

**Questions and Answers**  
**with**  
**Noson S. Yanofsky**

**1) What was the main motive in writing your book, *The Outer Limits of Reason: What Science, Mathematics, and Logic Cannot Tell Us*?**

I wanted to highlight two points about science:

1. Modern science is the greatest achievement of humanity. Scientists have come to understand many facets of our complex universe. They have also vastly improved our lives in many ways. However, over the past century or so, science has advanced to the point of seeing its own limitations. Science is now able to see what it cannot do or know. My main goal was to show many of these different limitations.
2. My second goal was to show that many of these limitations come about from similar ideas and have similar patterns. By examining these ideas and patterns, we can find even more limitations and see a clearer structure of reason.

I also felt that both of these goals could be described in an extremely nontechnical manner. As complicated as modern science is, I still believe that most advanced ideas can be explained to anyone on the street. This was a central goal of my book.

**2) The core theme of your book is reason. How do you define reason?**

That is not a simple question. At the end of the book, I discuss several possible definitions of reason. One can say that reason is a method for obtaining truth and avoiding falsehood. This would include science, math, engineering etc. However, this brings to light another question: Exactly what methods and ideas are right for obtaining truth and avoiding falsehood?

One of the main problems is that what was once considered not reason has become reasonable and what once was considered reasonable has become unreasonable. For example, bloodletting (therapeutic phlebotomy) was once considered a reasonable process for treatment of illness. We now know that is total nonsense. On the other hand, we once believed that it was unreasonable to communicate past the sound of our voice. We now have radio and electrical signals that vastly extend communication. Given the changing nature of reason, how can we define reason?

One of the ideas mentioned at the end my book is that reason can be defined by its limitations. We cannot easily say what reason is, but we can say what reason is not. So while I do not know if dark matter or string theory are part of reason (these are contentious issues in modern physics), but I can say with certainty that the newspaper astrology column or using gems to heal modern cancer are definitely not part of reason.

**3) In this book, you talked about all kinds of different topics. From the philosophical paradoxes to quantum theory, etc and you stated that most probably we cannot find the answer to lots of these questions. Yet a lot of scientists and philosophers think that there is no boundary for human knowledge. Do you think that their work is useless?**

No. Their work is not useless. They just did not read my book yet. : )

**4) These people have so much attachment to knowing all aspects of our universe. Do you think this worldview is rational?**

I am not sure there is any scientist who believe that all of life's great questions can be answered by science. There are so many things that science never claimed to be able to answer. Questions of value and meaning were always considered beyond science. The domain of science has always been somewhat limited to understanding cause and effect of physical objects. That is a small part of the human experience.

However even in terms of our physical universe, this worldview is still rational. After all, for hundreds of years scientists have focused their attention on certain aspects of our universe and have been successful in understanding that aspect. There is little reason to believe that this will not continue. Nevertheless, these limitations exist and science has to come to an awareness of them.

**5) I want to ask a question that I ask scientists and philosophers. In a section of your book, you mentioned that in quantum mechanics a question arose concerning the existence of free will. I want to know your personal view. Do you think humans have free will or not?**

The relationship between free will and quantum mechanics is actually very complicated. In fact, some believe that only with the seeming randomness of quantum mechanics, can one possibly go beyond the deterministic nature of classical physics and accept a notion of free will. My personal view is a question rather than a position about free will. The question is what exactly is free will? What does it mean that for a person to have free will as opposed to not have free will? We cannot answer whether a person has free will before we define free will. The usual meaning is that a person has free will if he can do what he wants. This obviously does not exist. I want to fly like Superman and spend money like a billionaire. I cannot do either because the basic laws of physics prevent me from flying and I do not have the money to spend like a billionaire. The definition of free will must be adjusted.

Some say a person having free will means nothing is causing that person to choose what he prefers. But this is also problematic. For example, if my mother taught me to help little old ladies cross the street, does that mean that I do not have free will when I, in fact, help a little old lady cross the street?

Another, still deeper problem with the idea of free will is the notion of the self. What does it mean that a person prefers something? We all have conflicting preferences. Which of the many conflicting preferences does free will work with? Let me give an example that I love to think about. There is a certain bakery not far from my house that makes the most delicious hot cinnamon Danish ever. They melt in your mouth in a most fantastic way. On the one hand, I love them and prefer to get one every time I pass the store. On the other hand, I am a little health conscious and prefer to avoid the extra calories at all costs. Which of these two preferences is the real me? If I ate one, did my free will win or lose?

