

# Final Words

Will we find a theory of everything? Though efforts are under way to know the universe, we are quite far from achieving the ultimate truth.

My 9-year-old son Nathan believes his brother Noah has become a star in the sky after his demise. In my view, this is a simple and powerful way of connecting to the cosmos, though children might have learned such metaphorical stories from fairy tales or stories told by elders.

We are linked to the stars in many ways. All the chemical elements that make us up came from the stars, and when we complete the terrestrial cycle, the fundamental particles must become part of something else. The cycles of creation and destruction will go on. Given enough time, our species must be able to discover many things that we can't even imagine now, assuming we don't destroy ourselves and we have the knowhow to escape the wrath of the destructive forces that have been unleashed on our planet.

In his 1956 short story, "The Last Question," Isaac Asimov takes the idea of future to a logical extreme. The story narrates that our descendants become advanced "energy beings" in the far future. They are able to fabricate a hyper-dimensional super-computer that essentially can reboot the unwinding universe. They asked the computer: "How can the net amount of entropy of the universe be massively decreased?" In other words, how can the workings of the universe be reversed? Each time, the response from the computer was "There was insufficient data for meaningful answer." Eventually, humanity is gone, and the universe is dead. The descendants of the computer that has been engaged in figuring out the answer all this time finally came up with an answer, but no one was around to accept it. So it decided to perform the reversal of the universe, and there is a second Big Bang when the computer asserts: "Let there be light!" And there was light!

Our intelligence may be augmented by the machines, they may even transcend us, but the fundamental questions remain the same.

In the last decade, the much-celebrated string theory has come to the fore. The string theory replaces zero-dimensional particles with one-dimensional string as the building blocks of matter. The vibrations of these extremely small strings manifest as matter and energy to create everything in the universe. String theory offers a ten-dimensional space-time instead of the familiar four-dimensional space-time. These extra dimensions are hard to conceive, let alone test for in a laboratory setup. The inability to provide any

quantitative experimental evidence is the main criticism against string theory. Some detractors even call it a theory of philosophy rather than physics.

In spite of all these limitations, string theory enjoyed wide participation from the greatest minds of our generation. Their goal was to unify the existing theories and fulfill Einstein's dream of the "theory of everything."

The emergence of different string theories in the last decades was misleading for scientists who have been looking for a cohesive, all-encompassing picture of the cosmos. Mathematically, all different types of string theories are equally acceptable, yet they differ in some features. This has led Edward Witten of the Institute of Advanced Study, known to many as the most brilliant physicist of our generation, to announce the M-theory in 1995. It was an extension of different string theories and sparked the second superstring revolution. The M-theory introduced membranes as the fundamental entities of existence, and it functions in an 11-dimensional space-time.

The existing experimental facilities may not be able to test string theory or M-theory in the near future. Some argue that such a scenario would qualify it to be considered as a mathematical framework rather than a physical theory. On the other hand, the large number of possible solutions offered by these theories has the potential to explain any phenomena that is beyond our current theoretical structure. Many scientists, especially the proponents of string theory, expect that the high-energy experiments scheduled at the Large Hadron Collider (LHC) may verify at least some aspects of the M-theory, possibly extra dimensions. Surprisingly, the existence of parallel universes is an undemanding result of the string theory, and to deny that, one needs to further complicate the theory.

We may not be able to answer the last question. Yet we are here for a short period of time to fine tune that final answer and must share our knowledge with our descendants, and they will continue their voyages to territories that are unknown to us. We are destined to do that before we depart to become star stuff. Science, as nothing else can do, teaches us humility while we seek the truth.

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