4

Modal properties and modal propositions; relative and absolute necessity

Consider, for a moment, logical necessity. The *sentence*

S1 "All unmarried men are men"

expresses a nonmodal proposition, that is, a proposition incorporating no modal concepts. But clearly this nonmodal proposition has the modal property of being necessarily true (i.e., is logically necessary). In contrast, the sentence

S2 "Necessarily all unmarried men are men"

expresses a modal proposition, that is, a proposition that incorporates a modal, concept.

Parallel distinctions can be made for other species of modality: epistemic, doxastic, etc. And thus we are prompted to ask: Are physical laws nonalethic modal propositions? And, What nonalethic modal properties do physical laws have? We will take these questions in order.

Are physical laws modal propositions? Everyday discourse, whether of the layperson or the scientist, provides no answer. A sampling of explanations citing physical laws offers both bounteous examples of sentences that depict physical laws as nonmodal propositions and equally large numbers of instances that portray physical laws as being modal propositions.

E1 "Why do you keep your furnace fan motor running throughout the winter, even when the furnace has cycled off?"

"Because (it is a physical law that) convection currents distribute warm air upward. By circulating the air by a fan, we draw some of the warmer air downward, and thus get better fuel economy."

E2 *"Why can't we travel by a very powerful rocket to Venus in one minute?"*

> *"Because Venus is never less than 40,200,000 kilometers from Earth, and because it is a physical law that no object (such as a rocket) having mass can travel faster than the speed of light. Since the speed of light is 299,792 kilometers per second, the minimum time for the trip is greater than 2.23 minutes."*

With little effort, one can manufacture countless other examples of each kind, those that like *E1* are free of modal terms (e.g., "Copper *conducts* electricity," "Sodium chloride crystals *are* cubic"); and those that like *E2* incorporate modal terms (e.g., "Nothing *can* get colder than –273.16° C," "A modulated carrier wave *must* have sidebands").

But really, the situation is even more indeterminate than just portrayed. For not only do quite ordinary examples seemingly provide instances both of nonmodal laws and of modal ones, they even seem to provide cases of nonmodal and of modal versions of the 'same' law, for example, "Nothing travels faster than light" / "Nothing can travel faster than light"; "Sodium chloride crystals are cubic" / "Sodium chloride crystals must be cubic". Indeed, it is probably true that we can with perfect propriety express every law in a weaker and in a stronger version of words: "For every action there is an equal and opposite reaction" / "For every action there must be an equal and opposite reaction."

Which kind of sentence we utter, with or without a modal term, doubtless depends on the pragmatics, or the context, of the explanation-seeking question posed. To mere "How-did/does/will-it-happen-that-...?" questions, we usually reply with sentences relatively free of modal terms. But to "How-is-it-possible-that-...?" and "Why-isn't-it-possible-that-...?" questions, we generally reply with stronger, modalized versions of sentences expressing physical laws. Which version we use is a context-dependent matter, and little should be inferred about the 'real' or 'true' form (analysis) of physical laws from these differing examples

All propositions, whether themselves nonmodal or modal, have indefinitely many alethic and nonalethic modal properties. For example, the nonmodal proposition that two plus two equals four has the alethic modal property of being necessarily true, and the nonalethic modal property of being believed (by someone). Similarly, the modal proposition that it is known that copper conducts electricity has the alethic modal property of being logically contingent and the nonalethic modal property of being doubted (by someone).

Regularists are intent to make two claims about physical laws. The first is that, occasional formulations notwithstanding, physical laws are nonmodal propositions. Regularists must, then, give an account of the modal terms in sentences expressing physical laws in such a way as to

allow that these propositions expressed are not themselves modal. The second claim they want to make is that, although physical laws have countless modal properties (e.g., being logically contingent, being believed), there is no need to ascribe to them any special kind of necessity that Necessitarians postulate as conferring lawful status. For the Regularist, lawful status arises out of a combination of ordinary ingredients such as universality, omnitemporal (eternal) truth, and omnispatial truth. The Necessitarian requires something more, a special, unique kind of law-bestowing necessity: nomological necessity.

