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SPEAKING FOR HAECCEITISTS

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Many of us are haecceitists: we believe that things could have been different without there having been different qualitative facts. A large part of the motivation for haecceitism stems from the plausibility of certain modal judgments. For instance, consider the following example:[1]

> **Particle Collision**. Two particles are set up to collide at high energies. When they collide, a shower of new particles is created, including two new intrinsic duplicate particles, *a* and *b*. The only physical differences there ever are between *a* and *b* stem from the fact that they travel away from the collision at slightly different trajectories.

Now ask yourself: is it metaphysically possible for things to be precisely this way except for that *a*'s and *b*'s trajectories are exchanged? The natural answer is the haecceitist's one: that could indeed have been so. For otherwise there would be a seemingly inexplicable modal fact: there would be two intrinsic duplicate particles with the same origins, yet only one of them could be emitted along a particular trajectory in these circumstances. But that would cry out for explanation—seemingly in vain.

However, the issue for haecceitists is that although such examples motivate their view, they also generate a problem for it. The problem can be stated intuitively. Observe that in making the above modal judgment the haecceitist posits a world which shares our world's qualitative facts and its intrinsic profile up to a time just before the collision. This creates a problem when combined with a standard formulation of determinism. For the thesis of determinism is true only if the intrinsic profile of

1. The use of similar examples to elicit haecceitist judgments dates back at least to Adams (1979, p. 22). Adams's central example trades on a violation of the identity of indiscernibles, which he exploits to elicit haecceitist judgments about how the symmetry could be broken. As Adams (1979, fn. 26) noted, however, the violation of the identity of indiscernibles is not key to the example: a pair of 'almost indiscernibles' will do. For related uses of such examples, see Melia (1999, pp. 646-648), Fine (2003), and especially Dorr et al. (2021, pp. 125-126), on which the above example is closely modelled.

our world up to a time physically necessitates that *a* is emitted along the trajectory it in fact travels. But given the widely accepted thought that the laws of physics are true qualitative propositions, they must all be true at the world where *b* travels along that trajectory. So, if physical possibility is just compatibility with those laws, it follows immediately, and surprisingly, that determinism is false. What might seem to haecceitists like merely metaphysical possibilities are pulled into the realm of physical possibility to undermine determinism.

To paraphrase Williamson (1990 [2013], p. 128), haecceitism thus appears to induce a 'curious kind' of indeterminism. The same particles could collide in the same high-energy state in the same circumstances, but nothing in the period prior to the collision would physically determine which of *a* or *b* would travel along a certain trajectory. And whatever pull one feels towards haecceitism, it is hard to dismiss the thought that indeterminism does not come so cheap.[2]

In response to this puzzle, one might embrace *anti*-haecceitism and the surprising thought that because *a* happens to be emitted along a certain trajectory in these circumstances, *a* is *essentially* emitted along that trajectory, when emitted in them at all. Alternatively, one might maintain haecceitism and opt for an alternative conception of determinism. For example, one popular alternative holds that only *qualitative* facts are physically necessitated by the past. But, as Hawthorne (2006, p. 243; emphasis mine) remarks, "it seems at least somewhat interesting to learn that the past and the laws of nature did not determine that *I* exist."

Given the costs of these responses, my aim in this paper is to develop a response to the problem that maintains haecceitism and the standard conception of determinism. To render haecceitism and determinism compatible, this view combines them with an independently motivated proposal about how haecceitists should view modal talk. At a certain

2. For similar sentiment, see Earman & Norton (1987, p. 516) who describe such haecceitistic failures of determinism as 'a very radical form of indeterminism'.

level of abstraction, this response will parallel a treatment of the puzzle via the doctrine of 'cheap haecceitism' (Lewis 1986; Russell 2015), which since its initial counterpart-theoretic development has played a prominent role in the literature. However, importantly, my response will make no use of the apparatus of counterpart theory itself.

I begin by formulating the problem of curious indeterminism much more carefully, by isolating precisely which assumptions are needed to generate it (§1). I then draw on this formulation to develop my response to the problem, which I argue is independently motivated on any haecceitist metaphysics (§2-3). I conclude by comparing this response to the 'cheap haecceitist' treatment of the puzzle (§4).

1. The Problem of Curious Indeterminism

1.1 Haecceitism

The first task is to isolate exactly which assumptions are needed to generate the problem of curious indeterminism, and to clarify how best to formulate them. I will begin with the thesis of haecceitism.

Haecceitism is usually characterized as the thesis that there are worlds which share the same qualitative facts but not the same non-qualitative (or 'haecceitistic') facts. To formulate this more carefully, we need to characterize the notions which are used to state it, such as those of a 'world' and 'sharing the same qualitative facts'. This can be done in a simple framework which extends a standard quantified propositional modal language with another propositional operator—an expression which combines with a formula to produce a formula—whose intended interpretation is the property of propositions *is qualitative* ('*Q*'). I will assume that this framework is governed by the principles of classical logic, a classical quantification theory for the propositional quantifiers, and the modal system S4, the principles of which are as follows:[3]

3. As is well-known, the combination of these modal and quantificational principles results in the controversial thesis of propositional necessitism (Williamson 2013). Although my core argument does not depend on necessitism, it is convenient to appeal to this standard combination of modal and quantificational principles.

K $\Box(p \to q) \to (\Box p \to \Box q)$

T $\Box p \to p$

4 $\Box p \to \Box\Box p$

Necessitation If $\vdash A$, then $\vdash \Box A$

For the time being, I do not make any assumptions about qualitativeness. However, at various points I discuss how natural principles about qualitativeness interact with the discussion.

In this setting there is a natural conception of worlds which has its roots in Prior (1957) and Fine (1970). According to this conception, worlds are just possibly true, maximally strong propositions, and for a proposition to be true at a world is for that world to necessitate that proposition. This conception of worlds and the corresponding notion of truth-at-a-world are formalized as follows:

$$Wp := \Diamond p \wedge \forall q(\Box(p \to q) \vee \Box(p \to \neg q))$$

$$p \vDash q := \Box(p \to q)$$

To improve readability, I introduce a convention for simplifying claims about worlds. According to this convention, formulas with the form of the schemas on the left may be rewritten in the manner displayed on the right:

$\forall p(Wp \to \varphi)$	$\forall w\, \varphi[w/p]$
$\exists p(Wp \wedge \varphi)$	$\exists w\, \varphi[w/p]$

Here, $\varphi[w/p]$ is obtained by replacing all free occurrences of p in φ with w. I reserve the variables w, v and u for this convention, which do not belong to the official object-language. It is worth noting that there may be multiple, necessarily equivalent worlds which make true exactly the same propositions; nonetheless I will often informally quotient that multiplicity away and speak as if any such worlds are one.[4]

To supplement this understanding of worlds, I will assume a principle which guarantees that worlds play their presumed theoretical role of being the witnesses of possibility claims. This is captured by a familiar Leibnizian principle:

Leibniz Biconditional $\Box\forall p(\Diamond p \leftrightarrow \exists w\, w \vDash p)$

This permits us to move freely between talk of existing propositions being possible and their being true at a world. As one would expect, this principle is equivalent in the current setting to the (necessitation of the) claim that a proposition is necessary iff it is true at all worlds.