In a sense with the realization that the notion of free will is not well defined and there is no single "self," the question of the existence of free will is irrelevant.

**6) Many people, including me, may find your thoughts about our inability in answering ultimate questions of reality somewhat depressing and in a sense nihilistic. Are you pessimistic about the future of science?**

I do not know what causes nihilism. But I highly doubt that nihilism is caused by either knowing everything there is to know about the universe or the realization of man's inability to know everything about the universe. Nihilism – to me – is a belief or a feeling about lack of values or lack of morality. Science never had anything to say about values or morality.

I do not see why anyone should take my book as saying anything depressing. The book discusses the fascinating structure of reason. Even with the realization that science cannot answer every question should not cause depression. Here is an analogy. Imagine being stuck in a room for a long period of time. Let us imagine two scenarios. Which of these two would be more depressing? To know every single aspect of the room or to realize that there is some things in the room that we will never be able to know. I think being stuck in a totally understood room is more depressing. So too, living in a universe that is totally understandable is boring ... and depressing.

There are those who thought that science will end “very soon”. The problem is that the main book pushing that idea was written over a quarter of a century ago. There have been no signs of science slowing down or stopping. I don't see why science should ever end. There will always be new questions arising.

**7) In your book you discuss many open questions in science. From all those questions, can you name three questions that you would really love to know the answer.**

There are many favorites. If forced to choose, I would try to learn the answer to the following three.

1. The Fermi paradox. This question asks where all the space aliens are. Given that there are billions and billions of stars and each of those stars have many planets, why have we not seen any creatures from these places. Some people believe that Earth is the only planet that has any form of intelligent life (This raises more questions. Why did life not come about anywhere else?) Some believe that they are out there and we did not find each other yet. Some even believe they are out there and they already visited us. Where is everyone? (I have my pet theory about this question. I think --- without a shred of evidence --- that the universe is teeming with intelligent life and the reason why they did not visit us yet is that we are simply not interesting enough for them. Just like us humans have not visited every anthill in Africa, so too, no super-intelligent alien has ever visited us with our mediocre intelligence. What a humbling thought!)
2. The question of consciousness. This asks how does the feeling of consciousness arise from the brain. Our brain is a physical device made of trillions of interconnecting neurons. And yet we somehow feel that we are thinking and feeling different feelings. We also have a feeling of being an “I”. How do these thoughts come about from simple firing of electrical impulses? Cognitive scientists are getting

closer and closer to understanding the working of the brain and the emergence of the mind

3.  $P = ? = NP$  question. This is a question about computer problems that demand an extraordinary amount of time to solve. How can we determine if there is a simple way of solving a seemingly hard computer problem? This question goes to the heart of all computing. As a computer professor, I have thought of this problem for a very long time. I do not have a clue as to how to solve it.

### **8) Are you planning to write another book for nonacademic people?**

Yes. I am working on such a book now. The book is tentatively titled *Our Illusions: What science tells us is not really real*. The book is not about any personal illusions that a person might be suffering from. Rather, it is about illusions that we all share. A simple example of this is gold. We all think gold is very valuable, but that is just an illusion. Gold has no intrinsic value whatsoever. The only value it has is what value society gives it. This is true with every type of object. Things do not have value in a society except for the value that society gives it. Other examples come from culture and aesthetics. Recently there have been many studies about things like expensive wine and classical music that show that certain aspects of our appreciation of them is not real. These and many other examples show some parts of our reality are not really real. Either we are physically programmed to believe some ideas or our society tells us to believe various ideas that are not really true. The book also gets into physics and mathematics. In physics, there are “fictional” forces that exist in a strange way. In mathematics, we discuss the existence and non-existence of mathematical structures. The book should be out in a few years and will be an interesting read.

### **9) What can you say to people who are interested in your field and want to study in this field?**

What I try to show in the book is that there are many fields that are wide open. If you are interested in it, go study it! I think the noblest professions are engineering, science and mathematics. These are careers that advance mankind or figure out certain aspects of the universe. What could be more important? What is most interesting is that the vast majority of paradoxes and conundrums discussed in my book are less than a century old. That is relatively recent in the scheme of things. There is much out there ready to be explored. Go and explore!