible substances (such as gunk)<sup>10</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 is hard to imagine plausible grounds for such robust *de re* counterfactuals about interactions between objects from such radically different possible worlds. Indeed, even if we bite the bullet of rejecting the possibility of gunk mountains and accept a plenitude of

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<sup>10</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, just as David Lewis holds a single possible world can witness the possibility of my being one twin or another (Lewis, 1986, :231). In this case, we would say that a single metaphysically possible world accounts for both the possibility of there being gunk which would resist our hand and gunk which wouldn’t resist our hands. Perhaps if one does this, one can avoid the idea that there must be different gunk-type essences whose different natures explain the disposition to interact with atomic matter, 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.

essences with different hidden scientifically undetectable natures grounding such counterfactuals, we are forced to choose 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 assumptions and intuitions about metaphysical possibility. Also, as noted in the introduction, Principle 2 entails that the concept of MOUNTAIN involves a kind of (hitherto unnoticed) 'implicit rigidified reference' to the actual world and the same arguments apply to a great many other ordinary language concepts. It has long been noted that 'water' applies to what is chemically similar to *the watery stuff* around here (Kripke, 1972,:135-6). But, if Principle 2 is correct, then "mountain" (and presumably many other such ordinary-language macroscopic-object terms) applies only to things that would resist penetration by the stuff that makes up *our* bodies. Thus, in David Chalmers' vocabulary, many more things will be 'twin earthable' than had previously been recognized.

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