To state the worlds-based haecceitist thesis, I introduce a relation of qualitative equivalence between worlds. Intuitively, this relation holds between a pair of worlds when they make true exactly the same qualitative propositions. In the framework I am using, one may formalize this notion as follows:

$$p \approx q := \forall r(Qr \to (p \vDash r \leftrightarrow q \vDash r))$$

It is straightforward to see that this relation is an equivalence relation on worlds.

This allows us to state the worlds-based haecceitist thesis as the claim that there exists a pair of qualitatively equivalent worlds which disagree over the truth of some proposition (equivalently: they are not necessarily equivalent worlds).

Haecceitism $\exists w \exists v(w \approx v \wedge \neg\Box(w \leftrightarrow v))$

4. Some care would have to be taken to extend this quotienting procedure to the higher-order setting introduced below, because it would need to be extended inductively to properties of worlds, properties of properties of worlds, and so on. A higher-order Choice principle would allow one to do this elegantly by permitting one to choose representatives from equivalence classes of worlds and giving the inductive definitions in terms of them in a way that ensures the inductive definitions do not depend on the choice of representative. However, in what follows I will leave these technicalities aside.

Since qualitative equivalence is an equivalence relation on worlds, at each world we may think of the worlds as partitioned into equivalence classes, with membership of each class determined solely by which qualitative propositions are true at each world.

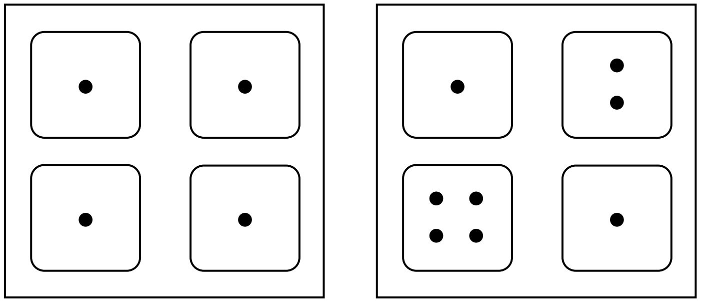

Fig. 1. Left: a representation of modal space (at a world) according to anti-haecceitism, in which no qualitative equivalence class contains more than one world. Right: a representation of modal space (at a world) according to haecceitism, with some qualitative equivalence classes containing more than one world.

In this setting, haecceitism can be understood as the thesis that at least some of these equivalence classes contain more than one world.

It is worth noting that this picture becomes even simpler in the presence of further assumptions. In particular, the underlying modal system could be strengthened to S5 by extending it with the following principle:

B $\Box\forall p(p \to \Box\Diamond p)$

Under this assumption, it becomes non-contingent which worlds exist and which propositions are true at a given world. Alongside this extension, one could make the further, popular assumption that qualitativeness is a necessary status of the propositions which have it:

Qualitative Persistence $\Box\forall p(Qp \to \Box Qp)$

In S5 this is equivalent to qualitativeness being a non-contingent status of propositions. Thus on this strengthened picture qualitative equivalence becomes a *non-contingent* equivalence relation on worlds. This would mean that the partition of worlds into qualitative equivalence classes is modally invariant: it does not change from world to world. There is a certain elegance to this picture, but since neither S5 nor Qualitative Persistence are needed for my arguments, I will not take them as assumptions.[5]

1.2 φ-Haecceitism

The general thesis of haecceitism has now been stated. But recall that a specific form of this thesis featured in the problem of curious indeterminism. In particular, the problem concerned a haecceitist who countenanced a world that shares the actual world's qualitative facts *and* its history up to a certain time.

Such particular haecceitist theses can also be captured neatly in the current framework. The basic idea is twofold. In addition to the relation of qualitative equivalence, one can introduce a *partial* equivalence relation on worlds that holds between a pair of worlds when they are qualitatively equivalent and both make true a certain proposition φ. For example, that proposition could be one describing the history of the actual world up to a certain time.

$$w \approx_\varphi v := w \approx v \wedge w \vDash \varphi \wedge v \vDash \varphi$$

Moreover one can say what it is for a world to bear this relation to the actual world:

5. Another reason to be cautious about moving to S5 is that recent work has shown interesting S4-consistent principles about qualitativeness to be inconsistent in S5. See the principle 'Quantified Separated Structure' in Bacon (2020) and related principles in Dorr et al. (2021, pp. 191-193) and Goodman (MS).

$w \approx_\varphi @ := \exists v(v \wedge w \approx_\varphi v)$

I pronounce the former claim as 'w and v are qualitatively equivalent φ-worlds' and the latter as 'w and the actual world are qualitatively equivalent φ-worlds'. Note that w and v are qualitatively equivalent φ-worlds only when they both make true φ.

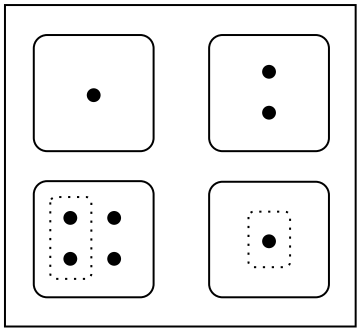

Fig. 2. A representation of modal space (at a world) according to haecceitism, with some qualitative equivalence classes containing more than one world; the dotted rectangles represent equivalence classes under the partial equivalence relation $\approx_\varphi$.

With these definitions in view, we can state the type of haecceitist thesis that figures in the problem of curious indeterminism:

φ-**Haecceitism** The actual world and some non-actual world are qualitatively equivalent φ-worlds.

This may be formalized as: $\exists w(\neg w \wedge w \approx_\varphi @)$. To obtain the instance of φ-Haecceitism that was used in the opening example, consider any time just before the particle collision, and let p be a proposition describing the intrinsic history of the world up to that time. Substituting p for φ in φ-Haecceitism delivers the relevant haecceitist thesis: there is a non-actual world qualitatively equivalent to the actual world that shares the actual world's intrinsic profile up to just before the particles a and b were created.

1.3 *Physical Necessity*

Two final assumptions figured in the problem of curious indeterminism. The first was that the laws of physics are true qualitative propositions. The second was that physical necessity is a 'restriction' of metaphysical necessity by the laws of physics.

The first of these assumptions is straightforward to formulate. If we extend the official language with another propositional operator 'L', whose intended interpretation is the property of propositions *being a law of physics*, it may be written as follows:

Nomic Inclusion $\forall p(Lp \rightarrow p \wedge Qp)$

The principle is so-called because it states that the laws of physics are included amongst the true qualitative propositions.[6] Observe that it is not a necessitated claim: this is because some have suggested that there are worlds in which there are haecceitistic physical laws (Tooley 1977, p. 687), so it is designed to be consistent with that suggestion.

The second assumption—that physical necessity is a restriction of metaphysical necessity by the laws of physics—is less straightforward to formulate. Nonetheless, it can be formulated elegantly by generalizing the framework and the assumptions that govern it in a natural way. So far, we have permitted quantification into sentence position to regiment propositional quantification. However, equally, we may permit quantification into propositional operator position to regiment quantification over *properties* of propositions, like lawhood and qualitativeness. More generally, to formulate the second assumption, it will be

6. Lange (2000) and Kment (2006) dispute the claim that all laws are true. However, presumably they would recognize a species of physical necessity according to which the actual world is physically possible relative to itself; this is the relevant claim that the central puzzle requires.

convenient to permit higher-order quantification of various forms.[7]

In formal terms, I work in a higher-order modal language based on a functional system of types. The typing system I use is relatively simple. There is a single base type t—the type of formula expressions—and all other types—the complex types—are defined recursively by the rule that if σ and τ are types then so is $(\sigma \to \tau)$. (I often omit type brackets, which are associated to the right.) Each expression is assigned a type. For example, $\neg$ and Q are propositional operators: they are of type $t \to t$ and hence combine with formulas (expressions of type t) to produce formulas.

