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Whose Design? Physical, Philosophical and Theological Questions Regarding Hawking and Mlodinow's Grand Design

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Stephen Hawking and Leonard Molodinow's (HM) *The Grand Design*[1] faces some of the big questions of the human thought: "Why is there something rather than nothing? Why do we exist? Why this particular set of laws and not some other?" (p. 10, p. 171). Their answer is rooted in the concepts of "scientific determinism" (p. 30, p. 34) and "model-dependent realism" (p. 7). According to this epistemological view, "our perception—and hence the observations upon which our theories are based—is not direct, but rather is shaped by a kind of lens, the interpretive structure of our human brains" (p. 46), so "a well-constructed model creates a reality of its own" (p. 172).

This background helps to understand some of the most controversial assertions of the book. In physics, scientists may prefer one model from another when the former explains more experiments and does it better.

[1] Hawking, Stephen, and Leonard Mlodinow. 2010. *The Grand Design*. New York: Bantam Books.

However, once we have the same explanatory power for different models, there is neither possibility nor need to make a decision among them. Reality becomes a 'model-dependent reality'. Now, HM's claim is that M-theory—"candidate for the ultimate theory of everything" (p. 8)—would already be able to explain and predict all physics involved in the universe, as well as their origin. With this explanation, God is no longer necessary. Of course, everybody is free to continue having this belief/ or "his/her faith" within his/her model-dependent reality.

Quantum Mechanics and the strong version of the anthropic principle are the main ingredients for the self-explanation of the universe. "Like a particle, the universe doesn't have just a single history, but every possible history, each with its own probability; and our observations of its current state affect its past and determine the different histories of the universe, just as the observations of the particles in the double-slit experiment affect the particles' past" (p. 83). It is then the very presence of human observations of the universe what selects its adequate past, in a (sort of) self-consistent process.

Certainly, "when the beings on a planet that supports life examine the world around them, they are bound to find that their environment satisfies the conditions they require to exist […]. Our very existence imposes rules determining from where and at what time it is possible for us to observe the universe. That is, the fact of our being restricts the characteristics of the kind of environment in which we find ourselves" (pp. 153–154). This principle is called the 'weak anthropic principle'. However, for HM, "a better term than 'anthropic principle' would have been 'selection principle', because the principle refers to how our own knowledge of our existence imposes rules that select, out of all the possible environments, only those environments with the characteristics that allow life" (p. 154). To sum up: "The fact that we exist imposes constraints not just on our *environment* but on the possible *form and content of the laws of nature* themselves" (p. 155).

The most precise way in which the physics of the entire process works is described in p. 180: "Because gravity shapes space and time, it allows space-time to be locally stable but globally unstable. On the scale of the

entire universe, the positive energy of the matter *can* be balanced by the negative gravitational energy, and so there is no restriction on the creation of whole universes. Because there is a law like gravity, the universe can and will create itself from nothing [...]. Spontaneous creation is the reason there is something rather than nothing, why the universe exists, why we exist. It is not necessary to invoke God to light the blue touch paper and set the universe going".

Last but not least, the grand design of M-theory changes our understanding of free will: "Though we feel that we can choose what we do, our understanding of the molecular basis of biology shows that biological processes are governed by the laws of physics and chemistry and therefore are as determined as the orbits of the planets [...]. It is hard to imagine how free will can operate if our behavior is determined by physical law, so it seems that we are no more than biological machines and that free will is just an illusion" (pp. 31–32). Of course, "since we cannot solve the equations that determine our behavior, we use the effective theory that people have free will" (p. 33). In fact, HM say "that any complex being has free will—not as a fundamental feature, but as an effective theory, an admission of our inability to do the calculations that would enable us to predict its actions" (p. 178). Since I will not refer to the question of free will until the last part of my article, let me point out here that there *is* a way to differentiate the human mind from an algorithmic Turing machine.[2] HM do not make any mention of it.

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HM's book has a large number of inexact claims. Sometimes the authors seem to simply express a wish: "Philosophy is dead" (p. 5). Others, they neglect the antique and medieval thinkers: "The Ionian idea that the universe is not human-centered was a milestone in our understanding of the cosmos, but it was an idea that would be dropped and not picked up again, or commonly accepted, until Galileo, almost twenty centuries later" (p. 22).

[2] See, e.g., Ch. 4 in Penrose, Roger. 1989. *The Emperor's New Mind. Concerning Computers, Minds, and the Laws of Physics*. Oxford: Oxford University Press.

