The Universe Never Had a Chance

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Abstract

Demarest asserts that we have good evidence for the existence and nature of an initial chance event for the universe. I claim that we have no such evidence and no knowledge of its supposed nature. Against relevant comparison classes her initial chance account is no better, and in some ways worse, than its alternatives.
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1 Introduction

Although cosmology, the study of the universe's evolution, has largely become a province of physics, philosophical speculation concerning cosmogony, the study of the origin of the universe, continues up to the present. Certainly, many believe that science has settled this too by way of the well-known and well-confirmed big bang model of the universe. According to the big bang account the universe began in a extremely hot, dense state, composed of all the different manifestations of energy that we know. Indeed, time itself began with the big bang. Yet, properly speaking, the universe's past singularity is not some event in spacetime according to the general theory of relativity. In cosmological models this hot dense state called the big bang is generally understood instead as just a very early stage of the universe's evolution, i.e. properly a part of cosmology and not cosmogony. While we may be highly confident that the entire big bang story is correct back to a very early time, our confidence should at some point decrease as we near the supposed "first moment". Thus there remains world enough and time to engage in traditional philosophical and scientific speculations about cosmogony and cosmology alike. Were there previous stages to the universe? What brought the universe into existence? What was the character of this initial happening (should it in fact exist)?

The ubiquity of probabilities in modern physical theories, e.g. quantum mechanics and statistical mechanics, has led some to wonder as well how chance should fit into our

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cosmogonical worldview. In this vein, Demarest (2016) argues that the probabilities of all events in a(n ostensibly) deterministic universe can be derived from an initial chance event and, what's more, that "we have good evidence of its existence and nature." In this paper I aim to dispute these latter claims. I argue that we do not have any evidence at all of an initial chance event in a big bang universe as described above, much less of its nature. What we rather have in Demarest's account is just a particular way of interpreting probabilistic theories, where all probabilities are taken to derive from ontic chances pertaining to the particular genesis of the relevant physical system, e.g. the universe as a whole. I claim that this interpretation, while coherent, should be disfavored in cosmology—we should rather say that *the universe never had a chance*.[1] Along the way I will make several clarifying remarks concerning the relation of chance and determinism, cosmological probabilities, and alternative interpretations of statistical and quantum mechanics.

2 Chance and Determinism in Physical Theory

By the *world* metaphysicians usually mean something like "the maximally inclusive entity whose parts are all the things that exist." Of course terminology varies. This particular rendering comes from Schaffer (2010, 33), who instead chooses to call this entity the *cosmos*. Cosmologists do not usually call their object of study the cosmos; more commonly they say that they study the *universe*. In *Cosmology: The Science of the Universe*, Harrison explicitly notes the philosophical and historical dimensions of the world taken in its broadest sense, designating this world as a whole the *Universe*. Cosmology, according to Harrison, is the study of universes, by which he means particular models of the Universe (Harrison, 2000, Ch. 1). Cosmological models are the particular concern of physical cosmologists; they are physical models of the Universe, which describe especially its large-scale structure and the evolution thereof.

In what follows I employ these terminologies in the following way. By the *world* I designate the locus of (principally) metaphysical questions concerning the Universe. Is the world deterministic? Is it chancy? By the *universe* I designate the locus of principally physical questions concerning the Universe. How did the big bang universe begin? How will it end? These are questions to which the big bang model should provide an answer.

I do not mean, of course, to introduce an admittedly arbitrary distinction between science and metaphysics by differentiating universes and worlds. Indeed, when one asks whether the world is deterministic, many metaphysicians of science would look first to models of the Universe to help decide the question. Wüthrich for example remarks, matter-of-factly, that "this metaphysical question deflates into the question of whether our best physical *theories* entail that the world is deterministic or indeterministic" (Wüthrich, 2011, 366).

[1] There are several senses, in fact, in which this claim is true. Cosmology suggests that the inevitable fate of the universe is to become ever more sparse and empty through the accelerated expansion of space under the influence of dark energy.

Indeed, many discussions of determinism adopt the approach mentioned by Wüthrich. Let *determinism* denote the thesis that the world is deterministic. Then, following for example (Lewis, 1983, 360), a world is *deterministic* if and only if the laws of that world are deterministic. To determine whether the laws of the universe are deterministic, we must look to our theories of which those laws are part and ask whether those laws taken together should be considered deterministic. It is by no means a straightforward matter to decide whether a given physical theory is deterministic of course. Even the classic example of deterministic physics, Newtonian mechanics, admits many counterexamples against its putative determinism (Earman, 1986; Norton, 2008). General relativity as well seemingly permits indeterministic phenomena in the form of causal pathologies (closed timelike curves) (Earman, 1995) and, if the hole argument is to be believed, is hopelessly rife with indeterminism (Earman and Norton, 1987).