Constants	**Type**
$\neg$	$t \to t$
$\to$	$t \to (t \to t)$
$\forall_\sigma$	$(\sigma \to t) \to t$
$\Box$	$t \to t$
Q	$t \to t$

Moreover, for each type σ there is a universal quantifier $\forall_\sigma$. Intuitively, this is a property of properties of type-σ entities: the property of being universally instantiated amongst the type-σ entities.[8] I write $\xi : \sigma$ for the claim that ξ is an expression of type σ. I also speak interchangeably of expressions and their semantic values as being of a certain type. And when it is instructive I indicate the type of an expression with a superscript, but often I suppress this notation to avoid clutter.

Like with the propositional fragment, I assume that this language is governed by the principles of classical logic, a classical quantification theory for the quantifiers of each type, and the modal system S4.

PL All instances of propositional tautologies.

MP If $\vdash A$ and $\vdash A \to B$, then $\vdash B$

Gen If $\vdash A \to B$, $\vdash A \to \forall_\sigma x B$ when x is not free in A

UI $\forall_\sigma F \to Fa$, where $F : \sigma \to t$ and $a : \sigma$

In addition, I assume that the language contains a λ-device for forming complex terms from other terms. This device is governed by a standard conversion principle ($\beta\eta$) that pins down its capacity to form such complex terms by abstraction.

$\beta\eta$ $\varphi \leftrightarrow \psi$, where φ and ψ are $\beta\eta$-equivalent

For a full definition of the notion of $\beta\eta$-equivalence which figures in this principle, see Bacon (2024, chap. 3). In what follows, the main point of the principle is that it allows one to substitute terms of the form $(\lambda v.M)a$ and $M[a/v]$ freely (where $M[a/v]$ is the result of substituting all free occurrences of v in M for a, which is defined in a standard way).

To get a sense of how the λ-device works, it helps to observe how it allows one to rework the definitions above to introduce a property of propositions *is a world* and a relation amongst propositions corresponding to truth-at-a-world:

$$W^{t \to t} := \lambda p. \Diamond p \wedge \forall q(\Box(p \to q) \vee \Box(p \to \neg q))$$

$$\vDash^{t \to (t \to t)} := \lambda pq. \Box(p \to q)$$

The other definitions used so far, such as that of qualitative equivalence, may be reworked in a similar way.

To formulate what it is to be a 'restriction of metaphysical necessity by the laws of physics' in this setting, it helps to make one further

7. See Dorr (2016), Bacon (2024), and Fritz & Jones (2024) for more on the use of higher-order languages in metaphysics, especially Bacon (2024, chap. 4) for further details about their syntax which I omit in what follows. I do not mean to suggest that the only way to formulate this assumption is to do so in this framework, but it does allow one to formulate the doctrine in a way that makes the problem of curious indeterminism particularly clear.

8. With the λ-device discussed in the next paragraph, one can recover the familiar notation for quantificational claims: when A is a formula, $\forall_\sigma x A$ abbreviates $\forall_\sigma(\lambda x.A)$, where x is a variable of type σ.

assumption.[9] This assumption is a comprehension principle that supplies an abundance of modally 'rigid' properties. Intuitively, these are properties which can neither 'lose' old instances nor 'gain' new ones. More formally, they are properties whose extensions are modally non-decreasing and non-increasing. This can be captured by the condition that restricted quantification over those properties' instances obeys the Barcan formula and its converse:[10]

$$\mathrm{Rig}^{(\sigma\to t)\to t} := \lambda X^{\sigma\to t}.\Box\forall Y(\forall x(Xx \to \Box Yx) \leftrightarrow \Box\forall x(Xx \to Yx))$$

Following Dorr et al. (2021), I refer to such properties as 'collections' and to their instances as being 'in' those collections. (Like with worlds, I shall often ignore that there may be multiple collections that are necessarily coextensive with one another.) To reflect this terminology, I adopt a convention for writing claims about collections according to which formulas with the form of the schemas on the left may be rewritten in the manner displayed on the right (I reserve the variable C for this convention, which does not belong to the official object-language):

$$\forall X(\mathrm{Rig}\, X \to \varphi) \qquad \forall C\varphi[C/X]$$

$$\exists X(\mathrm{Rig}\, X \wedge \varphi) \qquad \exists C\varphi[C/X]$$

The comprehension principle is now stated as follows:[11]

Rigid Comprehension$_{\sigma\to t}$

$$\Box\forall X^{\sigma\to t}\exists Y(\mathrm{Rig}\, Y \wedge \forall x(Xx \leftrightarrow Yx))$$

One can think of the rigid properties—the collections—supplied by this principle as surrogates for 'pluralities' or 'classes', which are usually taken to be modally rigid in an analogous sense.

We can now characterize what it is for physical necessity to be 'metaphysical necessity given the laws of physics'. The core thought is that the latter notion is to be equated with *entailment by being a physical law*. To implement this thought, I define a relation that behaves like many-one entailment between some propositions (e.g. the physical laws) and a proposition. This definition makes use of collections. The intuitive idea is that the propositions which have property F entail p when the 'conjunction' of the collection of those propositions necessitates the truth of p:

$\bigwedge_C := \forall p(Cp \to p)$, where C is of type $t \to t$

$$\leq := \lambda F^{t\to t} p^t.\, \exists C(C \equiv F \wedge \Box(\textstyle\bigwedge_C \to p))$$

To illustrate this with an example: *being a physical law* entails p when the collection C of our laws is such that, necessarily, if every member of C is true, so is p. The use of collections is key to this definition because F may be a modally variable property and have different instances at different worlds. We want to capture the idea that the propositions which are *in fact* the Fs entail some given proposition. For example, we want to capture which propositions are necessitated by *our* laws, not those which are just materially implied by the laws in each respective world.

To formalize the general notion of a restriction, we introduce for any property of propositions F (e.g. *being a physical law*) the property of *being entailed by F*:

$$\Box^F := \lambda p.\, F \leq p$$

9. I say 'helps' because this assumption is not needed. Its primary use here is to define the notion of many-one entailment below, but this can be done in a slightly more complicated way without the assumption (Bacon & Zeng 2022).

10. See Dorr et al. (2021, pp. 43-45). To appreciate why the definition captures the intended idea, it may help to remember that in the Kripke semantics for quantified modal logic the frame conditions for the Barcan formula and its converse are, respectively, that domains are non-increasing and non-decreasing along the accessibility relation.

11. Here it is worth noting that, if the modal principles of the underlying higher-order logic are strengthened to those of S5, Rigid Comprehension$_{t\to t}$ implies the Leibniz Biconditional (Dorr et al. 2021, pp. 50-51).

To be a restriction of metaphysical necessity by F, then, is just to be *being entailed by F*; and to be a restriction of metaphysical necessity is to be a restriction of metaphysical necessity by some F.[12]

$$\text{Restr}^F := \lambda Y^{t \to t}. Y = \Box^F$$

$$\text{Restr} := \lambda Y^{t \to t}. \exists F\, \text{Restr}^F\, Y$$

These definitions make clear what is meant by a 'restriction of metaphysical necessity by the physical laws' and 'metaphysical necessity given the physical laws'.

