Necessary Laws and the Problem of Counterlegals

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Substantive counterlegal discourse poses a problem for those according to whom the laws of nature are metaphysically necessary. I discern two types of necessitarianism about laws: dispositional essentialism and modal necessitarianism. I argue that Toby Handfield's response to the problem of counterlegals cannot help the modal necessitarian, according to whom all possible worlds are identical with respect to the laws. I thus propose a fictionalist treatment of counterlegals. Fictions are not limited by metaphysical possibility; hence, fictionalism affords the modal necessitarian the means to account for the apparent substance of counterlegals even granting the metaphysical necessity of the laws.

1. Introduction and Context. According to modal necessitarianism (MN), all possible worlds are nomologically identical. MN thus makes a stronger claim than dispositional essentialism (DE; e.g., Ellis 2001; Bird 2007). According to DE, the laws are necessary conditional on the instantiation of the relevant properties or kinds, and worlds may differ with respect to which properties and kinds are instantiated. Bird (2004, 2007) and Wilson (2013), among others, have argued that MN is consistent (contra Schaffer 2005) and that it has some theoretical advantages over DE.

A counterlegal is a counterfactual with a physically impossible antecedent. The idea that the laws are metaphysically necessary has been criticized on the grounds that it is incompatible with prima facie substantive counterlegal discourse as well as with many everyday counterfactuals, which turn out to be implicit counterlegals. The concern is that to realize a counterlegal antecedent a law must be violated. But if the laws are necessary, then there is

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no possible world in which an actual law is violated and all counterlegals come out vacuously true. A counterfactual will be an implicit counterlegal when, to avoid excessive backtracking, a law violation is required to realize the counterfactual antecedent.

Handfield (2004) has offered a solution to the problem of counterlegals as it affects DE, which, I argue, does not help MN. Interest in MN is partly motivated by a desire to do without the mysterious notion of metaphysical possibility by assimilating it to physical possibility, thus providing a naturalized metaphysics and epistemology of modality. That Handfield's proposal does not respect this motivation for MN is evident from his invocation of possible alien properties, that is to say, possibilities that are not grounded in the actual world.

The modal necessitarian is thus tasked with reconciling the prevalence of apparently substantive counterlegals with the nomological identity of all possible worlds. I offer an account of how this may be achieved, which takes inspiration from fictionalism about scientific models.[1]

My discussion will proceed as follows. In the rest of this section, I outline Handfield's response to the problem of counterlegals on behalf of the dispositional essentialist. In section 2, I discuss MN and argue that Handfield's response will not help the modal necessitarian. In section 3, I discuss scientific modeling and highlight the use of counterlegals in modeling. In section 4, I present Frigg's fictionalist account of scientific models. In section 5, I argue that counterlegals can be given a similar fictionalist treatment, and I respond to some objections.

Handfield's Suggestion.—Handfield argues that counterlegal utterances include an implicit presupposition of the falsity of necessitarianism about laws and that if we make this presupposition explicit the counterlegals of concern are nonvacuously interpretable via possible worlds semantics. Consider the following statement:

> (1) if mass had obeyed an inverse cube law, then the planets would have had different orbits.

Parsing 1 in accordance with Handfield's suggestion yields something like:

> (1*) if it turns out that mass could have obeyed an inverse cube law, then if mass had obeyed an inverse cube law, then the planets would have had very different orbits.

1. One might think that the obvious solution would be to accept a realist account of impossible worlds. However, this approach does not sit comfortably with the broader motivations for MN. I highlight these motivations at various points during the course of the article, which enables me to then situate my proposal with respect to impossible worlds in sec. 5.

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Handfield suggests that, even assuming the metaphysical necessity of the laws, in the sense implied by DE, 1* is nonvacuously true.

What, then, do we mean by "if it turns out that mass could have obeyed an inverse cube law" and "if mass had obeyed an inverse cube law" given the laws' metaphysical necessity? The type of possibility invoked here is what Chalmers (2006) has called *deep epistemic possibility*, although Handfield prefers the term *conceptual possibility* (I will stick with the latter). Conceptual possibility concerns how things could turn out (according to one gloss, P is conceptually possible if and only if [iff] not-P is not a priori). P is conceptually necessary, then, if for all worlds *w*, if it turns out that *w* is the actual world, then P will be true (see Handfield 2004, 408–9).

While it may be metaphysically necessary that mass obeys an inverse square law, it is at least conceptually possible that mass obeys an inverse cube law, by which we mean that it could have turned out that our world is such that the property that plays the mass role obeys an inverse cube law. Although we are granting for the sake of argument that the laws are metaphysically necessary (in the sense implied by DE), it could nonetheless turn out that the laws are different because we could discover that our world is in fact a world in which *schmass*, say, obeys an inverse cube law.[2] To the utterer of the counterlegal, we attribute this presupposition that the laws turned out to be other than they actually are (because the schmass world turned out to be the actual world, say) and a fortiori that they could have been other than they actually are.

