The Tim Ferriss Show Transcripts
Episode 115: Lisa Randall
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Tim Ferriss: Hello, my little maguey, this Tim Ferriss and welcome to another episode of the Tim Ferriss Show. In each episode, it is my job to deconstruct a world class performer. I take a peak under the hood, inside their brain, and tease out their thinking, frameworks, tools, and tricks you can use.

In this episode, we have waves in the background. Waves are lapping the deck next to me. I have had a change of location to a more beach-based environment. We also have Professor Lisa Randall. I'm so excited about this one. She is @lyrarandall on Twitter. She researches particle physics and cosmology at Harvard, where she is a professor of theoretical physics.

Professor Randall was the first tenured woman in the Princeton Physics Department, and then the first tenured female theoretical physicist at Harvard. She is a killer in the best way possible. In autumn of 2004, she was the most cited theoretical physicist of the previous five years. In 2007, Randall was named one of *Time* magazine's 100 most influential people, under the section for scientists and thinkers. Randall was given this honor for her work regarding the evidence of a higher dimension.

We get into dimensions. We get into time. We get into hidden dimensions and all sorts of fascinating things in this conversation. She's also a very adept rock climber, among many other things, and has a lot of involvement with music. She's written several mind expanding books, the newest of which is *Dark Matter and the Dinosaurs: The Astounding Interconnectedness of the Universe.*

If you want a semi psychedelic experience, viewing the world through a new lens without imbibing any substances or risking incarceration, the book is well worth checking out. I love reading about physics. It is a pet obsession of mine. Many of you know I have as one of my heroes Richard Feynman. We go all over the place. I know not of what I speak when it comes to physics, but I do enjoy speaking with someone like Professor Randall.

I should make a couple of notes. The first is that we had some connection difficulties so the sound quality may be challenging. I ask you to bear with me. Please don't bitch and moan excessively on the Internet about it. Here's the thing, with very busy guests sometimes it is a go or no-go decision. That means we can do an interview with suboptimal sound quality – which I think is perfectly fine with most people quite frankly – or we cannot do the interview at all because schedules need to match. So please bear with us. I appreciate your patience. I still think you'll be able to get a whole hell of a lot out of it. I think 99-plus percent of it is audible, so you should be able to get tons.

Last but not least, Professor Randall has question at the end and she'd love to hear from you. Please ping her on Twitter @lyrarandall. With that, please enjoy my conversation with Professor Lisa Randall.

Professor Randall, welcome to the show.

Lisa Randall: Thanks for having me here.

Tim Ferriss: I am so excited to dig in today and talk for many reasons. We have mutual friends, of course. But beyond that, I have been simultaneously fascinated by physics and embarrassed by my lack of knowledge of physics for a very long time. I went to Princeton undergrad, became obsessed with Richard Feynman, bought *Surely You Must Be Joking, Mr. Feynman!*, and then his many other books. I'm hoping we can dig into your areas of expertise, but also perhaps answer some very basic questions that have led me to have a lot of insecurity related to the sciences. That's a long intro, but I'm happy to have you here.

Lisa Randall: I actually mention this at the end of my book. When you tell people you do physics, everyone feels compelled to tell you their attitude or relationship to physics. If you say, "I'm a lawyer," they don't feel like they have to tell you how they feel about the law. But somehow with physics everyone feels like they have to tell you whether they like it, hate it, or are interested or not. It's very funny.

Tim Ferriss: I feel like pleading ignorance up front is always a good insurance policy. If I'm wading deep into the –

Lisa Randall: I see. It's plausible deniability.

Tim Ferriss: Yeah. If there's a likelihood I'll drown in my own stupidity later, then I want to put on the life vest of plausible deniability first. But when you're at a cocktail party and you meet someone who asks you what you do, how do you answer them?

Lisa Randall: Obviously, I'm going to tell them in most circumstances that I'm a professor of physics and what I study. I study the fundamental nature of matter, the universe, how the universe has evolved, and the nature of space. But I don't necessarily go into all of that. Sometimes, if I want to make my life a little bit easier, I just tell them that I write about physics. Eventually, they'll ask me what I write about and it'll come back to the fact that I'm doing research, too.

One of the things for me, when I started writing about physics, I was doing research as the primary thing. I found that it was so much easier to talk to people about it, because people understand writing more than they understand research.

Tim Ferriss: Or they think they do at the very least.

Lisa Randall: That's a good point. It turned out, though, that I had many more friends who were writers than I had appreciated. Once I started writing, I realized, "Oh wow. I have a lots of friends who write."

Tim Ferriss: All of these closet authors come out of the woodwork.

Lisa Randall: No, they were actual authors. I had just never made the lists to realize what a sizable fraction of my friends were writers.

Tim Ferriss: I've spent a lot of time looking at your bio. I have to admit that I could really use some definitions. You researched particle physics and cosmology at Harvard where you were a professor of theoretical physics. So I'd like to start with the basic basics. What is or what are physics?