As a brief aside, we can verify that this notion of a restriction is in good standing. In particular, we can see that any restriction of metaphysical necessity satisfies the conditions for being a 'species of necessity' (for short: a necessity). According to a prominent conception, a necessity is just a formally well-behaved property of propositions. There are various ways in which one might understand this notion of 'formal well-behavedness'.[13] But a standard one is that it involves necessarily meeting a condition that corresponds to the 'rule of necessitation' from modal logic and being 'closed under modus ponens':

$$\text{N} := \lambda X. \forall p(\Box p \to \Box X p)$$

$$\text{K} := \lambda X. \forall p \forall q(X(p \to q) \to Xp \to Xq)$$

$$\text{Nec} := \lambda X. (\Box \text{N}X \wedge \Box \text{K}X)$$

Our definition of a restriction generates the neat result that every restriction is a necessity.[14]

Theorem 1. $\vdash \text{Restr}\, X \to \text{Nec}\, X$

This assures us that the notion of a restriction which will figure in the problem of curious indeterminism is in good standing.

To return to the main thread, we can now formulate the final assumption needed for the problem of curious indeterminism:

Nomic Entailment Physical necessity is *entailment by being a physical law* (i.e. $\Box^L$).

If we introduce a new propositional operator '$\blacksquare$' to the language that expresses physical necessity, this may be formalized as the identification: $\blacksquare = \Box^L$.

1.4 The Problem Stated

With all this in view, the problem of curious indeterminism can be stated as a simple argument schema. Recall that the conclusion of this argument was an indeterminist thesis. In the opening example, the particular indeterminist thesis was that some physically possible, non-actual world shares the intrinsic profile of our world up to a time before the particles *a* and *b* are created. However, just as we formulated φ-Haecceitism schematically for the purposes of the argument, the indeterminist conclusion can be formulated schematically too. On this construal, the argument takes the following schematic form:

12. This definition of a restriction of metaphysical necessity is essentially that of an 'infinitely closed relative necessity' from Bacon & Zeng (2021). In the current setting, it is equivalent to the definition of relative necessity from Roberts (2020). Bacon & Zeng provide a more inclusive definition of 'relative necessity' according to which relative necessities need only be 'finitely closed'. This definition is more complicated than the one I use here, but with the appropriate modifications my arguments can be run using it.

13. See for example Bacon (2018), Bacon & Zeng (2021), and Dorr et al. (2021, chap. 8).

14. The argument is similar to that of Proposition 3.15 from Bacon & Zeng (2022), although they use a slightly different definition of a restriction.

The Indeterminism Argument

φ-**Haecceitism** The actual world and some non-actual world are qualitatively equivalent φ-worlds.

Nomic Inclusion The laws of physics are true qualitative propositions.

Nomic Entailment Physical necessity is *entailment by being a physical law*.

φ-**Indeterminism** There are two different physically possible φ-worlds.

Using the new operator ■, and its dual ⧫, the official formalization of the conclusion is: $\exists w \exists v(\neg\Box(w \leftrightarrow v) \wedge \blacklozenge w \wedge \blacklozenge v \wedge w \vDash \varphi \wedge v \vDash \varphi)$

The argument is 'valid' in the underlying logical system in the sense that, if we formalize the premises in the manner specified above, the conjunction of the premises implies the conclusion.

Theorem 2 (Indeterminism Argument).

$\vdash$ φ-Haecceitism $\wedge$ Nomic Inclusion $\wedge$ Nomic Entailment $\rightarrow$ φ-Indeterminism

The intuitive reason for this is that, given Nomic Entailment and the claim (from Nomic Inclusion) that the laws of physics are qualitative, physical necessity does not discriminate between qualitatively equivalent worlds: any pair of such worlds are either both physically possible or both physically impossible. But, given Nomic Entailment and the claim (again from Nomic Inclusion) that the laws of physics are true, the actual world is physically possible. Thus any world that is qualitatively equivalent to the actual world is also physically possible. Given φ-Haecceitism, φ-Indeterminism is then immediate.

It is now easier to appreciate just how general the problem of curious indeterminism is. Any haecceitist who recognizes that the actual world and some non-actual world are qualitatively equivalent φ-worlds will face this problem. And of course there are a great many instances of φ-Haecceitism that paradigm haecceitists will embrace. There are those similar to the example involving the particles a and b with which I began. But another notable class of examples is arguably found in the literature on the hole argument against substantivalism. On certain reconstructions of that argument, it may be understood as generating instances of the above argument schema. In these instances, the focus is on non-actual qualitatively equivalent worlds that make true a true proposition about the state of the world outside of a specific region of spacetime—the 'hole'.[15]

It is also now easier to appreciate the concern that the failures of determinism induced by haecceitism are objectionably 'cheap'. For many haecceitists will maintain that the actual world is not special, and that, in general, the qualitative facts could tolerate haecceitistic differences—differences of the sort liable to undermine determinism.[16] But then determinism would be almost metaphysically impossible, if not completely so. And that renders it opaque why the mere metaphysical possibility of a deterministic world strikes one antecedently as so plausible.

To summarize, we now have a guarantee that the intuitive problem of curious indeterminism with which we began can be embedded in a systematic framework for theorizing about haecceitism. Moreover, we have isolated precisely which assumptions are needed to formulate the problem: only φ-Haecceitism and widely accepted claims about physical necessity. Given that haecceitists should think φ-Haecceitism admits

15. See Teitel (2022) for a recent reconstruction of the argument which lends itself to this understanding.
16. When running the indeterminism argument with respect to a non-actual world, the truth of Nomic Inclusion at that world implies that the laws of that world are qualitative. Since, as mentioned above, some have argued for the possibility of haecceitistic laws, there might not be an analogue of this particular indeterminism argument with respect to such particular non-actual worlds (if there are any).

a range of plausible substitution instances, the problem of curious indeterminism is one which they cannot afford to ignore. How they might reckon with it will be the focus of what follows.

2. Haecceitistic Realizations

Upon being confronted with the indeterminism argument, haecceitists might just acquiesce in its conclusion. Indeed many have been tempted just to accept the relevant instance of φ-Indeterminism and retreat to a weaker *qualitative* determinist thesis that is not undermined purely by the presence of mere haecceitistic differences between worlds:[17]

Qualitative φ-Determinism Any physically possible φ-worlds are qualitatively equivalent.

What is tempting about this reaction is that haecceitists would appear to have few alternatives. If one accepts a suitable instance of φ-Haecceitism, the only alternative to embracing φ-Indeterminism is to reject either Nomic Inclusion or Nomic Entailment. Yet Nomic Inclusion is just the thought that the physical laws are true qualitative propositions—a widely accepted, partly empirical claim whose rejection looks difficult to shoulder. Moreover, as we have seen, Nomic Entailment stems from a natural conception of restricted necessities.

Be that as it may, I want to explore a response to the indeterminism argument that challenges Nomic Entailment. This response accepts the claim that the physical laws are true qualitative propositions, but it rejects the thought that physical necessity is a restriction of *metaphysical necessity* by only qualitative propositions. My line of argument is general: my aim is to argue that haecceitists have reason to reject such thoughts about many such necessities as a matter of principle.