We thus have a proliferation of conceptual possibilities where there are no metaphysical possibilities. However, there is still a limit on conceptual possibility. It is not conceptually possible, for example, that $2 + 2 = 5$ because whatever world turned out to be actual—schmass world, Hume world, or whatever—two plus two would still equal four.

We can now discern two distinct operations on the same possibilia (worlds) corresponding to metaphysical and conceptual possibility, respectively: Counterfactual, where the denotation of our rigid designators is locked in based on how the actual world is; and Counteractual, where the denotation of our rigid designators is up for grabs, to be settled by how things are at the alternative world considered actual (Handfield 2004, 409). According to Handfield, the dispositional essentialist can interpret "if mass had obeyed an inverse cube law" as an invitation to consider some other world actual, one in which some other property, schmass, plays the mass role and which is such that schmasses are universally attracted in accordance with an inverse cube law. So long as

2. Fine (2002, 240) seems to be getting at a similar idea when he dismisses the suggestion that there may not even be a putative counterexample to the inverse square law of gravity as "too outlandish to deserve consideration." In entertaining MN, I am considering this outlandish hypothesis.

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the dispositional essentialist maintains that when we make statements such as 1 what we are doing is imagining that the schmass world is actual and that 'mass' denotes schmass, the counterlegal's nonvacuity is consistent with the metaphysical necessity of the laws; its truth or falsity will depend on how things are at the closest schmass world considered actual. In essence, Handfield proposes deploying conceptual possibilities where there are no metaphysical possibilities to rescue DE from the problem of counterlegals.

2. Modal Necessitarianism. MN is the view that all possible worlds are nomologically *identical*—two-dimensional semantics cannot help MN to overcome the problem of counterlegals. For the counteractual operation to yield substantive truth conditions for counterlegals, we must admit possible worlds with different laws and properties to those present at the actual world. But this is exactly what MN denies.[3]

A brief digression: possible alien kinds/properties conflict with the thesis of actualism and with the desire to give a naturalized account of the metaphysics and epistemology of modality. My contention is that a naturalistic modal metaphysics suggests grounding facts about modality in the concrete constituents of the actual world.[4] The resultant shrinking of the set of true modal propositions is thus motivated by a desire to resist appeal to mere possibilia and to resist the tendency to ground modality somehow outside of robust reality,[5] and thus, to assimilate the epistemology of modality to familiar scientific epistemology.[6] Similar considerations motivate MN—the idea that all possible worlds are nomologically identical and hence that physical possibility/necessity is the highest form of possibility/necessity. We are thus moved to resist possible alien properties in the interest of retaining the link between what is robustly actual and what is possible.

Something like the dispositional essentialist's account of laws holding in virtue of the essentially dispositional properties of kinds is a plausible pass

3. One might worry that if the laws are deterministic, then counterlegals, which are counterpossibles according to MN, will be thoroughly ubiquitous. Wilson discusses this concern (2013, 660–63). It would be beyond my present scope to address this point in detail, but suffice it to note for now that Wilson argues that MN is best twinned with the assumption that the world is fundamentally indeterministic, which he argues is very plausible in light of current physics.

4. Vetter (2015) provides a systematic account of the metaphysics of modality that grounds modal facts in robust reality. What is more, this account may well imply the necessity of the laws of nature in the modal necessitarian's sense (see, e.g., chap. 7). So, Vetterian "hardcore" actualism may be naturally allied with MN.

5. Lewis (1986), e.g., grounds modal truths outside of our reality, although admittedly he maintains that his grounding is robust. Proxy actualists (e.g., Linsky and Zalta 1994; Williamson 1998) ground modal truths in the actual world, but the ontology that they require to do so could hardly be described as robust.

6. Wilson (2013) offers this thought in favor of MN.

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at an ontological underpinning for MN. But to yield the nomological identity of worlds, one must also deny the that there are any possible alien kinds and properties that would ground alien laws. However, with this supplement in place, Handfield's attempt to reconcile necessitarianism about the laws of nature with apparently substantive counterlegal assertions cannot be invoked. Given MN, there is nowhere that the counteractual operation on worlds can take us that the counterfactual operation cannot. Thus, Handfield's suggestion does not offer the modal necessitarian a way of reaping the benefits of a realistic semantics for counterlegals.

3. Models and Idealization. If MN yields the result that all counterlegal discourse is vacuous, then it is at odds with apparently substantive counterlegal claims common in scientific contexts. This would, in turn, spell trouble for MN's desire to achieve continuity with science.