In addition, they misinterpret the history of thought: statements which say Aristotle rejected the idea of science based principally on observation (cf. p. 23), and "suppressed facts he found unappealing and focused his efforts on the reasons things happen, with relatively little energy invested in detailing exactly what was happening" (p. 24) are mistaken, as well as saying that "among the heresies [condemned by Tempier] was the idea that nature follows laws, because this conflicts with God's omnipotence" (p. 25). However, sometimes they simply are badly uninformed, since Galileo was not convicted for heresy (cf. p. 87).

We can also find internal contradictions along different argumentations. Within the framework of the M-theory (of everything), saying that "decisions are often not rational" (p. 33) or that "simplicity is a matter of taste" (p. 39) would be meaningless, because one has no basis to make such distinctions. Similarly, when HM claim that "according to model-dependent realism, it is pointless to ask whether a model is real, only whether it agrees with observation. If there are two models that both agree with observation […], the one cannot say that one is more real than another. One can use whichever model is more convenient in the situation under consideration" (p. 46), one should ask what does the word 'convenient' mean in this global theory. On the other hand, the explanation may be tough, as the difference between the bottom-up and the top-bottom approaches (cf. pp. 139–140), or may present, a more subtle internal contradiction. For instance, what is the criterion to distinguish —as they certainly do— between the local and the global scale of the entire universe in p. 180? If "we are the product of quantum fluctuations in the very early universe" (p. 139), how is it possible that, as stated before, the presence of human beings selects the universe which we inhabit? Who is who's product? Even HM's analogy between the selection of universes and the natural selection of evolution in biology is flawed, because evolution develops through transitions among actual species, while HM's book does not explain how the universe that we dwell in turns out to be fixed in its physical laws.

Misleading assertions can also be found from a scientific point of view. The claim that the anthropic principle can be used to make predictions

(cf. p. 154) is irrelevant for the main issue of the book, since it does in the same manner that we can predict a star's age or formation when we know about its composition. HM seem to forget the precise causality limits given by the null cones in Minkowski space when they affirm that: "In space-time, time is no longer separate from the three dimensions of space, and, loosely speaking, just as the definition of left/right, forward/backward, or up/down depends on the orientation of the observer, so too does the direction of time vary depending on the speed of the observer" (pp. 99–100). Unproven assumptions are frequent. We can offer three examples: (a) "So though we do not yet have a complete quantum theory of gravity, we do know that the origin of the universe was a quantum event" (p. 131). However, Penrose presents a model for a Big Bang stemming from a smooth transition between aeons, where quantum gravity is not invoked; the assumption of finite Weyl curvature being enough[3]. (b) "Once we add the effects of quantum theory to the theory of relativity, in extreme cases warpage can occur to such a great extent that time behaves like another dimension of space" (p. 134). This simply remains to be proven within such an up-to-date lacking theory. (c) "For a theory of gravity to predict finite quantities, the theory must have what is called supersymmetry between the forces of nature and the matter on which they act" (pp. 180–181). But this needs not to be the case[4].

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Let's enter now into a deeper criticism of HM's basic ideas in their grand design. Regarding physics, the authors invoke (cf. pp. 55–58) the well-known wave-particle dualism to defend their model-dependent realism and their assumption of an all-encompassing M-theory, which gathers all different partial theories explaining different aspects of reality. Now, while the wave-particle dualism is well explained by Quantum Mechanics, as a better theory in which either the wave or the particle behavior can be

[3] See, e.g., Ch. 3.5 in Penrose, Roger. 2010. *Cycles of Time. An Extraordinary New View of the Universe*. London: The Bodley Head.

[4] As, e.g., stated in chapters 32–33 of Penrose, Roger. 2004. *The Road to Reality. A Complete Guide to the Laws of the Universe*. London: Jonathan Cape.

retrieved within proper limits, M-theory remains currently a mysterious theory, much more unknown than the more elemental string theories from which it is supposed to be formed.

However, let's imagine that M-theory has already acquired the level of a respected theory for everything. Is this really true? Does M-theory really explain all the experimentally-accessible reality? Does it explain, for instance, the Second Law of Thermodynamics or the very notion of entropy? It is remarkable that along the 198 pages of the book, the concept of entropy is absent. HM acknowledge that "for our theoretical models of inflation to work, the initial state of the universe had to be set up in a very special and highly improbable way. Thus traditional inflation theory resolves one set of issues but creates another—the need for a very special initial state" (pp. 130–131). Though, "that time-zero issue is eliminated in the theory of the creation of the universe we are about to describe" (p. 131). It is strange not to find a single word or reference on the estimate given by Penrose about the degree of 'specialness' of that initial state, given the Bekenstein-Hawking formula for the entropy of a black hole[5].