Bringing out why this is the case will involve looking at haecceitism

17. In the literature on the hole argument this has not been an unpopular response. See Melia (1995), Brighouse (1997), and the closing remarks in Teitel (2022). Nonetheless, for countervailing pressure see Builes & Teitel (2022) for a series of arguments in support of determinism.

in a slightly different light. Haecceitism is typically viewed as an exclusively metaphysical doctrine, something within the purview of metaphysics and only of metaphysics. But its scope is actually much broader: haecceitism has ramifications for how we must view ordinary modal talk and the general practice of modal theorizing. The aim of this section is to highlight these ramifications; in the next section, I return to the indeterminism argument with them in view.

Turning to the details, suppose that in Particle Collision a scientist arrives hours before the collision occurs and closely observes the entire process unfold, including the trajectories of the different particles emitted from the collision. In describing this scenario, many would find it difficult—if not absurd—to reject the following counterfactuals (where t is the trajectory along which a is in fact emitted):

(1) Had the scientist arrived one nanosecond later, he would still have observed a being emitted along t.

(2) Had the scientist cleared his throat one more time before arriving, he would still have observed a being emitted along t.

(3) Had a particle on Mars been moving slightly faster, the scientist would still have observed a being emitted along t.

Let us say that the emission of a along t is *counterfactually stable* with respect to the different antecedents in question. This counterfactual stability arises because the emission of a along t is not contingent on minutiae such as the scientist's exact arrival time or events on Mars.

This counterfactual stability is not an isolated phenomenon. In describing the scenario, many would also find it difficult to reject any of the following claims:

(4) Given that the scientist was observing the collision so closely, he couldn't easily have missed a being emitted along t.

(5) Given that the scientist was observing the collision so closely, it was practically impossible for him to miss a being emitted along t.

(6) Given that the scientist was observing the collision so closely, it was

humanly impossible for him to miss *a* being emitted along *t*.

Indeed it would be utterly natural for one to assert just the following:

(7) Given that the scientist was observing the collision so closely, he couldn't have missed *a* being emitted along *t*.

The initial counterfactual stability judgments are accompanied by other stability judgments. The scientist's witnessing the emission of *a* along *t* is modally stable according to many modalities—easy possibility, practical possibility, human possibility, and modalities regularly invoked in ordinary discourse. Let us call this family of modalities the *local modalities*.

Now, although such stability is present in the realm of local possibility, haecceitists *must* recognize that there is a broader realm of possibility from which it is absent. Given any antecedent-satisfying world *w*, haecceitists will maintain that there is a world *v* which differs from *w* by a mere permutation of *a* and *b*. For example, suppose *w* is a world where the scientist arrives one nanosecond later and *a* is emitted along *t*. Typically, haecceitists will countenance a world with the same qualitative facts as *w*, at which the scientist also arrives one nanosecond later, but where the careers of *a* and *b* have been permuted.

Despite this, I take it that no one would seriously claim that haecceitists must reject (1)-(7). The reason for this is straightforward: just because a certain haecceitistic swap is metaphysically possible, it does not follow that it is locally possible. This allows counterfactuals to discriminate between qualitatively equivalent worlds, indeed discriminate between certain qualitatively equivalent φ-worlds, for various substitution instances of φ (e.g., where φ is a detailed haecceitistic proposition which necessitates that the scientist arrives one nanosecond later).

These considerations generalize to the other examples. If modal judgments like (1)-(7) are correct, and if they are representative of how the local modalities generally behave, the local modalities must discriminate between certain qualitatively equivalent φ-worlds.

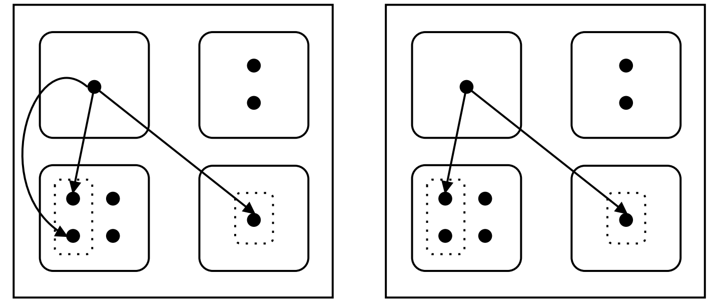

Fig. 3. Two representations of the modal space (at a world) from Fig. 2. Left: the arrows represent what is possible from some world according to a necessity that does *not* discriminate between qualitatively equivalent φ-worlds. Right: the arrows represent what is possible from that world according to a necessity that *does* discriminate between qualitatively equivalent φ-worlds.

This demonstrates a crucial point about how haecceitists should view ordinary modal talk. As they must see it, the local modalities may 'hold fixed' a great deal of haecceitistic information that is neither made explicit nor salient on the relevant occasion of use. For example, consider again the modality of easy possibility. A familiar thought is that, as used in (4), this modality holds fixed lots of information. It holds fixed propositions about the scientist observing the collision, precise features of the immediate environment, what preceded the observation, certain laws, certain aspects of the qualitative state of the world, and so on. But additionally the haecceitist must recognize that, on the same occasion, it also holds fixed information about which particular haecceitistic realization a qualitative state may achieve. For were such information not held fixed, our ordinary modal talk—as exemplified by (1)-(7)—would be pervaded by error.

This phenomenon can be described much more precisely. Let us say that a proposition is a *world selector* when it is compatible with exactly one member (modulo necessary equivalence) of any qualitative equivalence class of worlds:

$$\text{Selector} := \lambda p.\forall w \exists v \forall u(\Box(v \leftrightarrow u) \leftrightarrow (w \approx u \wedge \Diamond(p \wedge u)))$$

For each total possible qualitative state, world selectors pick out a unique haecceitistic realization that witnesses that qualitative state. Intuitively, one may think of them as large, haecceitistic conjunctions of material conditionals, each linking a total possible qualitative state to a particular haecceitistic realization of it, with no two material conditionals in the conjunction sharing the same antecedent.

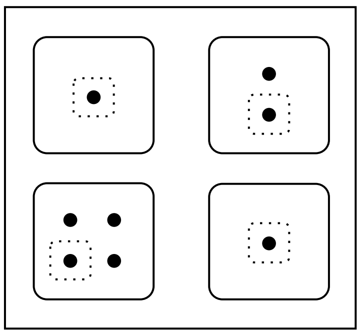

Fig. 4. A representation of modal space (at a world) according to haecceitism; the dotted rectangles represent a world selector.

Next, say that a necessity is *selecting* when it applies to a world selector:

$$\text{Selecting} := \lambda X.\text{Nec}\, X \wedge \exists p(\text{Selector}\, p \wedge Xp)$$

For any metaphysically possible total qualitative state, such necessities admit as possible at most one world that instantiates that state. (There may, however, be some metaphysically possible qualitative states which those necessities deem impossible.) As a consequence, they will behave like 'anti-haecceitist necessities'. By this, I mean they will license the thesis of anti-haecceitism (i.e. the negation of haecceitism), according to which any qualitatively equivalent worlds they deem as possible are the same:

$$\langle X \rangle := (\lambda p.\neg X \neg p)$$

$$\text{AH} := \lambda X.\forall w \forall v(w \approx v \wedge \langle X \rangle w \wedge \langle X \rangle v \to \Box(w \leftrightarrow v))$$

Theorem 3. $\vdash \text{Selecting}\, X \to \text{AH}\, X$

The selecting necessities, then, are those in which haecceitists may see a grain of truth in anti-haecceitism.