Although classical theories like classical mechanics and general relativity are nevertheless debatably deterministic, surely probabilistic theories like quantum mechanics are properly characterized as indeterministic (at least so long as the probabilities involved are objective features of the world). Yet various interpretations of probabilistic theories seek to avoid indeterminism even here, where it seems unassailable, by characterizing probabilities as merely epistemic or subjective, or else by presenting them as fully deterministic theories (as in the Bohmian interpretation of quantum mechanics). Philosophers have raised serious concerns, however, over how one can truly understand probabilities in deterministic theories, an issue that has been termed the "paradox of deterministic probabilities" (Loewer, 2001; Winsberg, 2008; Lyon, 2011) in statistical mechanics, since objective probabilities seem to entail indeterminism necessarily.

The most well-known and successful reconciliation of chance and determinism in the context of statistical mechanics is defended by Loewer (2001). It is seldom recognized by interpreters, however, that there is no reconciliation in the sense of simultaneous compatibility between chance and determinism. The world cannot both be chancy and deterministic as a matter of metaphysical fact. As Lewis writes, "to the question of how chance can be reconciled with determinism, or to the question of how disparate chances can be reconciled with one another, my answer is: *it can't be done* (Lewis, 1986, 118). This is because chance entails indeterminism, the contrary of determinism. Thus, insofar as the probabilities of statistical mechanics and quantum mechanics are objective, these theories are indeterministic theories. Loewer's account actually shows us how deterministic laws can co-exist with indeterministic laws within a theory. The source of all probabilities in statistical mechanics, according to Loewer, is in an initial chance distribution over microscopic states of affairs. After the initial time these states of affairs evolve deterministically. Note that although for almost all times evolution is deterministic, it is not so at all times. There is an initial chance event, which is where the indeterminism of the theory appears. A deterministic theory is, recall, a theory whose laws are deterministic, not a theory whose laws are mostly deterministic or operate deterministically for almost all times.

Loewer's account is also presented in terms of Humean chances, so he does not believe

these chances and laws actually exist. According to the modern Humean, they merely are the result of the best systematizations of the occurrent facts, in keeping with Lewis's "best systems account" of laws and chances. Demarest, however, offers a small tweak to Loewer's Humean account by invoking a "robustly metaphysical account of chance" (Demarest, 2016, 256). She claims that such chances are compatible with determinism, and indeed they are when, as said, compatibility is understood to pertain to the co-existence of indeterministic and deterministic laws in a single theory—which, however, do not operate at the same time.[2]

Demarest's central claims are that this initial chance event exists and that we have good evidence for it. I dispute these claims in the remainder of the paper.

To begin, it is not so clear what exactly Demarest takes the evidence for the initial chance event to be. She does contrast the evidential position of her view with the Humean view of Loewer, claiming that, "for the Humean, the statistical patterns in the world are not evidence of an initial chance event" (Demarest, 2016, 261)—presumably this is so because Humeans reject the metaphysics of chance for the usual Humean reasons. One might suppose, then, that she believes that statistical patterns in the world are evidence of an initial chance event for all those who do not share the Humeans ontological worries. Let us accept, for the moment then, that statistical patterns may be *some* evidence for the existence of chances, for it is difficult to see what other evidence there might be for an initial chance event. In that case, on what grounds might we say that statistical patterns are good evidence for initial chances? I consider a series of three salient contrast classes.

First, do statistical patterns in data provide good evidence for indeterministic (i.e. chancy) theories *rather than deterministic theories*? It would seem that the answer is: not necessarily. (Werndl, 2009), for example, argues for the observational equivalence of indeterministic theories and deterministic theories. If one could contrive a fully deterministic theory that reproduces the same statistical patterns of the relevant phenomena observed in nature, then it would seem that such patterns provide no better evidence for the indeterministic theory than the deterministic one. However, since the theories under discussion, statistical mechanics and quantum mechanics, are generally characterized as indeterministic, let us flag but set aside the possibility of fully deterministic alternatives to them.