There is, however, one kind of necessity, physical necessity, that Regularists will allow attaches to physical laws. But physical necessity is not the Necessitarian's nomological necessity. Physical necessity is a weaker, or degenerate, kind of necessity, a necessity by courtesy perhaps. And it is nothing but this innocuous species of necessity, Regularists say, that is connoted by the occasional use of modal terms (e.g., "must," "can't") in sentences (see, e.g., *E2* earlier in this chapter) expressing physical laws.

Regularists and Necessitarians alike subscribe to the same definition of "physical necessity"[1]:

> Definition**:** "A proposition *p* is **physically necessary** if and only if *p* is implied (entailed) by the set of physical laws."

Introducing **L** to stand for the set of physical laws, and ◩ to stand for the propositional operator "it is physically necessary that," we have:

$$\text{Definition } \blacksquare\text{: } \blacksquare p =_{df} (\exists x_i) \ldots (\exists x_k)[(x_i \in \mathbf{L}) \,\&\, \ldots \,\&\, (x_k \in \mathbf{L}) \,\&\, \{(x_i \,\&\, \ldots \,\&\, x_k) \rightarrow p\}]$$

More perspicuously,

$$\text{Definition } \blacksquare\text{: } \blacksquare p =_{df} \mathbf{L} \rightarrow p$$

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[1] I have throughout this book used "physically" as opposed to the less perspicuous "empirically." The latter connotes, in a way that "physically" does not, an epistemological category. I have even changed the terminology in some direct quotations, in the interests of both stylistic uniformity and philosophical propriety. I am quite sure that by so doing I have in no case distorted the original author's intent. In any event, I have marked each place where I have recast (/paraphrased) a quotation.

Obvious parallel definitions are adopted for "physical possibility" and "physical impossibility":

Definition**:** "A proposition *p* is **physically possible** if and only if *p* is consistent with (the conjunction of) all physical laws."

and

Definition**:** "A proposition *p* is **physically impossible** if and only if *p* is not consistent with (the conjunction of) all physical laws."

I have just spoken of certain *propositions* as being physically necessary, physically possible, and physically impossible, respectively. But there is another equally well-established use of these latter concepts, in which they are attributed to states of affairs, situations, or facts in the world. Thus, for example, one may speak of the (true) proposition that there is a pen on my desk now (at the time of my writing this paragraph) as being physically possible; but equally well, one can speak of my pen's being on the desk as being physically possible. What sort of thing is *my pen's being on my desk*? We are inclined to say such things as "My pen's being on my desk is true," which would suggest that my pen's being on my desk is a proposition; but we are also inclined to say such things as "My pen's being on my desk annoyed my wife who was looking for my pen in the bureau drawer," which, on one reading, would suggest that my pen's being on my desk is a physical state or an event that has causal consequences. (No proposition has causal consequences; they are not the sorts of things that do.)

From a strictly logical point of view, it is propositions that are physically necessary, physically possible, and physically impossible. For these latter properties are defined in terms of the relations of implication, consistency, and inconsistency, respectively, and these latter relations, in turn, obtain only between propositions. But with this acknowledged, there seems to be no good reason not to *extend* the notions of physical necessity, physical possibility, and their like to facts, situations, states of affairs, and their like. Indeed, if ordinary usage were to be our guide to logical reconstruction, we would have to put the logical priorities the other way around, since in ordinary speech we are far more likely to say such a thing as "It is physically possible to put a man on the moon" than we are to say "The proposition that we put a man on the moon is physically possible." (However, the ordinary – if somewhat less likely to be uttered – locution, "It is physically possible that we should put a man on the moon" does suggest our attributing physical possibility to a proposition, rather than to a state of affairs.) No matter. Few of the issues to be discussed subsequently in this book turn in any important way on making this distinction rigid. And so I am content, in most cases, to continue to talk, interchangeably, either of certain propositions or of what it is they describe as being physically possible, impossible, etc. Only in Chapters 10 and 11 will I have to be meticulous in insisting on the correct logical priority.