Before putting selecting necessities to use, it is important to head off one potential confusion about them. As Theorem 3 captures, the thesis of anti-haecceitism is true with respect to anti-haecceitist necessities. However, these necessities license anti-haecceitism because they hold fixed a great deal of *haecceitistic* information. This haecceitistic information is codified in the world selector to which they apply, which, recall, one can think of as linking each metaphysically possible total qualitative state with a unique haecceitsitic realization of it. This is what makes selecting necessities anti-haecceitist. For any total qualitative state they deem possible, there is only one haecceitistic realization of it they also deem possible: the one 'given' by the world selector to which they apply. So a necessity is anti-haecceitist *by virtue* of holding fixed so much haecceitistic information.

To now put selecting necessities to use, what I take the above examples of ordinary modal talk to indicate is that haecceitists should think that the local necessities are selecting.[18] On this picture, when we engage in modal theorizing we often invoke modalities that 'hold fixed' propositions about which haecceitistic description will be realized if the world is in a certain total qualitative state. In other words, it is a picture on which ordinary modal discourse is permeated with haecceitistic con-

18. There is of course a great deal of contextual variability in which necessities are expressed in ordinary modal talk. So, to be clear, the suggestion is that in many standard contexts, like those in which (1)-(7) are true, the modal terms express necessities that are selecting. Hereafter I suppress this qualification.

tent in unexpected ways. This would explain why seemingly obvious truths like (1)-(7) are still true in the presence of haecceitism.

To conclude this section, I want to highlight two important points about the claim that the local necessities are selecting. According to the definition above, for a necessity to be selecting is just for it to apply to some world selector—for it to select a unique haecceitistic realization of each total qualitative state it deems possible. The first point I want to make is that, in one respect, this is quite a weak condition. It is natural to assume that there are many different world selectors, some of which will select haecceitistic realizations of qualitative states that, intuitively, are not possible according to any of the local necessities. For example, consider a haecceitistic realization of the actual qualitative state in which you occupy the qualitative role of an inanimate object. In saying that the local necessities are selecting—that they apply to some world selector—I am not trying to specify precisely *which* world selectors they apply to. That is a difficult question best deferred to the metasemantics of those expressions. And there is nothing unusual about doing so: all questions about which facts get held fixed in modal discourse are best deferred to metasemantics, and this is simply one of them.

This makes salient the second point, which is that one must both permit and expect vagueness in *which* world selector a local necessity is based on in a given context. In fact, a natural model of this is already available: it is inspired by the Stalnakerian treatment of counterfactuals. This treatment validates 'conditional excluded middle', which, intuitively, amounts to there being a unique counterfactually closest world. To assuage concerns about this world being selected arbitrarily, however, the Stalnakerian permits the counterfactual conditional to be a source of vagueness. And so although determinately there is a unique counterfactually closest world, there is no unique world that is determinately the counterfactually closest one.[19] Plausibly, this model will predict that the counterfactual often makes selections between qualitatively equivalent worlds. In such contexts, its different precisifications will hold different bodies of haecceitistic information fixed—in particular, information about the haecceitistic realizations of qualitative states. Different haecceitistic realizations of one and the same qualitative state will then be possible on different sharpenings of the counterfactual.[20] It is precisely this idea that I recommend the haecceitist use to allow for intra-contextual vagueness in which world selector is operative. The suggestion is that a given local necessity X, say practical necessity, determinately applies to some world selector, but there is no particular world selector such that determinately X applies to it. In other words, each local necessity determinately necessitates that a given possible qualitative state has a unique haecceitistic realization, but there is no particular haecceitistic realization of it which the necessity determinately necessitates that qualitative state to realize.

3. Nomic Selection

With these observations in view, we can return to the indeterminism argument. In that argument, Nomic Entailment was motivated by the thought that physical necessity is a restriction of metaphysical necessity by a body of only qualitative propositions, the physical laws. However, once the haecceitist has come to appreciate that ordinary modal discourse is permeated with unexpected haecceitistic content, this inference should strike them as much less obvious. If the necessities invoked in ordinary discourse are selecting, it would not be surprising if some of our utterances of 'physical necessity' expressed similar necessities. But then in those contexts Nomic Entailment would be false, for physical necessity would be a restriction of a selecting necessity—as opposed to metaphysical necessity—by only the physical laws.

19. Compare classical treatments of the sorites: determinately there is a last bald person, but no particular person is such that determinately *they* are the last bald person.
20. This model of the counterfactual is discussed further in Goodman (MS).

How might utterances of 'physical necessity' express such a restriction? The question becomes particularly salient when one recalls that physical necessity is often equated with entailment by *being a physical law*, a property of only qualitative propositions. Nevertheless haecceitists have a natural answer: the world selector is given by the operative notion of entailment. For whereas initially only one entailment relation was identified, the reality is that there are many such relations, each generated by a given species of necessity. That is to say, given a necessity X we can characterize a notion of X-entailment:

$$\leq_X := \lambda Fp.\, \exists C(C \equiv F \wedge X(\bigwedge_C \to p))$$

Indeed for any property of propositions F and any necessity X, the operation *being X-entailed by F* is a necessity:[21]

$$X^F := (\lambda p.\, F \leq_X p)$$

Theorem 4. $\vdash \text{Nec}\, X \to \text{Nec}\, X^F$

Thus if physical necessity is a restriction of a selecting necessity, it is still guaranteed to be a genuine species of necessity.

This makes salient an alternative to Nomic Entailment according to which physical necessity is a restriction of some particular selecting necessity by *being a physical law*:

Nomic Selection For some selecting necessity X: physical necessity is *X-entailment by being a physical law*.

In formal terms: $\exists X(\text{Selecting}\, X \wedge \blacksquare = X^L)$. This implies that physical necessity itself is selecting, and so it will not deem possible distinct qualitatively equivalent worlds.

Crucially, even in the presence of φ-Haecceitism and Nomic Inclusion, Nomic Selection does *not* imply φ-Indeterminism, for, as just mentioned, physical necessity will no longer regard any distinct qualitatively equivalent worlds as both possible—at most one of them will be selected by it. To make this point more concrete, we can connect it with the opening example of Particle Collision. Thinking back to that example, we can now see that Nomic Selection implies that at most one of the qualitatively equivalent worlds that the haecceitist posited on the basis of Particle Collision will be physically possible. Accordingly, the mere existence of such a pair of worlds will not constitute a counterexample to determinism. Nomic Selection thus delivers to the haecceitist a conception of determinism that is compatible with the modal judgments they wish to make about Particle Collision.

Several comments about this general point are now in order. First, notice that many of the local modalities are characterized in terms of entailment by certain propositions. For instance, it is common to see practical necessity characterized by what is entailed by our practical constraints. However, if practical necessity licenses claims like (5), as it should do, the underlying relation of entailment in terms of which it is characterized should be X-entailment, where X is not metaphysical necessity but rather some selecting necessity. Thus the key thought behind Nomic Selection is a generalization of a mechanism which underwrites much of ordinary modal discourse.

Second, it is important to return to the remarks from the end of §2, where I emphasized that saying the local necessities are selecting is, in one respect, quite a weak claim. Saying that a local necessity applies to a world selector leaves open the question of *to which* world selector it applies. Instead of trying to settle this, however, I deferred it to the metasemantics of the modal expressions in question. Here I do the same. Some world selectors better fit our discourse about physical necessity than others; the metasemantics decides which one it expresses. In fact, like before, I doubt that any particular one of these world selectors is uniquely best: there is vagueness in to which world selector physical necessity applies. But all this does is bring the treatment of physical necessity even further in line with that of the local necessities, and the Stalnakerian treatment of the counterfactual that guides it.