3.1. Counterlegals in Science. Much scientific discourse appears to proceed under the assumption that while some counterlegals are true, others are false.[7] For example, counterlegal reasoning is characteristic of episodes of theory change in science. Consider Eddington's 1919 test of Einstein's general theory of relativity. The formulation of this experiment at least implicitly depends on a counterlegal supposition along the following lines:

> (**N**) if gravity were Newtonian then a beam of light passing through the sun's gravitational field would follow a curve of x arc seconds.[8]

Counterlegal **N** appears substantive, regardless of whether gravity is or is not Newtonian as a matter of nomological necessity. The specific details of this counterlegal seem relevant to its truth and to the experiment in a way that the specific details of vacuous conditionals, in virtue of their vacuity, are not relevant to their truth. The very fact that **N** (if gravity were Newtonian then a beam of light passing through the sun's gravitational field would follow a curve of x arc seconds) is implicit in the theoretical underpinning of Eddington's experiment, whereas the counterlegal **N*** (if gravity were Newtonian then donkeys would talk) is not, is indicative of the fact that we should not want to simply deem all counterlegals true. If there is no more

7. Tan (2019) provides various examples of nonvacuous counterlegals in scientific practice. Furthermore, Tan argues that these examples are in fact *counterpossibles*, where the type of possibility is metaphysical. Tan does not assume MN in order to argue that the counterlegals in question are in fact counterpossibles. If Tan's arguments in this respect are sound, then the importance of the current article extends beyond debates about necessitarian accounts of laws.

8. General relativity predicts a greater bend in the path of a light beam passing through the sun's gravitational field. More on this in sec. 5.

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to say about counterlegals than that they are vacuously true, it is unclear what conditions a counterlegal must fulfill in order to be appropriate to some bit of scientific reasoning. Why, for example, is **N** but not **N*** implicit in the theoretical shift from Newtonian to relativistic gravity? The modal necessitarian ought to have something to say on this matter.

3.2. Counterpossibles and Possible Worlds. It is well documented that counterpossibles are problematic for possible worlds semantics. The latter deems all counterfactuals with an impossible antecedent vacuously true, which is troubling if one wishes to distinguish between true and false counterpossibles in general. It is plausible, for example, that 'if water were XYZ, then the main ingredient of Orangina would be XYZ' is true whereas 'if water were XYZ, then oranges would be square' is false. So, one might argue that the modal necessitarian need not be too perturbed by the objection that her theory implies the vacuity of counterlegals since this result only follows because of a more general shortcoming of the possible worlds scheme.[9] However, the severity of this shortcoming is accentuated by MN. The conjunction of MN and possible worlds conflicts with substantive counterlegals in scientific discourse, but no such conflict results from possible worlds alone.

Possible worlds semantics itself implies nothing about what is possible and what is impossible and, hence, does not by itself specify the precise class of vacuous counterfactuals; these results will depend on philosophical considerations and the context of the debate.[10] Possible worlds just provide us with a means of representing the results of our deliberations on such issues. Although it is a feature of the possible worlds scheme that all counterpossibles are vacuous, it does not follow that the current concerns are purely semantic. The possible worlds scheme itself does not imply the vacuity of counterlegals; this is only implied by the conjunction of possible worlds semantics with MN. And since scientific considerations would seem to imply that there is substance to much counterlegal discourse, we are motivated in the course of defending MN to think about providing some alternative way of understanding counterlegals qua counterpossibles.

3.3. Modeling in Science. I suggest taking inspiration from the practice of modeling in science in an attempt to respond to the problem of counterlegals on behalf of the modal necessitarian. At least some instances of

9. This is the line taken by Wilson (2013).

10. And of course, what the proper context, broadly speaking, is will itself be up for debate. The revival of interest in metaphysics that occurred in the wake of Kripke's work could be viewed as a shift in context in the sense that in the previous context what was meant by possibility was logical consistency, whereas the post-Kripkean context was somewhat more discerning with respect to what it deemed possible.

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modeling apparently involve something like inferring what would be the case if certain counterfactual suppositions were to obtain or, perhaps, inferring what would be the case if certain iterated counterfactual suppositions were to obtain. For example, we may first postulate a frictionless plane, in which case we could infer that certain complications of a set up involving a plane subject to the force of friction would be absent. This is a first-order piece of counterfactual reasoning. We can then make judgments about the behavior of an object placed on the frictionless plane at varying degrees of inclination. This will involve higher-order, or iterated, counterfactual reasoning about what would be the case were certain lower-order counterfactual scenarios varied in certain ways.

The first-order counterfactual supposition (e.g., that the plane is frictionless) is motivated by a desire to simplify our thought about an otherwise intractably complex real-world system (see Frigg 2010, 252). Assuming that the model achieved via the first-order simplifying counterfactual supposition represents a real-world target system, the higher-order counterfactual suppositions—an object on differing inclinations of the frictionless plane, say—enable us to infer something in general about the behavior of objects on inclines (see also Weisberg 2007, 225).

The simplifying counterfactual supposition is typical in the setup of many scientific models. Furthermore, it seems that such counterfactual suppositions are often actually counterlegals because they would require a law violation to realize. A frictionless plane, for example, would require a violation of the laws governing intermolecular forces; a Bohr atom would violate quantum mechanics. However, as we will go on to see, the Bohr atom is best considered in somewhat different terms from the frictionless plane.