So, second, do statistical patterns provide good evidence for initial chances *rather than non-initial chances*? It would seem that the answer is firmly: no. There is a variety of ways one could implement chances into a probabilistic theory like statistical mechanics. All one must do, as Loewer shows us by example, is neatly separate when the indeterministic laws are operative and when the deterministic laws are operative. Loewer chooses to locate all the indeterminism in one place—the initial time—but one could equally locate it at another time, at many times, or even all times. Statistical mechanics does not wear its interpretation on its sleeve, just as quantum mechanics does not decide between solutions of the measurement problem, whether initial chances as in Bohmian mechanics or collapse

[2]Still, it is worth emphasizing that her claim that her account applies to deterministic worlds is false, for chancy worlds are not deterministic.

dynamics as in GRW (discrete time collapses) or CSL (continuous collapses). Unless there are evidential reasons to favor one implementation of indeteterministic probabilities over the others, there is not good evidence for an initial chance event. Certainly statistical patterns in nature will not do so.

Third, do statistical patterns provide good evidence for "robustly metaphysics" chances *rather than Humean chances*? It seems as if this might Demarest's intended contrast class, since much of the discussion in the paper concerns the Humean account. I will have something to say about the relative merits of Demarest's non-Humean account and Loewer's Humean account at the end of the next section. In any case though, it does not seem as if statistical patterns decide the matter in Demarest's mind, for she repeatedly demurs in the face of Humean responses to the considerations she raises, claiming only to offer an alternative "for philosophers who are antecedently sympathetic to governing laws of nature or powerful properties" (Demarest, 2016, 261-2). She finds it "plausible to think of the universe as having an initial state and as producing subsequent states in accordance with the laws of nature (some of which may be chancy)" (Demarest, 2016, 261). Such metaphysical intuitions are not grounded on observations of statistical patterns. Statistical patterns do not have any evidential bearing on the metaphysical dispute between the Humean and non-Humean.

Therefore, based on my canvassing of relevant alternatives, I conclude that we in fact do not have good evidence for an initial chance event, where evidence is interpreted in terms of statistical patterns (or in any usual sense of the term "evidence"). At best we have a motivation to attend to indeterministic theories when our evidence displays statistical patterns. It is another matter entirely to decide how to implement probabilities in that theory.

That said, Demarest's reasoning could be interpreted at points as invoking explanatory considerations as justification for the initial chance interpretation. Insofar as one considers "what justifies" as constituting evidence, perhaps these explanatory considerations should be counted as evidence.[3] Nevertheless, it does not look, on the face of it, like we have good evidence for an initial chance event still. Repeating the three cases considered before: deterministic and chancy theories can both serviceably explain statistical evidence; alternative implementations of chance in interpretations of indeterministic theories explain statistical evidence equally well; Humean and non-Humean metaphysics each render a story for how statistical patterns come about (merely subjective intuitions notwithstanding). Without explicit explanatory reasons to prefer one of these alternatives to the other, reasons lacking in Demarest's argument, good evidence (in this wider sense) for an initial chance event remains elusive.

[3]There are obvious dangers with going to far in this direction. Suppose that the Supreme Being explains all. Then it would appear that we have very good evidence of Its existence, which is obviously absurd.

3 Chance and Determinism in Systems of the World

In the previous section I gave reasons to doubt Demarest's claims about an initial chance event and our evidence for it. I disputed especially that we have evidence for it and did so by comparing it to alternatives of three different kinds. In the first case I characterized the issue (in part) as a matter of theory choice, namely of choosing between an indeterministic and deterministic theory. In the second case I characterized the issue as a matter of theory interpretation, namely of interpreting between different ways of implementing probability in a theory that does not decide one way or another on how this must be done. In the third case I characterized the issue as a matter of metaphysics, namely of deciding between the ontological status of chances.

In this section I consider more broadly whether there are any reasons to favor Demarest's interpretation, in particular in the sense of the just given second characterization of the issue. The question is whether the world should be thought to have an initial chance event, when one might consider that it is chancy in various other ways, e.g. its laws of evolution themselves are always probabilistically indeterministic.

First of all, it is worth mentioning that from the point of view given by the contemporary standard model of cosmology this question is moot. The so-called ΛCDM model, a development of the older standard big bang model, is a model of the general theory of relativity, a theory which makes use of no probabilities at all in its basic description of gravitating systems (including the universe). In this different sense it is also true that the universe never had a chance.