Third, I am not suggesting that speakers think of what is expressed

21. The argument is similar to that for Theorem 1: see fn. 14.

by 'physical necessity' under the guise of 'X-entailment by *being a physical law*' (where X is a selecting necessity). For just as one can think of the different individuals under the same indiscriminate guise, one can think of different necessities under an indiscriminate guise too. Indeed in different contexts speakers may think of what is expressed by 'physical necessity' under the same indiscriminate guise, for instance 'what follows from the laws' or 'a modal status of the laws but not of our practical constraints'.

Fourth, it is important to be clear about the status of Nomic Selection. I am not suggesting that the term 'physical necessity' could never be used to express (metaphysically necessary) entailment by *being a physical law*. In some cases, it is simply stipulated to do so. Rather the key point is that in contexts where 'physically necessary' licenses determinist theses, it does so by expressing a selecting necessity. The claim is that the permeation of ordinary modal discourse by unexpected haecceitistic content colors our judgments about physical necessity and determinism. It is not that the haecceitistic restrictions are inescapable. Thus I am offering Nomic Selection to haecceitists as a hypothesis that explains and vindicates our determinist-judgments in contexts where they seem so compelling.

For the fifth point, recall the response to the puzzle of indeterminism that I discussed at the beginning of §2. This response was simply to reject full determinism and accept only *qualitative* determinism with respect to physical necessity, which it equated with (metaphysically necessary) entailment by *being a physical law*. In other words, the response embraced Qualitative φ-Determinism and Nomic Entailment. Together, these theses imply a principle closely related to Qualitative φ-Determinism

Qualitative φ-Determinism$^{\Diamond^L}$ Any $\Diamond^L$-possible φ-worlds are qualitatively equivalent.

In the presence of Nomic Entailment, Qualitative φ-Determinism$^{\Diamond^L}$ is equivalent to Qualitative φ-Determinism; but without Nomic Entailment, they are not equivalent. Interestingly, though, given Nomic Selection there is a neat argument from Qualitative φ-Determinism$^{\Diamond^L}$ to φ-Determinism:[22]

φ-Determinism Any physically possible φ-worlds are identical.

For take any physically possible φ-worlds w and v. Since physical possibility is no more inclusive than $\Diamond^L$-possibility, w and v would also be $\Diamond^L$-possible. Hence by Qualitative φ-Determinism$^{\Diamond^L}$, they would be qualitatively equivalent. Yet if physical necessity is selecting, any qualitatively equivalent worlds which are both physically possible are identical, which means that w and v must be the same. The philosophical upshot to this is that, on my view, full determinism is downstream from a qualitative determinist thesis to which other responses to the puzzle retreat.

To summarize the main contention, I have drawn attention to the fact that haecceitists should recognize that much of our ordinary modal discourse is permeated with haecceitistic content in subtle ways. In light of this, I have proposed that it is natural for haecceitsts to see this haecceitistic permeation as afflicting expressions like 'physically necessary' too. As a consequence they have a new determinist-friendly solution to the indeterminism problem that draws on a philosophy of language which sits naturally with their view.

4. Conclusion: Cheap Anti-Haecceitism

To conclude, I want to highlight that there are close parallels between the position I have developed and Lewis's (1986, chap. 4) famous doctrine of 'cheap haecceitism'.[23]

According to Lewis's doctrine, worlds are disjoint, causally discon-

22. See Theorem 5 of the appendix for this result and a more careful version of the following argument.
23. Cheap haecceitism is developed differently in Russell (2015); in many respects my approach is even closer to Russell's, although Russell distances himself from what he calls a 'multiple modalities' approach that bears some similarities to mine.

nected spacetimes. He also required that no two worlds differ 'merely haecceitistically', by which he meant that no two of them have the same qualitative character. However, in his theory there is an additional layer of complexity, which is that *de re* modal discourse is to be interpreted via the apparatus of counterpart theory. And according to the cheap haecceitist, different individuals may bear different counterpart relations to one and the same individual in a given world. So, as Lewis (1986, p. 230) puts it, *possibilities are not possible worlds*.

This allows the cheap haecceitist to recover both haecceitist and anti-haecceitist modal judgments in a way that many philosophers have found attractive. To take the example of Particle Collision, the cheap haecceitist will recognize only one spacetime with the relevant qualitative character, in which two duplicate particles of the same type are emitted from a particle collision along different respective trajectories. However, although there is only one such spacetime, there are many counterpart relations borne to the individuals there. There is one such relation which only the particle *a* bears to the particle that is emitted along the trajectory *a* in fact travels, and there is another relation which the particle *b* (and perhaps still *a* too) bears to the particle that is emitted along that trajectory. According to the former counterpart relation, the relevant thesis of determinism may be true and haecceitism false. This is because the interpretation of the modal operator furnished by that relation must deem it impossible for the qualitative state of the world to tolerate a haecceitistic swap between *a* and *b*. But according to the latter counterpart relation, determinism is false and haecceitism true. This is because the interpretation of the modal operator furnished by that relation must deem it possible for that qualitative state to tolerate such a swap.

Seen from this perspective, the structure of the cheap haecceitist response closely parallels that of my own. Both approaches draw on their underlying metaphysics to identify different interpretations of modal operators which diverge over the truth of determinism and haecceitism respectively.[24] The metasemantics of the views are similar too. Lewis let context determine which counterpart relation is invoked, embracing vagueness in precisely which one is, just as my approach does with world selectors. The main difference between the approaches stems from their different underlying metaphysics. Whereas Lewis's cheap haecceitist draws on a contentious metaphysics of worlds and counterpart relations, the version of haecceitism I have developed simply draws on a general theory of relative necessities. As I have tried to bring out, the underlying framework of relative necessities is grounded in assumptions that many will already accept. Thus, to reconcile the seemingly opposed haecceitist and anti-haecceitist judgments that generate the problem of indeterminism, one can avoid the detour through counterpart theory that might initially have seemed necessary.

This is important because, as Lewis emphasized, cheap haecceitism achieves its flexibility by divorcing possibilities from possible worlds. In effect, this involves rejecting his analogue of the Leibniz Biconditional. However, as others have emphasized, the consequences of doing this are not to be understated: indeed they raise the question of whether cheap haecceitism creates more trouble than it is worth—of whether cheap haecceitism genuinely is so cheap.[25] But since the version of haecceitism I have developed avoids these issues, the flexibility of cheap haecceitism can be had a better price.

24. The idea that different counterpart relations generate different interpretations of modal operators is suggested strongly by the translation of quantified modal logic into counterpart theory from Lewis (1968). In his later work Lewis (1986, pp. 12-13), seemed to attach much less importance to translating modal discourse into counterpart theory. However, I side with the sentiment voiced in Russell (2013) and Dorr (MS) that counterpart theorists should attach great importance to this task.

25. See Fara & Williamson (2005), Kment 2012, and Russell (2013; 2015) for detailed treatments of this issue. I am inclined to see this issue as a symptom of a much broader problem with counterpart theory, which is that it invalidates core axioms of modal and *non*-modal logic—such as the K axiom and even Free Universal Instantiation—unless it places restrictions on counterpart relations which undermine the guiding picture of counterpart theory. See Kripke (1969), Hazen (1979), and Dorr et al. (2021, chap. 10) for further discussion.