Bokulich (2011) distinguishes between models as idealizations and models as fictions. While a frictionless plane may be considered an idealization because we could imagine some non–ad hoc de-idealization process, which took us from the idealized model back to the real-world target—a process, which, it is argued, can account for the explanatory power of some models (see 37)—arguably the same cannot be said of Bohr's model of the atom. We seem unable to systematically relate the Bohr atom to the quantum picture of the atom via any principled de-idealization procedure. Thus, Bokulich suggests that the Bohr atom is better conceived of as a fiction than an idealization (43). So, while the setup of the frictionless plane model seems to require some idealizing counterlegal supposition, it is less clear that counterlegal reasoning is relevant to Bohr's model of the atom. However, Bokulich goes on to argue that models as fictions, like the Bohr atom, can nonetheless be explanatory, not because they can be subject to a principled de-idealization procedure but in virtue of their exhibiting similar patterns of counterfactual dependence to a real-world target (43). It is plausible, then, that the counterfactuals that are true of the Bohr model are counterlegals in the sense that

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realization of a counterfactual antecedent that pertains to the Bohr atom would require (radical) departure from reality as circumscribed by the laws of nature.

If I am correct that modeling in science often makes essential use of counterlegal reasoning, then, to bring this thought back to our current interests, we may ask whether it is necessary for the intelligibility of the modeling practice that the counterlegals invoked be conducive to a truth-conditional possible worlds treatment.[11] In other words, is it essential to their intelligibility that the counterlegal posits of many scientific models constitute real possibilities? A negative answer to this question presents itself in the form of Frigg's (2010) explication of scientific modeling via the pretense theory of fiction (Walton 1990). I will argue that this *antirealist* approach—one that makes no use of the shady concept of metaphysical possibility—may be extended to provide MN with the means to account for the apparent substance of counterlegals even granting the nomological identity of all possible worlds.

3.4. Modeling and Metaphysical Commitment. The history of science presents many cases in which the subject of inquiry is the model itself and in which it is known that nothing could possibly be as the model describes. Examples include ideal pendulums, perpetual motion machines, infinite populations, and again, the Bohr atom. Now for the more metaphysically entrenched, it may be tempting to understand the truth conditions for these models as concerning the goings-on at the closest possible world in which the model is concretely realized. But it is highly unlikely that working scientists would have to hand this sort of interpretation or indeed that they should have any need for it.

The Bohr atom explained, by providing a theoretical underpinning for, the Balmer series (see Bokulich 2011, 41) of spectral line emissions of the hydrogen atom, which had previously only been deduced in an ad hoc fashion from empirical data. In other words, Bohr could explain why the spectral lines of hydrogen appeared where they did by showing, with the aid of his model, that they had to appear there. Something could be truly said of the Bohr atom, namely, that it predicted four visible spectral lines corresponding to four different electron transitions in the hydrogen atom. Maybe we could go even further and say something like this: the Bohr atom itself has four visible spectral lines, which is surely true of the fiction that is the Bohr atom.

The predictive power of the model can be explained by reference to certain structural similarities between it and the hydrogen atom. But there was

11. Stalnaker (1968) makes the jump from Ramsean acceptability or belief conditions for counterfactuals to truth conditions with the introduction of *possible worlds*. The Stalnaker-Lewis possible worlds semantics for counterfactuals subsequently became orthodoxy. But it is on this account that counterpossibles all come out vacuously true.

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no need for Bohr to think in terms of where the visible spectral lines of the model atom would be if it were realized; for all intents and purposes it could not possibly be realized. Rather, these predictions were deductive implications of the model and the known values of certain physical constants. The work that this model could do is no mystery, and the things true of it are substantive, even if we think, as scientists likely do given the quantum picture of the atom, that the Bohr atom is really an impossibility in the strongest sense. It seems unlikely that working scientists would distinguish between physical and metaphysical possibility, or at least the present considerations suggest that they need not make any such distinctions for their invocation of physical impossibilities to be theoretically useful. The physical impossibility of the Bohr atom can plausibly be taken to mean that there could not possibly be a Bohr atom, in any sense. But this need not cast any doubt on the model's theoretical utility or on the implication that some things are true and others false of the model.

Some authors, however, do seem to talk about scientific modeling as if the practice were committed to the real possibility of the models under investigation. Godfrey-Smith, for example, says: "They [models] do not exist, but at least many of them might have existed, and if they had, they would have been concrete, physical things, located in space and time and engaging in causal relations" (2009, 101). And, in the context of the analogy between models and fiction: "The world of a novel is something that does not actually exist, but would be concrete if real; *it is apparently a candidate for physical existence*" (104, my emphasis; the implication being that models, too, are candidates for physical existence).

