

## Book Review

### THE GRAND DESIGN

STEPHEN HAWKING and LEONARD MLODINOW

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The book, "The Grand Design" is a 'popular science book' of two hundred pages written by the great distinguished physicist and thinker of our time, Stephen Hawking along with Leonard Mlodinow. The book is an outcome of recent discoveries and theoretical advances in the field of Physics with a super blending of logic. It has tried to answer the most fundamental questions about the origin of the universe and of life itself. Authors have raised some genuine and ever-debating questions like when and how did the universe begin? Why are we here? Why is there something rather than nothing? What is the nature of reality? Why are the laws of nature so finely tuned as to allow for the existence of beings like ourselves? And, finally, is the apparent 'grand design' of our universe evidence for a benevolent creator who set things in motion? Or does science offer another explanation?

There are eight chapters in the book. Stephen Hawking and Leonard Mlodinow start with chapter on 'The Mystery of being' explains the shortcomings of classical approach of atomic and subatomic scales of existence and superiority of quantum physics over it. Taking reference of Feynman, "a system has not just one history but every possible history", they say that the universe itself has no single history. The paradoxes of realities should be dealt with model-dependent realism; which is based on the idea that our brains interpret the input from our sensory organs by making a model of the world. If two physical theories or models accurately predict the same events, one can not be said to be more real than the other; rather we are free to use whichever model is most convenient. M-theory (theory of everything) predicts that a great many universes were created out of nothing. Their creation does not require the intervention of some supernatural being or god. These multiple universes arise naturally from physical law. Each

universe has many possible histories and many possible states at later time.

The second chapter, 'the rule of law' explains the ignorance of nature's ways led people in ancient times to invent the gods of every aspect. As time passes on a gradual but slow ideas on the favour of laws of nature were flourished which started to challenge the reign of the Gods. Here they explain how various philosophers and thinkers formulated the laws of nature based on common logic and understandings in the past. A law of nature is a rule that is based upon observed regularity and provides predictions that go beyond the immediate situations upon which it is based. And if nature is governed by laws, three questions arise: i.e. What is the origin of the laws? Are there any miracles? Is there only one possible set of laws?

The third chapter, "what is reality?" Explains, there is no picture or theory independent concept of reality. Instead we adopt a view that we will call model dependent realism: the idea that a physical theory or world picture is a model and a set of rules that connect the elements of the model to observations. For example, according to the principles of quantum mechanics, which is an accurate description of nature, a particle has neither a definite position nor velocity unless and until those quantities are measured by an observer.

Many scientific theories that had proven successful were later replaced by other equally successful theories based on wholly new concepts of reality. The same phenomenon can be described accurately by two very different theories. Each theory can describe and explain certain properties and neither theory can be better

or more real than the other. So that there seems to be no single mathematical model or theory that can describe every aspect of the universe, rather there seems to be the network of theories called *M-theory*. In that view, the universe does not have a single existence or history but rather every possible version of the universe exists simultaneously in what is called a quantum superposition.

The fourth chapter, “Alternative Histories” explains the quantum physics as a new model of reality that gives the picture of universe. The predictions of Newtonian theory match the view of reality we develop as we experience the world around us but individual atoms and molecules operate in a manner profoundly different from that of our everyday experience. i.e. according to quantum model many concepts fundamental to our intuitive understanding of reality no longer have meaning. The laws of nature determine the *probabilities* of various futures and pasts rather than determining the future and past with *certainty*. Probabilities in quantum theory reflect a fundamental randomness in nature. For a general system, the probability of any observation is constructed from all the possible histories that could have led to that observation So that this method is called the “sum over histories” or “alternative histories” formulation of quantum physics.

The fifth chapter, “The Theory of Everything” explains the possible unification of all fundamental forces of nature into a single law that is compatible with quantum theory. The different theories like GUT, standard model, string theory etc on unification of these fundamental forces have faced different unique problems. ie they were not successful in uniting all the forces.

The five different string theories and supergravity are different approximations to a more fundamental theory, each valid in different situations and this is called M-theory (M for master, miracle or mystery or all).

M theory has eleven space-time dimensions which was predicted to be ten by string theorists. It can contain not just vibrating strings but also point particle, 2-D membranes, 3-D blobs P-branes etc.