Nevertheless, these close parallels notwithstanding, there is one respect in which my approach inverts the Lewisian one. Lewis described his approach as cheap *haecceitism* because he took no two worlds to differ merely haecceitistically. But on the approach I have proposed, it is *anti-haecceitism* which comes cheap: there is an unrestricted sense of 'necessity' according to which haecceitism is true, whereas anti-haecceitist judgments can be vindicated only when the sense of 'necessity' is restricted.[26] There is consequently a cheap substitute for anti-haecceitism available to haecceitists. And, as I have argued, they may use it to dispel one of the main concerns about their view.[27]

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26. As others have observed (Dorr MS, pp. 32-33), the unrestricted sense of 'necessity' on Lewis's view is arguably given by the maximally liberal counterpart relation, which every individual bears to every other individual. But this sense of 'necessity' will license the *modal* thesis of haecceitism—that some truth is not necessitated by the qualitative truths—too, and so Lewis's view shares in common with mine the prediction that the modal thesis of haecceitism is true when the modal operator is given an unrestricted reading.

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Appendix

Theorem 2 (Indeterminism Argument).

$\vdash$ φ-Haecceitism $\wedge$ Nomic Inclusion $\wedge$ Nomic Entailment $\rightarrow$ φ-Indeterminism

Proof. Given Nomic Entailment, we assume throughout that physical necessity is simply entailment by the laws, i.e. $\blacksquare = \Box^L$. We first show that given Nomic Inclusion, i.e. $\forall p(Lp \rightarrow p \wedge Qp)$, physical necessity does not discriminate between qualitatively equivalent worlds:

$$\Diamond^L w \wedge w \approx v \rightarrow \Diamond^L v \tag{1}$$

For this, observe that to establish the consequent we must just show that the collection C coextensive with L is such that:

$$\Diamond(\forall p(Cp \rightarrow p) \wedge v) \tag{2}$$

Given that v is a world, this is equivalent to:

$$\Box(v \rightarrow \forall p(Cp \rightarrow p)) \tag{3}$$

Moreover, since C is a collection, this is equivalent to:

$$\forall p(Cp \rightarrow \Box(v \rightarrow p)) \tag{4}$$

To derive (2), observe that, for similar reasons to the equivalence of (2) and (4), the assumption $\Diamond^L w$ gives us:

$$\forall p(Cp \rightarrow \Box(w \rightarrow p)) \tag{5}$$

Moreover the assumption $w \approx v$ implies:

$$\forall p(Qp \rightarrow (\Box(w \rightarrow p) \rightarrow \Box(v \rightarrow p))) \tag{6}$$

Thus by Nomic Inclusion, (1), (2), and the assumption that C is coextensive with L deliver (4). This suffices to establish (1).

Next, recall that φ-Haecceitism implies the existence of an actual world @, i.e. a world at which every truth is true. By Nomic Inclusion, we have:

$$\Diamond^L @ \tag{7}$$

For otherwise, we would have:

$$\Box(@ \rightarrow \exists p(Cp \wedge \neg p)) \tag{8}$$

But, by Nomic Inclusion, every instance of C is a truth.

Recall further that φ-Haecceitism tells us that there is a non-actual world w which is qualitatively equivalent to @, each of which makes φ true. With (1) and (7), this implies that w is physically possible:

$$\Diamond^L w \tag{9}$$

It follows that there are two different physically possible φ-worlds, which is what φ-Indeterminism states. □

Theorem 3. $\vdash$ Selecting $X \to$ AH X

Proof. It first helps to establish a lemma about world selectors, which states that they are compossible with exactly one world (modulo necessary equivalence) from any given qualitative equivalence class.

$$\text{Selector } p \to \forall w \forall u(\Diamond(p \wedge w) \wedge \Diamond(p \wedge u) \wedge w \approx u \to \Box(w \leftrightarrow u)) \tag{1}$$

To see why this holds, assume Selector p and observe that the definition of a world selector gives us:

$$\forall w \exists v \forall u(\Box(u \leftrightarrow v) \leftrightarrow (w \approx u \wedge \Diamond(p \wedge u))) \tag{2}$$

Thus for any world w we have the existence of a world v such that for any world u:

$$\Box(u \leftrightarrow v) \leftrightarrow (w \approx u \wedge \Diamond(p \wedge u)) \tag{3}$$

$$\Box(w \leftrightarrow v) \leftrightarrow (w \approx w \wedge \Diamond(p \wedge w)) \tag{4}$$

Hence from the reflexivity of qualitative equivalence and the assumptions of $\Diamond(p \wedge w)$, $\Diamond(p \wedge u)$ and $w \approx v$, standard modal reasoning gives us $\Box(w \leftrightarrow u)$.

With (1) to hand, assume X is a selecting necessity such that for worlds w and v:

$$w \approx v \wedge \langle X \rangle w \wedge \langle X \rangle v \tag{5}$$

Since X is selecting, there is a world selector p such that Xp. Thus, by the fact that X is a necessity, we have:

$$w \approx v \wedge \langle X \rangle (p \wedge w) \wedge \langle X \rangle (p \wedge v) \tag{6}$$

Again, since X is a necessity (which implies NX), this gives us:

$$w \approx v \wedge \Diamond(p \wedge w) \wedge \Diamond(p \wedge v) \tag{7}$$

And hence by (1), $\Box(w \leftrightarrow v)$. This suffices to establish AH X. □

The final result concerns one of the last claims made in §3, that there is an argument from Qualitative φ-Determinism$^{\Diamond^L}$ and Nomic Selection to φ-Determinism. This is underwritten by the following formal result:

Theorem 5.

$\vdash$ Selecting $X \;\wedge\; \forall w \forall v(\Diamond^L w \wedge \Diamond^L v \wedge (w \vDash \varphi) \wedge (v \vDash \varphi) \to w \approx v) \to$
$\forall w \forall v(\langle X^L \rangle w \wedge \langle X^L \rangle v \wedge (w \vDash \varphi) \wedge (v \vDash \varphi) \to \Box(w \leftrightarrow v))$

Proof. To establish this, it helps to record the following lemma:

$$\forall p(Xp \to Yp) \to \forall p(X^L p \to Y^L p) \tag{1}$$

(1) holds because $X^L p$ unpacks to the following:

$$\exists C(C \equiv L \wedge X(\textstyle\bigwedge_C \to p)) \tag{2}$$

Thus, given $\forall p(Xp \to Yp)$, we have:

$$\exists C(C \equiv L \wedge Y(\textstyle\bigwedge_C \to p)) \tag{3}$$

This is just $Y^L p$, and so (1) holds.

Given (1), it straightforward to verify the following:

$$\text{Nec}\, X \wedge \text{Nec}\, Y \to \forall p(Xp \to Yp) \to \forall p(\langle Y^L \rangle p \to \langle X^L \rangle p) \tag{4}$$

Moreover, given Selecting X (and hence Nec X), we also have $\forall p(\Box p \to Xp)$. And so, since it is straightforward to verify Nec $\Box$, (4) and Theorem

4 give us:

$$\forall p(\langle X^L \rangle p \to \Diamond^L p) \tag{5}$$

Turning now to the main claim, assuming $\langle X^L \rangle w \wedge \langle X^L \rangle v$, (5) gives us $\Diamond^L w \wedge \Diamond^L v$. And so, assuming $w \vDash \varphi$ and $v \vDash \varphi$, we have $w \approx v$. Now, it is easy to verify that the assumption of Selecting X implies Selecting X^L. Thus by Theorem 3 it follows that $\Box(w \leftrightarrow v)$. □