Physical possibility: Physical possibility is a *different* notion from that (introduced in Chapter 2) of falling under a physical law. Falling under a physical law is restricted to subsets of true conditional propositions and of ordered pairs of true categorical propositions. But the class of propositions that are physically possible includes some single propositions that are categorical, as well as some propositions that are false.

Consider, for example, the true proposition that someone is born in Vancouver on February 27, 1972. This categorical proposition hardly falls under a physical law; but since this proposition is true, it cannot be inconsistent with the members of the class of physical laws since they, too, are all true, and truth is a guarantee of consistency. Hence, this proposition is physically possible.

But truth is not a necessary condition for physical possibility. Someone shakes a pair of dice and rolls a seven. Is it physically possible that he should have rolled an eight? We will return to this sort of question later (in Chapters 5-8, 10, and 11) for a more thorough answer. But, for the moment, we can say that if we describe the unrealized outcome simply as "someone rolls an eight," without further elaboration of the particular circumstances that actually prevailed in the rolling of the seven, then we may say that the latter description, even though false of the actual situation, describes a physical possibility.

Physical necessity: According to Definition ◩, physical necessity may be regarded as a consequential or, to use the more standard term, a *relative* necessity: Whatever logically follows from the set of physical laws will be physically necessary. But of course one of the things that follows from the set of physical laws is each and every one of the physical laws themselves. Thus, according to Definition ◩, each and every physical law turns out – on both the Regularists' and Necessitarians' accounts – to be physically necessary. That is, being physically necessary is a logically necessary condition for being a physical law.

Understood thus, the concept of physical necessity cannot figure in the analysis of the concept of physical lawfulness. Were we to include it, we would make the analysis circular. It is important to understand why this is so; otherwise, there is a powerful tendency to regard physical necessity as just one *more* necessary condition of physical lawfulness alongside such other properties as generality, omnitemporal truth, omnispatial truth, and – perhaps – nomological necessity.

By looking at a parallel case, we can see why physical necessity must be proscribed in the analysis of lawfulness. Suppose we wanted to analyze not the concept of being a physical law,

but instead, let us say, the concept of being evil. Obviously, one of the logical consequences, and hence a logically necessary condition, of being evil is being evil or being rectangular.[2] Yet we should hardly want to reckon *being evil or being rectangular* among the conditions figuring in the analysis of being evil. Were we to do so, the analysis would become circular.[3] In analogous fashion, to make being physically necessary (which just *means,* one recalls, being a consequence of the set of physical laws) a condition in the analysis of physical law, would render that analysis self-defeating.

Nomological necessity: Regularists and Necessitarians both must regard the property of physical necessity as supervenient on the properties figuring in the analysis of physical lawfulness. But the disputants disagree implacably as to what these latter properties might be. For the Necessitarian argues that, in addition to such properties as generality, omnitemporal and omnispatial truth, etc., physical laws have the property of nomological necessity, which is a real, or absolute, necessity, quite unlike relative, physical necessity.

Inasmuch as the Necessitarian's set of physical laws turns out to be a proper subset of those allowed by the Regularist, the Necessitarian's set of propositions that are physically necessary will be correspondingly smaller; and his set of propositions that are physically possible, correspondingly larger. That is, there will be propositions that the Regularist will want to say are physically necessary that the Necessitarian will want to say are not; equivalently, there will be propositions that the Necessitarian will want to say are physically possible that the Regularist will want to say are not.

The debate opens with a clash of powerful, preanalytic intuitions. Eventually, we will have to take account of remote consequences. But, for the moment, we begin by examining a Necessitarian challenge that alleges that the Regularist's theory of physical laws leads to egregiously counterintuitive consequences.

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[2] Concepts, like propositions, have implications. See Bradley and Swartz 1979, 90-1, 240-5.

[3] Being a consequence of, and being part of the analysis of, are, then, different notions. The former subsumes the latter, but not conversely. Indeed, the analysis of most concepts is a small finite set of conditions; the consequence-set, an infinite set.