Of course, HM are free to assume the Hartle-Hawking (HH) "no boundary condition" as their favorite initial condition for the path integral over universe histories. Nevertheless, since this technique involves the Euclideanization of the theory, some words might have been said on the problems of the eventual analytic continuation of the final solution. Perhaps this calculation, implemented with the requirements of the strong anthropic principle, might offer a self-consistent, smooth, and habitable universe. But even then, it has to be noted that M-theory is misinterpreted as *the* ultimate scientific explanation; it has to obey the ubiquitous Second Law. The putative generic origin of the universe—via the HH no boundary condition—turns out not to be such. The initial state is still special from the thermodynamic point of view, and remains to be explained.

HM's proposal has obviously profound epistemological consequences. But some questions about terminology must be posed before. First: do par-

[5] See (Penrose 1989, Ch. 7; 2004, Ch. 27; 2010, Ch. 2.6).

ticular histories of the universe exist or do they not? Second: Why are these histories sometimes called 'universes,' instead of 'possible histories of the universe,' that compose the quantum superposition of the universe wave-function? Third: What is the epistemological difference among the laws of nature—seemingly different from one history to another—and the omni-present M-theory? Why does M-theory itself remain unchanged, as a sort of "goddess" or divine theory? The epistemological level of the M-theory must be clarified, if "regarding the laws that govern the universe, what we can say is this: There seems to be no single mathematical model or theory that can describe every aspect of the universe" (p. 58).

According to HM, "people are still trying to decipher the nature of M-theory, but that may not be possible. It could be that the physicist's traditional expectation of a single theory of nature is untenable, and there exists no single formulation. It might be that to describe the universe, we have to employ different theories in different situations. Each theory may have its own version of reality, but according to model-dependent realism, that is acceptable so long as the theories agree in their predictions whenever they overlap, that is, whenever they can both be applied" (p. 117). Now, the question is: can a theory which fails to explain the differences and overlaps of less fundamental theories be the theory of everything? "The laws of M-theory therefore allow for *different universes* with different apparent laws, depending on how the internal space is curled" (p. 118). However, are we sure at this point about what a law is and what is not? For instance, is the principle of quantum superposition a law? May it be changed depending on the way internal dimensions are curled? If not, is it some sort of 'superlaw'? What distinguishes a law and a superlaw? One finds throughout HM's grand design a denial of their claim that "the original hope of physicists to produce a single theory explaining the apparent laws of our universe as the unique possible consequence of a few simple assumptions may have to be abandoned" (p. 119). In fact, what they come to say is that "M-theory is the *only* candidate for a complete theory of the universe. If it is finite—and this has yet to be proved—it will be a model of a universe that creates itself [...]. M-theory is the unified theory Einstein

was hoping to find" (p. 181). In short, we find internal inconsistencies on epistemological grounds.

It is also necessary to discuss the book's philosophical statements. HM continuously use the term 'nothing' as equivalent to the ground state of empty space. Of course, their 'nothing' has 'something,' because 'vacuum' is not 'nothing'. HM claim that "M-theory predicts that a great many universes were created out of nothing. Their creation does not require the intervention of some supernatural being or god. Rather, these multiple universes arise naturally from physical law" (pp. 8–9). It is then unclear whether the multiple universes arise either out of nothing or from physical law. Are they perhaps identifying their 'nothing' concept with the empty space? The answer seems to be irrelevant since, as they point out: "An important consequence of that [the Heisenberg uncertainty principle] is that there is no such thing as empty space" (p. 113). This is a very important claim, because it implicitly acknowledges that Physics does not deal with concepts like 'nothing.' In other words: Physics needs a physical reality to study, and the ultimate answer to the question "why is there a universe?" (p. 123) does not belong to the realm of Physics. Nevertheless, HM insist "that is possible to answer these questions [why is there something rather than nothing?; why do we exist?; why this particular set of laws and not some other?] purely within the realm of science, and without invoking any divine beings" (p. 172). But, after reading the book, one might still ask: Who created the law of gravity? Who created M-theory? If these laws need not be created, they seem to be divine by themselves. So the universe would simply be the expression of an absolute divine law. But has Physics, as a science, anything to say about divinity? HM are in my opinion right when they claim that God is not necessary to light the universe on. However, God is necessary at a deepest, transcendental level that they neglect.

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Yet, the reader may think: All right. But philosophical criticisms are not so important. What if they guess correctly after all? Let me explain from the very grounds of the physics we know up to date why their main argument is flawed.

HM's book contains several arguments based on a *petitio principii*. For instance: "Our presence selects out from this vast array only those universes that are compatible with our existence" (p. 9). We humans must select something that is compatible with our existence. But do we not already exist? If a living conscious being is to determine the universe in which it lives, it has to exist; but it does not exist until the universe has been determined by the existence of itself (!) So, the flaw of the argument is: how do I myself come to existence within a universe that is determined by my own existence? That is a philosophical *petitio principii*. It is definitely a circular argument.