The laws of M-theory allow for different universes with different apparent laws, depending on how the internal space is curled, perhaps as many as  $10^5$ , i.e. it allows for  $10^5$  different universes;

each with its own laws. It means the original hope of physicists to produce a single theory explaining the apparent possible consequence of a few simple assumptions may have to be abandoned.

The sixth chapter, “choosing our universe” has tried to answer the questions like why is there a universe. And why is the universe the way it is? Hubbles idea of expanding universe is, the farther away a galaxy, the faster it is moving away from us. But with the expansion of space the size of material objects does not increase. Friedmann’s model universe begins with zero size and expands until gravitational attraction slows down, and eventually causes it to collapse in upon itself. Astronomers have also found fingerprints supporting the big bang picture of a hot, tiny early universe. But it may not give us a true picture of the origin of the universe. Because Einstein’s theory of general relativity breaks at singularity and therefore can not predict how the universe began, only how it evolved afterwards. A probable idea may be the combination of general relativity and quantum theory of gravity to understand the origin of the universe. There seems to be a vast landscape of possible universes. We live in one in which life is possible, but if the universe were only slightly different, beings like us could not exist. But why?

The seventh chapter explains about, “ The Apparent Miracle”. Here the writers have beautifully explained the logical evidences for the fine tuning of our universe in this form. The laws of nature form a system that is extremely fine tuned, and very little in physical law can be altered without destroying the possibility of the development of life as we know it. Were it not for a series of startling coincidences in the precise details of physical law, it seems, humans and similar forms would never have come into being.

The most impressive fine tuning coincidence involves the cosmological constant in Einstein’s equations of general relativity which was based on static universe. When it was discovered that the universe was not static, he eliminated the constant from his theory and called it as his greatest blunder. But in 1988 observations of very distant supernovas revealed that the universe is expanding at an accelerating rate, an effect that is not possible without some kind of repulsive force acting throughout space. The cosmological

constant was resurrected. That means either the reasoning employed in the calculation was wrong or some other effect exists that miraculously cancels all but an unimaginably tiny fraction of the number calculated. If the value of the constant were much larger than it is, our universe would have blown itself apart before galaxies could form and once again life would be impossible. Just as Darwin and Wallace explained how the apparently miraculous design of living forms could appear without intervention by a supreme being, the multiverses concept can explain the fine tuning of physical law without the need for a benevolent creator who made the universe for our benefit.

The final chapter, "The Grand Design" explains the idea of scientific determinism that there must be a complete set of laws that given the state of universe at a specific time, would specify how the universe develop from that time forward. These laws should hold everywhere and at all times: otherwise they wouldn't be laws. There could be no exceptions or miracles. If the God has created the universe then there comes a natural question to ask, who created the God? So that the entire systems should be explained by the idea of model dependent realism.

We know gravity is attractive and gravitational energy is negative. Since gravity shapes space and time, it allows space time to be locally stable but globally unstable. On this scale of entire universe, the possible 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. And it is not necessary to invoke God in this regard. The theory of gravity predicts finite quantities so it must have super symmetry between the forces of nature and the matter on which they act. M-theory is the most general supersymmetric theory of gravity. For these

reasons M-theory is the only candidate for a complete theory of the universe.

"The Grand design" thus attempts to outline a complete scenario for the nature of the universe and our place in it. The universe exists because it must exist; if it didn't, it would come into existence spontaneously. Once it exists, the combination of quantum mechanics and general relativity coaxes the universe into a dizzying variety of regions with different local conditions and physical laws. Most of these might be extremely alien and inhospitable; but some will be just right to allow for the development of complexity and consciousness. Among those, happily, is our own.

Whether this ambitious conception is actually correct remains unclear. It's not especially idiosyncratic, many theorists hold similar views of the multiverse and the anthropic principle. The most important lesson of "The Grand Design" is not so much the particular theory being advocated but the sense that science may be able to answer the deep "Why?" questions that are part of fundamental human curiosity.

Thus Hawking and Mlodinow take the reader through a whirl wind tour of fundamental physics and cosmology, concluding with an enthusiastic endorsement of the idea that our observable universe is only a tiny part of a much larger conglomeration, multiverse. The presentation is simple and lucid and even common reader can go through it.

The title "Grand Design" seems to be used for adding extra flavour to the book though the final topic tries to put some outline of design of the universe/multiverse. But the authors' answer to the riddle of universe has nothing to do with intelligent design.

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