What these quotes from Godfrey-Smith highlight is that it can be all too easy to slip into interpreting modeling as dealing in real possibilities. There is some prima facie plausibility to the idea that the practice of modeling implies such metaphysical commitments. However, I suggest that this is due to the fact, on the one hand, that modeling can often be shown to essentially invoke counterfactual/counterlegal reasoning and, on the other, that Stalnaker-Lewis semantics for counterfactuals pervade our philosophical psyche.[12] But, with a bit of care, the idea that models are fictions can free us of commitment to the real possibility of the counterlegal suppositions that are essential to many models.

I suggest following Frigg (2010) and borrowing from the pretense theory of fiction to provide an account of the metaphysics and semantics of models, which yields a deflationary, metaphysically innocent account of this aspect

12. Working scientists, disinterested in such philosophical issues, may be unaware of Stalnaker-Lewis semantics and thus be less inclined to think of the counterlegal posits of their models as really possible in the way that this semantics requires a counterfactual antecedent to be such that the conditional may be substantively true or false.

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of scientific practice. Fictionalism provides the resources to explain away modelers' apparent commitment to the metaphysical possibilities of their models. The fictionalist about possible worlds (e.g., Rosen 1990), for example, interprets claims of possibility not as claims about what is true at some possible worlds, thereby committing to possible worlds and the possibility of their constituents, but as claims about what is true according to the fiction of possible worlds. Modal fictionalism does not infer metaphysical commitment from modal claims. Similarly, fictionalism about models absolves us of the need to think of models as candidates for physical existence any more than we need think of the fiction according to which, for example, Archimedes squares the circle, as a candidate for physical existence. We thus have good grounds to challenge the sentiments expressed by Godfrey-Smith, above.

A possible further benefit of this approach is its ability to show how the largely consensual attitude among scientists of distinct disregard for metaphysical concepts can align with what they are committed to from a philosophical point of view. Of course, it remains possible, or even likely, that there are at least some scientists of a more metaphysically entrenched mind-set, who do see themselves as trading in metaphysical possibilities. But if, as also seems likely, these scientists are in the minority, it would appear to be a plus if we could reconcile the attitudes of those scientists in the majority with the ontological commitments of their activity, from a philosophical point of view.

4. Models as Fictions. Frigg presents six questions that an account of scientific models ought to answer. Questions I4 and I6 concern the semantic question and the question of metaphysical commitment, respectively:

> (I4) *Truth in model systems.* On what basis are claims about a model system qualified as true or false? . . . What we need is an account of truth in model systems, which, first, explains what it means for a claim about a model system to be true or false and which, second, draws the line between true and false statements at the right place (for instance, an account on which all statements about a model systems come out false would be unacceptable).
>
> (I6) *Metaphysical commitments*. We need to know what kind of commitments we incur when we understand model systems along the lines of fiction, and how these commitments, if any, can be justified. (2010, 257)

It is Frigg's contention that the pretense theory of fiction (Walton 1990) can provide the tools to account for truth in models, which, unlike possible worlds semantics, incurs no metaphysical commitment.

Two of the notions central to Walton's (1990) pretense theory, of which Frigg makes use in his account of scientific models, are *props* and *rules of generation*. Props are objects, where the scope of 'objects' is very wide,

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which prompt us to imagine something "due to the imposition of a rule or 'principle of generation'" (Walton 1990, 38). The rule of generation prescribes "what is to be imagined as a function of the presence of the object" (Frigg 2010, 258). The idea, then, is that works of fiction and models can be considered props in this sense. From this we get an account of *fictional truths* in terms of what is prescribed for imagination, which can be extended to provide an account of *truth in a model*.

Props, together with the rules of generation, generate fictional truths in the form of propositions that are prescribed for imagination. Some fictional truths follow directly from the prop, while others result only indirectly given some rule of inference. For example, that Piggy in *Lord of the Flies* has asthma is given explicitly by the prop—the work of fiction—it is a direct truth. Whereas that Piggy lacks a rapport with the other boys is an inferred truth that the reader may deduce; the prop and the rules of generation prescribe the imagination of this proposition. The question of what the rules are that may be used to discern indirect truths is a source of controversy, but Frigg argues that for his purposes it suffices simply to note that there are such rules (2010, 259).

Models, like works of fiction, can be considered props in games of make-believe. Truth in a model is, then, much the same as truth in fiction, where both types of truths follow from the prop and certain rules of generation. In Frigg's words: "What is explicitly stated in a model description (that the model-planets are spherical, etc.[13]) are the primary truths of the model, and what follows from them via laws or general principles are the implied truths" (2010, 260).

Although truth in fiction/models is being accounted for in terms of what we are prescribed to imagine, it is argued that such "truths" are nonetheless independent of anyone actually imagining them. There will be a fact of the matter as to whether some proposition P is prescribed by a given prop and rule(s) of generation, regardless of whether anyone actually does any imagining. Thus, truth in fiction/models on this account suffers no mind dependence or context sensitivity.