Of course, one could still argue that this argument is just a way to show the self-consistent process of the universe expressing itself. This is correct. But then, another problem arises, for we can discover the 'existence' of other universes, there is a clear-cut difference between what my physical presence does and what my mind can know. HM cannot avoid dualism. Actually, this problem points to a more radical quantum measurement paradox. If our human observation selects the histories which are consistent with our physical presence, where does the reduction of the universe wavefunction come from? There are only two possibilities: (a) If it is due to human consciousness, this one has to be originated within one of the possible evolving histories. Then, why is human consciousness special (responsible for the wavefunction collapse)? (b) If it is because of a physical process, it's no longer true that "we create history by our observation" (p. 140). What HM are claiming would imply to have solved the measurement problem of Quantum Mechanics. If so, they should not be silent on it. If it is not so, HM's main argument is flawed because they are omitting the explanation about how the different paths for the multiverse reach reality.

Another interesting question which HM do not touch upon is the following. Along with the fine tuning of many physical constants 'to produce life', there are many other measurements in the universe with no direct or relevant interest to do so. Therefore, if everything is the way it is because of us, sentient and conscious beings, what is our measurable influence in those measurements that turn out to be irrelevant for life? In short, if the

universe is the work of man, then it should show his mark everywhere, *which is precisely what we do not observe*; rather, we observe something that has to have a design[6]. Perhaps David J. Bartholomew is right and chance, together with the laws of probability, is the subtle way God has to introduce purpose in the universe[7].

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Undoubtedly, HM's grand design has good points and good scientific intuitions. They present the need of the three spatial dimensions for having stable elliptical orbits (cf. pp. 160–161). They affirm quite properly that "general relativity has transformed physics into geometry" (p. 102) and they admit the mathematical weakness of the renormalization techniques (cf. p. 107). Occasionally, they even show correct epistemological arguments regarding, e.g., the Big Bang theory: "Although one can think of the big bang picture as a valid description of early times, it is wrong to take the big bang literally, that is, to think of Einstein's theory as providing a true picture of the *origin* of the universe" (pp. 128–129).

Some of their more controversial statements might even push for a better philosophical and theological understanding of the creation concept: "The realization that time behaves like space presents a new alternative. It removes the age-old objection to the universe having a beginning, but also means that the beginning of the universe was governed by the laws of science and doesn't need to be set in motion by some god" (p. 135). This statement could be shared by a philosophical point of view where God is not an efficient, but a transcendental (first) cause of the universe. Perhaps, "when one combines the general theory of relativity with quantum theory, the question of what happened before the beginning of the universe is rendered meaningless" (p. 135). HM could be right if, indeed, the very

[6] See, e.g., Rhonheimer, Martin. 2008. "Teoria dell'evoluzione neodarwinista, Intelligent Design e creazione. In dialogo con il Cardinal Christoph Schönborn." *Acta Philosophica* 17: 87–132.

[7] See Bartholomew, David J. 2008. *God, Chance and Purpose. Can God Have It Both Ways?* Cambridge: Cambridge University Press.

idea of origin of the universe guides directly to God. Because it does not, the origin of the universe stays beyond the HM's perspective as a sort of meaningless question.

HM, somehow, pose an important issue when they observe that "our universe and its laws appear to have a design that both is tailor-made to support us and, if we are to exist, leaves little room for alteration. That is not easily explained, and raises the natural question of why it is that way" (p. 162). In a sense, their book is very valuable, for it raises awareness of the level of serendipity involved in the evolution of the universe (cf. pp. 159–161). However, the main problem is that their central arguments are flawed and their final conclusions deceptive: there is undoubtedly (as Hoyle would say) a deliberate design in the laws of physics... but for HM it is only ours! As a matter of fact, these arguments are even starting to create fancy literature[8].

From a theological perspective, the strong anthropic principle assumed by HM is the opposite of perceiving God "in what he has made" (Rom 1:20). God is substituted by man. It's us, men, who are ultimately responsible for the form the universe has. Pity for the universe and pity for us! But why pity? We did it, right? So pity is also a consequence of our conscious being producing the universe... Or isn't it? Fortunately, HM affirm, in their acknowledgements, that "a book does not appear spontaneously from nothing. A book requires a creator" (p. 187). It's difficult to thank anybody when you believe all what is said in this book. Yet, HM are incoherent enough to show—though their free thanksgiving attitude—why their grand design philosophy is wrong.

[8] See, e.g., Rodriguez Dos Santos, Jose. 2006. *A Fórmula De Deus*. Lisboa: Gradiva.