Demarest is not particularly interested in cosmology or the universes of general relativity however. She is concerned with probabilistic theories like classical statistical mechanics and quantum mechanics as applied to the world at large. We should, that is, imagine a statistical mechanical universe or a quantum mechanical universe (never minding that no concrete such model exists in physics that describes our universe) as a conceptual possibility when asking metaphysical questions about the world. Given the different ways of implementing probabilities in such a universe, we should ask whether one way is preferable to the others.

I should point out that this is not Demarest's question, for she explicitly restricts attention to "deterministically evolving worlds". Of course these worlds are not actually deterministic so long as the probabilities involved are chances. Nevertheless, unaffected by that fact is one of her central points: "that positing just one initial chance event can justify the usefulness and explain the ubiquity of nontrivial probabilities to epistemic agents like us, even if there are no longer any chance events in our world"(Demarest, 2016, 249). I say: so can a lot of other ways of conceiving chance in these theories. It is therefore necessary to compare them if we are to take Demarest's (and Loewer's) account seriously.

For present purposes, I am happy to agree with Demarest that the initial chance account can indeed justify and explain nontrivial probabilities used to describe subsystems of the universe.[4] But is it a good explanation? Is it worth believing?

[4]Notwithstanding pressure to move in this "global" direction in statistical mechanics (Callender, 2011)

The initial chance account invites the oft-invoked (in cosmology) picture of the (blind and unskilled) Creator throwing a dart (Wald, 2006, 396) or pointing a pin (Penrose, 1989, 442) at the set of possible universes, thereby picking out the initial conditions of the universe. That such pictures are intended as pejorative jabs at dubious metaphysics is plain. A mere picture is hardly an objection, of course, so what is it that seems problematic about initial chances for the universe? Could it not be the best cosmogonical story of our universe, that is, that a matter of chance determined its actualization out of a vast range of possibilities that could have been actualized had only their sisal been struck?

Intuition suggests that this just is not a serious, satisfying story for how the world could be. The probabilities of events in the actual world would derive ultimately from the probabilities for the actualization of our world. But why should we not just assume that the world started in the state that it did, with probability one or with certainty? Presumably the response of the initial chance advocate is that in that case we would lose the justification and explanation of subsystem probabilities. Yet is there anything to lose, if this metaphysical explanation is epistemically untrustworthy? How can we come to know these ultimate probabilities of other worlds? Is the metaphysical story sufficiently complete even? How could the probabilities of other worlds matter for what happens in *our* world?

I am willing to grant that these questions do have some answer, for what strikes me as a more serious difficulty is the following. Insofar as they are objective and justified, the probabilities agents like us use for specific events in subsystems of the world must be epistemic probabilities. On Demarest's (and Loewer's) account all such epistemic probabilities derive from initial epistemic probabilities for different initial conditions of the world. How is it that these probabilities obtain their needed objectivity and justification, and hence explanatory power? According to Demarest it is because they accord with the actual chances. However, what has one achieved by invoking "actual chances" at this stage? Although these chances do not merely have a *virtus dormitiva* per se, "just so" stories like this surely make the explanatory credentials of chances suspect. Does one dare invoke a transcendental argument or thump the realist table to defend their objectivity?

If we were somehow forced to adopt the initial chance explanation of epistemic probabilities, then we might swallow whatever dubious metaphysics attendant to it. If there were reasonable alternatives, however, should we not prefer them? And indeed there are other interpretive options available. Locating the chances at another time (or even "outside the universe") constitutes one set of possibilities, but they obviously suffer from the same awkwardness as the initial chance account. Another is based on the idea that chancy behavior occurs at discrete time intervals. One finds this idea in the orthodox Copenhagen and other collapse interpretations of quantum mechanics for example. One might be uneasy with the invocation of chancy behavior at potentially ill-defined times in such interpretations, and even with their postulation of two dynamical laws of nature, a deterministic one and an indeterministic one (although it is a feature of the initial chance account as well). However one at least avoids a commitment to chance figuring into

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(and quantum mechanics) in order to justify and explain probabilities in subsystems of the universe, serious reservations about whether doing so is itself justified are advanced by, inter alia, Earman (2006).

cosmogenesis and also the questionable leap to objectivity in agential probabilities, since chances in these interpretations are physical processes that happen within the universe, whether as part of the general evolution of the universe or tied to the evolution of individual systems.