The application of pretense theory to the practice of modeling can be made explicit as follows: descriptions of model systems in conjunction with the laws and principles taken to be at work in the model can be such that they prescribe the imagination of certain propositions about the model system, which can be thought of as the truths in/about that system. Again, in Frigg's words: "For instance, 'the solar system is stable' is true in the Newtonian model of the solar system iff the description of the system together with the laws and principles assumed to hold in the system (the laws of classical

13. In the Newtonian model of the solar system.

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mechanics, the law of gravity, and some general assumptions about physical objects) imply that this is the case" (2010, 262).

Frigg maintains that this account of scientific models incurs no metaphysical commitments because it inherits all of the antirealist flavor of Walton's pretense theory from which it derives (Frigg 2010, 264). Indeed, Frigg highlights that the notion of 'truth in fiction' is really distinct from *truth* and that the former is not a species of the latter (261). This fact is at least partly responsible for the metaphysically innocuous character of Frigg's pretense theory of models since it is often felt that truth simpliciter requires *truthmakers* and that these things, whatever they may be, will constitute metaphysical baggage.

Fictionalism about Impossibilities.—One final point to note before I attempt to make the connection between the foregoing and the problem of counterlegals; if modelers really do trade in impossibilities in the strictest sense,[14] then this would constitute additional support for the view of models as fictions understood in accordance with the antirealist pretense theory. Importantly, fictions can involve impossibilities due to their metaphysical innocence.

Works of fiction can describe impossibilities such as the round square. And it can be true in these fictions that, for example, Archimedes squared the circle and that the square circle shocked the realm and that Archimedes is a hard worker, without thereby incurring any odd metaphysical commitments. Possibilities, however, seem to require some form of metaphysical grounding, whether it be possible worlds or the dispositions or laws of the actual world. Indeed, a lack of any such grounding tends to be what we mean when we deem something impossible. But that is not to say that we cannot, in a sense, represent impossibilities imaginatively. Fictionalism, with its essential appeal to the imaginative capacities, thus seems an appropriate scheme for fruitfully considering impossibilities.

5. Fictionalism about Counterlegals. If there are no counterlegal worlds, as MN implies, we can nonetheless understand counterlegals qua counterpossibles along fictionalist lines. My suggestion is that we think of a counterlegal *antecedent* as a prop, in the sense employed by Walton (1990) and Frigg (2010). Given this prop and the rules of generation, certain consequences will be prescribed for imagination. A counterlegal will be "true" on this account iff the consequent is prescribed for imagination given the antecedent and the rules of generation. Reconsider the following counterlegal:

14. This is implied by MN and the observation that modeling often makes essential use of counterlegals.

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(**N**) if gravity were Newtonian then a beam of light passing through the sun's gravitational field would follow a curve of *x* arc seconds.

The counterlegal **N** can be understood as asserting that from the prop (i.e., the antecedent A: if gravity were Newtonian), we are prescribed to imagine the consequent C (a beam of light passing through the sun's gravitational field would follow a curve of *x* arc seconds), provided the rules of generation. The counterlegal prop thus constitutes a fiction on this account, and the entire counterlegal will be true iff the consequent, C, is true according to that fiction, by which we mean it is prescribed for imagination.

Will (1988) discusses calculations of Newtonian deflections of light by a gravitational mass. The value calculated for the angle of Newtonian deflection of a ray of light grazing the sun's surface is 0.875 arc seconds (414). General relativity doubles this predicted value, the reason being that general relativity adds the effect of the curvature of space-time near the gravitational mass (414). So, the Newtonian fiction includes the absence of curved space-time, among other features such as Newtonian laws of motion, a corpuscular theory of light, and so on, all of which are relevant to the angle of deflection of a ray of light grazing the sun's surface that is prescribed for imagination. I refer the reader to Will's paper for details of the derivation of C (a beam of light passing through the sun's gravitational field would follow a curve of 0.875 arc seconds) from the prop A (if gravity were Newtonian).

It was suggested in the above discussion of pretense theory that the notion of *rules of generation*, because of its vagueness, may be a weakness for that theory. However, when understanding the types of counterlegals that are relevant to scientific practice along fictionalist lines, it should be more obvious what the rules of generation are. If we ask what sort of rules could be such that from the fiction of Newtonian gravity we are prescribed to imagine light following a curve of 0.875 arc seconds through the sun's gravitational field, the rules of mathematics immediately present themselves. From the Newtonian "prop" (which includes no space-time curvature, Newtonian laws of motion, a corpuscular theory of light, etc.), the consequent, C, of **N** follows mathematically. So, the rules of generation, which will allow us to arbitrate on whether a given consequent is true according to a given counterlegal fiction and, hence, on the truth of the overall counterlegal conditional in question, will be the familiar rules of mathematics (and perhaps logic) central to scientific inquiry.[15]

15. This suggests the possibility of assimilating the question of how counterlegals explain to the familiar question of how best to make sense of mathematical explanations in science. Unfortunately, further discussion of this point would be beyond the scope of the current article, although this presents an interesting avenue for future research.