Lisa Randall: That's a question that changes to some level with time. Really, we're trying to understand the fundamental nature of matter – what stuff is made of and how it works. It's the physical processes by which things happen. There are other levels at which we can look at things. We look at biological processes or [inaudible – connection] processes, but ultimately we're looking at the substrate. We're looking at the matter from which all of these other things emerge. What is stuff made of and how do we put it together to get the kinds of things that we observe? And what are the forces that act on that matter to produce what we see?

Tim Ferriss: So these are questions that people have had for a very long time. What is theoretical physics and what is the alternative?

Lisa Randall: Theoretical physics means that I can do my work with essentially a pencil and paper. I'm not running the experiments with which we'll test the ideas. I'm not running the experiments that provide data. I might interact with experimenters, and do quite often. I look at the data. It's not that I don't care about what happens with experiments, or observations in the case of astronomy, but I am not doing those things myself.

I'm thinking about how we can tie it all together in a theoretical sense. How do we make sense of what we see? What are the fundamental underlying connections? What are the forces? What is there?

Tim Ferriss: What is cosmology? I'm stumbling over whether physics is plural or singular.

Lisa Randall: Physics is a word like chemistry. So it's singular the same way chemistry is singular.

Tim Ferriss: Got it.

Lisa Randall: Cosmology is the study of the evolution of the universe – how the universe has become what it is today, how it's changing. How does the universe as a whole evolve?

Particle physics is the study of the fundamental nature of matter. If you keep digging deeper and deeper, what is the basic stuff of which things are made? What are the forces that act at that level?

Just to clarify, if we're talking on a computer that's made of stuff. Everyone knows it's made up of molecules which are made up of atoms. Those atoms are made up of nuclei with electrons around them. The nuclei are made up of protons and neutrons, which are made up in turn of particles called quarks, which are held together by gluons.

As a particle physicist, I'll study things at the level of quartz and gluons and electrons and the proton that produces electromagnetism. I'll say, "Is there an understanding of why those particles have the masses they do? Are they fundamental? Are they even smaller, in some sense, particles of which these guys are made?" So we're trying to understand the basic elements of matter and how they're related.

Tim Ferriss: Got it. Thank you. I have so many questions, but I want to turn back the clock a little bit. There is the current state –

Lisa Randall: Don't we all?

Tim Ferriss: I know. It just so happens that today is Back to the Future Day.

Lisa Randall: That's right.

Tim Ferriss: It's perfect and very appropriate. It turns out a lot of my fans think I look exactly like Biff Junior, who wears a chrome helmet. But I had a lot more hair.

Turning back the clock is always something I wanted to be able to do. Please feel free to correct any of this. You were the first tenured woman in the Princeton Physics Department and the first tenured female theoretical physicist at Harvard.

Lisa Randall: Um-hum.

Tim Ferriss: Your sister, I believe, is in computer science. Is that right?

Lisa Randall: Yeah, she is in computer science theory. She's a mathematician.

Tim Ferriss: You're both women male dominated fields. How did you both end up as scientists? What was the formation of both of you – or speaking to your personal experience – as scientists?

Lisa Randall: There is a joke. My sister, who is four-and-a-half years younger, gets mad at me. People will ask me if there were scientists in my family and I'll say no because when you're a kid and it's your younger sister, you don't really feel like there's another scientist in the family. And we weren't scientists back then. But when they ask her, she'll say, "Yes, my older sister did science." Having said that, she's absolutely brilliant and is of course an outstanding scientist today.

It's [inaudible] to say exactly what it is. When people ask me, I always joke – only half-jokingly – we weren't properly socialized. I didn't know I wasn't supposed to do it. We're both good at it and I like challenges. I thought if this was something I might want to do

I should try to do it and see how it works out. People are much more open about talking about this as an issue. It's not like I didn't notice that I was the only woman in my class. Sometimes it was even worse than that, there would be a few women in the class and by the end I would be the only one. It's not like you don't notice that.

But it's not a defining feature. I was taking the same classes and doing the same things. As you get more senior you're more aware of it in the context of how it affects your relationship with colleagues. But at the time, I was just trying to do my work.

Tim Ferriss: If we look at some of the specifics, did the Hampshire College summer studies in mathematics come before high school or during high school?

Lisa Randall: I'm happy you brought that up. I actually did that when I was in high school. It was a fun place to be. It was western math, but it was essentially math camp. It sounds totally embarrassing, but for us maladjusted people, it was actually a really fun thing to do. We got out of New York City and got to go there.

But joking aside, I actually feel very strongly that these summer programs are really important. I was at one National Science Foundation meeting where they were asking about things we can do. I raised the [inaudible] that having these summer science programs can be really important. The other woman in the room felt the same way. I think it's something that helps with minorities and disadvantaged students. It's a way to get outside whatever is your environment.