Another possibility is suggested by continuing this line of thought, i.e. of spreading chanciness out further in time. Instead of chancy behavior at discrete intervals, why not suppose that it occurs continuously? In quantum mechanics this idea is implemented in some interpretations, such as continuous spontaneous localization, and in statistical mechanics there are various stochastic dynamics approaches. Advantages of this idea are that one has a single law of evolution, an indeterministic one, and, again, one does not make chanciness a matter of cosmogenesis. What disadvantage? To some that it makes the world rife with indeterminism. Yet who is afraid of indeterminism? It surely does not mean anything goes, nor does it threaten the possibility of knowledge of the world (although there are limits to what we can know). Besides, by accepting quantum mechanics (or even statistical mechanics) we have already let indeterminism in the door in physics.

When we look at the interpretations available for a world governed by probabilistic laws, in every case the alternatives to the initial chances view therefore appear preferable. Indeed, it would seem that only one who demands that the world be as deterministic as possible could favor the initial chances view, but it is hard to see what motivation there could be for that demand. I therefore conclude, in a final sense, that *the universe never had a chance*.

That said, I emphasize that this judgment applies only to the case where we treat the universe as a statistical mechanical system or quantum mechanical system. In other words, the world is the universe, our world-metaphysics is our universe-metaphysics. The considerations leading to this conclusion change shape somewhat when we confine the application of our theories to systems describable by those theories. The initial chance account is far less dubious when attached to individual statistical mechanical systems and not automatically to the universe at large. Indeed, it could well be that the initial conditions of similar systems are best treated as randomly distributed, for here we do have empirical evidence that this interpretation can be used to explain—unlike with the universe, where we have but one system.

There is, as noted, sometimes pressure to globalize our theories, especially in the case of statistical mechanics. If we ask what accounts for the randomness in initial conditions of a particular class of systems, it is natural to look at larger systems that contain them. If we find that these systems have random initial conditions, then we continue to expand our scope, ultimately reaching the "maximally inclusive entity whose parts are all the things that exist." This globalization of statistical mechanics is the kernel of the so-called imperialism of (Albert, 2000) and Loewer. If we are right to feel this pressure to interpret the world at large in the same terms as individual physical systems, then there is concomitant pressure to hold the same interpretive of chance in both cases. I have argued, however, that the intuitive considerations vary somewhat, at least with respect to the initial chance account. Is this reason to disfavor it in the case of individual systems? Or is our confidence in its applicability for individual systems sufficient to overcome any hesitation at

accepting it for the universe? My inclination is to answer "yes" and "no", but I offer no grounds for the preference here. I do believe that metaphysicians of science should care about considerations like this, however, having to do with the relation of subsystem and universe, for often enough what seems right in one context is questionable in the other.

I close this section with a brief comment on the relation of Loewer's and Demarest's accounts. As I argued above, empirical evidence and explanatory considerations do not favor one over the other, since they account for empirical evidence in essentially the same way. The central difference is whether chances are understood as reducible to other facts, hence not part of the fundamental ontology of the world, or as "robustly metaphysical", in which case they are. The problems Demarest mentions for the Humean view—past events may have nontrivial chances, the chance of an event depends on what one knows, worlds with identical frequencies cannot have different chances, etc.—are surely not problems when viewed properly through the Humean lens. However, whereas the problem I raise for the initial chance view, concerning the explanatory credentials and justification for the posit of initial chances, threatens Demarest's account, it will not worry the Humean of Loewer's stripe, for these initial chances do not exist for the Humean. Humean chances do not produce or generate any actual states of affairs. Of course one may raise the usual complaint against the Humean, that there is a circularity in the Humean account involving descriptions explaining themselves, and others besides. I do not care to enter into this debate here of course. I only wish to point out that my argument about how chance can fit into a cosmogonical worldview appears to give some reason to favor the Humean account in this particular context.

4 Conclusion

In this paper I considered whether we should think that the world had one chance, as claimed by Demarest. First I considered her claim that we have good evidence that an initial chance event occurred by contrasting it with relevant classes of alternatives. I argued that evidence neither favors a chancy theory over a chanceless theory, nor initial chances over other implementations of chances, nor metaphysically robust chances over Humean chances. I concluded, therefore, that we do not have good evidence to adopt the initial chance account.

I then considered whether there were other reasons to favor or disfavor the initial chance account. I argued that the dubious nature of worldly chances provides a strong impulse to look for other accounts that do not make chance a matter of cosmogenesis. The other implementations did not suffer from this defect, so I suggested that from a cosmogonical perspective they should be preferred. But the relation of the universe and its subsystems makes a demand to have a consistent interpretation. As the initial chance account looks favorable on the subsystem level (to many) and not on the universe's level (as I argued), there remains a significant metaphysical tension to be resolved.

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