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One might worry that the example of Newtonian gravitation is an especially simple one and that problems may arise in more complex cases that do not arise here.[16] In response, I would again refer the reader to Will's (1988) discussion of Newtonian gravitational lensing, which includes a fair deal more complexity than I have space to reproduce and which may thus assuage the concern that the present example is especially simple. For example, Will is concerned with differing assumptions about the speed of light in the Newtonian "fiction" leading to (negligibly) different predictions for Newtonian deflection of a ray of light (414). Perhaps in more complex cases there will be additional scope for different assumptions to lead to divergent "prescribed imaginings." But this is not a particular problem for the current account of counterlegals. Rather, it just follows from the fact that in order to draw out the implications of scientific hypotheses, those hypotheses need to be sufficiently unambiguous, and disambiguating hypotheses may be harder, the more complex those hypotheses are.

The approach outlined so far does constitute a concession: if we want to be modal necessitarians, our account of truth, as it pertains to counterlegals, will be different from our account of truth elsewhere, since elsewhere we may want a more realist theory of truth. If one found this dualism objectionable, there is of course the option of embracing a thoroughgoing fictionalist account of truth, but such a drastic measure would be ill motivated.

The dualist result should come as no surprise to the committed modal necessitarian, because really it constitutes a restatement of her position. If there are no possible worlds in which the laws are different from those at the actual world, then there are no things that may provide a realist semantic underpinning for statements about what would be the case if the laws were different. If we were to embrace thoroughgoing fictionalism in the interest of avoiding semantic dualism, MN would lose its substance because it would be unclear in virtue of what counterlegal suppositions are different from counterfactual suppositions consistent with the laws, in which case, the claim that the laws are strongly necessary loses its bite.

One might object that the concern is not really with possible *worlds* but with restricting oneself to just the use of *possible* worlds—if we admit impossible worlds, the problem of counterlegals goes away (see, e.g., Nolan 1997; Brogaard and Salerno 2013; Priest 2016; Berto and Jago 2019, for discussions of the metaphysics and theoretical virtues of impossible worlds). In response, I would first emphasize that, for the modal necessitarian, possible worlds do not ground or make modal propositions true. One motivation for maintaining that the laws are metaphysically necessary is the desire to avoid the problems engendered by taking possible worlds to be the truth-makers for modal propositions (e.g., what do the goings-on at some other possible

16. My thanks to an anonymous reviewer for raising this.

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world have to do with what is possible at this world?). The modal necessitarian will likely understand metaphysical possibility as (at least roughly) consistency with the laws, and, hence, modal propositions will be made true by the actual world in a way that seems intuitive. This does not preclude all appeal to possible worlds (their use in model theory, e.g., may remain intact). The modal necessitarian may understand possible worlds as something like maximal consistent sets of propositions, where *consistency* will require consistency with the laws. Maximal sets of propositions that are inconsistent with the laws might then be among the impossible worlds. Possible worlds, so understood, are a useful way of representing modal space, and perhaps impossible worlds can be invoked to do some theoretical work too (such as modeling impossible beliefs; see Nolan [2013] for discussion of this and other applications of impossible worlds). But, ultimately, it will be the actual world that is of the utmost importance to the metaphysics and semantics of modality because it's laws will determine which "worlds" are possible.

Now the impossible worlds—sets of propositions detached and free-floating from actuality—look awfully like fictions. Hence, pretense theory may present a useful way of understanding these things. Perhaps, then, the suggestion that we admit impossible worlds is not at odds with my suggestion in this article. I have just sought to offer more in the way of an understanding of these impossible worlds and the contrast with possible worlds. A concern with admitting impossible worlds is that it makes a mystery of the distinction between possibility and impossibility; such an admission demands an explanation of why some worlds are possible and others impossible. In a sense, I agree with the above "objection"; in a sense, what I have established here is that the modal necessitarian might appeal to impossible worlds in her semantics for counterlegals. But I have also attempted to meet an explanatory demand that the admission of impossible worlds raises. It has been argued that, for the modal necessitarian, the distinction between possible and impossible worlds corresponds to the distinction between those worlds that really do represent ways the world could be, given its laws, and those that are mere fictions.[17]

I consider one final objection before concluding. Jenkins and Nolan (2012) have argued that there are such things as impossible dispositions—dispositions with impossible stimulus or manifestation conditions. They appeal to two kinds of examples: those in which agents are disposed to react in particular ways to metaphysical impossibilities, for example, Jane's disposition to be surprised at a perceptible round square object in front of her (738), and those involving nomologically impossible reactions to nomologically

17. Nolan (2013, 369) floats the idea of coupling realism about abstract possible worlds with fictionalism about impossible worlds. The foregoing could thus be understood as going some way toward motivating this kind of position.

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impossible circumstances, for example, photons' disposition to "have a speed of $3 \times 10^{10} m/s$ in circumstances where they are in a vacuum and the speed of light is $3 \times 10^{10} m/s$" (743). Since the current concern is with MN, metaphysical and nomological necessity need not be distinguished, and the above two examples can both be understood as metaphysically impossible dispositions. Now if there are indeed impossible dispositions, then perhaps they could provide the modal necessitarian with truth-makers for counterlegals. Impossible dispositions are consistent with MN because it can be accepted that there is no possible world in which they are manifested, so there is no possible world in which an actual law is violated. And, contra my fictionalist proposal, they would allow for a unified account of modal truth.[18]

I have two things to say in response to this concern. First, the impossible dispositions approach is inconsistent with a dispositionalist/hardcore actualist account of modality. Dispositionalism is characterized by adherence to something along the following lines:

> (**POSS**) 'Possibly *p*' is true iff something has a disposition whose manifestation consists in *p* (see, e.g., Vetter 2015).[19]

If there are impossible dispositions, then there are counterexamples to **POSS** because something could have a disposition whose manifestation consisted in *p* without 'possibly *p*' being true. But dispositionalism is naturally allied with MN. Dispositionalism presents an attractive modal metaphysics that shares similar motivations with MN, and, what is more, dispositionalism is plausibly understood such as to imply the nomological identity of all possible worlds (see also n. 4 above). So, admitting impossible dispositions causes trouble for a natural ally of MN.

Second, and perhaps more importantly, Vetter (2016) has provided strong reasons to doubt Jenkins and Nolan's conclusion that there are impossible dispositions. On the one hand, Vetter takes issue with Jenkins and Nolan's heavy and explicit reliance on linguistic intuitions to draw their metaphysical conclusions (2688). Vetter has argued (2014, 146–48) that linguistic intuitions about the expressions 'disposed' and 'disposition' are an unreliable guide to the metaphysics of dispositions. But, more generally, Vetter argues that there cannot be any impossible dispositions, because impossible dispositions give rise to referential opacity and dispositions never give rise to referential opacity (see Vetter 2016, sec. 3, for details of the argument). The examples that Vetter offers of impossible dispositions giving rise to referential

18. My thanks to an anonymous reviewer for raising this.

19. Two other prominent developments of dispositionalism are Borghini and Williams (2008) and Jacobs (2010).

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opacity are ones in which the disposition ascription involves a name. Thus, one might respond that the kinds of impossible dispositions that would serve as truth-makers for counterlegals (e.g., a photon's disposition to have a speed of $3 \times 10^{10} m/s$) need not involve any name and so are unproblematic. But this would be too quick. The intuitive evidence adduced for impossible dispositions seems just as strong in the case of disposition ascriptions involving names as in the case of disposition ascriptions that do not involve names. If one accepts Vetter's argument, it "suggests that something was wrong with the intuitive considerations [in favor of impossible dispositions] in the first place, so why rely on them elsewhere?" (2692–93). In a nutshell, Vetter has given us good reason to be very wary of impossible dispositions in general by casting doubt on the veracity of the evidence in their favor and by showing that they have an unpalatable consequence.[20]

I thus suggest that the fictionalist treatment of counterlegals is favorable to the impossible dispositions approach because it leaves open the option of twinning MN with a dispositionalist account of modality, and there are compelling reasons to be skeptical about impossible dispositions in general.

6. Conclusion. Anyone who claims that the laws of nature are metaphysically necessary is tasked with responding to the concern that their view implies the vacuity of apparently substantive counterlegal discourse. Dispositional essentialists claim that the laws are metaphysically necessary in the sense that they admit of no counterexamples because the laws hold in virtue of essentially dispositional properties. Toby Handfield thus proposes invoking two-dimensional semantics to overcome the problem of counterlegals as faced by this type of necessitarianism about laws. However, this strategy cannot help the modal necessitarian, who maintains the stronger view that all worlds are nomologically identical. I thus propose supplementing MN with a fictionalist semantics for counterlegals. This yields a kind of semantic dualism whereby counterlegals (qua counterpossibles), but not ordinary counterfactuals, are understood along antirealist lines, but this, I have suggested, is quite a natural position for the modal necessitarian to adopt.

20. Vetter (2016) herself concludes that nonvacuous counterpossibles should be given an epistemic reading. One may wonder, then, why I do not just draw the same conclusion about counterpossibles that Vetter draws. However, I take my conclusion to be consistent with Vetter's. When read epistemically, a counterfactual $A > C$ is understood as saying something like "on the assumption of A, the evidence would lead one to conclude C." Similarly, I have argued that (e.g.) on the assumption that gravity is Newtonian, the evidence (broadly construed and including the rules of generation) would lead one to conclude that light passing through the sun's gravitational field would follow a curve of 0.875 arc seconds. The fictionalist proposal constitutes an elaboration of the notion of concluding C on the assumption of A and the relevant evidence.

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