I'd love to believe we can instantly improve all high schools all over the country, but we're not going to do that right away. So the idea that the best students, or students with a lot of interest, in a particular area have the opportunity to meet other excellent students and have fun with it and not be defined by their environment – it was Hampshire college. People came from all over. I think that's a very valuable experience.

Tim Ferriss: I agree. The translation of location in that social circle, or the context that may be hindering or helping that person, I also found very valuable. I hesitate to say this because it implies I actually know something about it, but I went to a summer camp for physics in Northfield Mount Hermon in high school and then went to –

Lisa Randall: Awesome. That is so great.

Tim Ferriss: Now, in fairness, it wasn't because I was excelling and trying to graduate in three years. It was because I wasn't going to graduate if I didn't satisfy my physics –

Lisa Randall: Even so, it's nice. One of the problems defining the educational system is that if you don't do the subject at the same rate you're going to be in trouble. In the sciences and math, it's a much more serious issue, I think. If you fall behind in a physics class or math class, you're basically never going to catch up. And the rest of the time is wasted. So to have these opportunities to sort of catch up is very important.

Tim Ferriss: I totally agree. It's an interesting example of early influences. In tenth grade, my younger brother and I went to the same school. We both had two different math teachers for tenth grade. My math teacher was a good teacher, but she was embittered through the academic process. I ended up disliking math as a result. I actually went to Princeton partially because there was no math requirement. But that led to the necessity of going to physics summer camp. So it blew up in my face in that respect.

Lisa Randall: That's an awfully interesting way of choosing which college you go to.

Tim Ferriss: It was a necessary, but not sufficient, criterion. But my brother, on the other hand, had a wonderful experience in tenth grade. Neither of us were predisposed to math. And he now is finishing his PhD in statistics.

Lisa Randall: How interesting.

Tim Ferriss: For you and your sister, if you look back, what did your parents do when you were growing up in Queens?

Lisa Randall: Just for the record, I have two sisters. I have an older sister who was learning disabled on some level. I think that's one of the reasons I was very aware of how you learn and [inaudible] education a lot. I did feel that I was lucky I was able to learn things. I felt sort of a responsibility to really learn because of that. I was given this ability and I thought it wasn't fair. I thought I should be able to use it.

Frankly, part of it was taking our studies seriously. It's not that it was all easy. I actually had to argue quite a bit to go to Stuyvesant High School because it meant I had to take public transportation in the '70s to get from Queens to Manhattan. I think there was a sense in which they did just value learning.

Tim Ferriss: Your parents?

Lisa Randall: Yeah, I think so.

Tim Ferriss: What did they do professionally?

Lisa Randall: My mother was a teacher who stopped when she had kids. My father studied engineering but did sales. They weren't scientists by any means. A lot of people ask if my parents were scientists and they weren't. It really was something that I decided for myself that I was interested in and wanted to do. I think both my sister and I really liked math.

I went to a Stirrup school in the '60s. I shouldn't give away my age, but it's easy to look up on Wikipedia. It was this time of great uncertainty. My joke is my first day of school didn't exist. We had school strikes and all of that. I think I liked the certainty of math and science and having answers. Of course, when you do research you realize it's all about not having answers.

But no matter how bad the teachers were, there was still going to be a right and wrong answer of everything. You could still learn it on your own if you needed to. I like reading and all sorts of things, but I did like that sense of security that you have with math. It was fun. I like puzzle solving and I think my younger sister does, too.

She was a lot younger, so I really feel like I was [inaudible] these things. It's not like I knew right away. I remember in junior high school very decidedly thinking I would be a lawyer.

Tim Ferriss: Why a lawyer?

Lisa Randall: I had a very idealistic sense of finding and arguing for the truth. I like getting the right outcome, so it seemed like something that would be worthwhile. I think it was before the days of junior high schools learning about corporate law. Then I went to high school, Stuyvesant in New York. I want to say how important I think really good public schools are. It was a public school that I got to by public transportation, which honestly was a pain. I had to take a bus to the subway, but there was a way of getting there.

I took my first physics course and liked it. I couldn't really see myself doing math for my entire life, but I thought it would be interesting to try to understand the world through math. There was never an option for me to be an experimenter. I was always going to be a theoretical physicist if I did physics.

Tim Ferriss: Why is that?

Lisa Randall: I just like the game playing. I like the solving of problems. I have no patience and I'm very messy. So I would make a terrible experimenter.

Tim Ferriss: That's funny. It reminds me of a question I was asked when I was researching cooking for *The 4-Hour Chef*. They said, "Do you like to fold your socks or underwear?" I said, "Kind of. Why?" They said, "Because that would mean you're going to be good as a baker. If you're going to be a chef, those are the messy folks who are impatient."

Lisa Randall: That's very funny.

Tim Ferriss: The conversation with your parents to go to high school and take public transportation. Tell me about that. How did that go? What was your argument?

Lisa Randall: It sounds like I'm bragging, but I'm answering your question. I really did one of the best at the test in the city. I felt like I had a right to go. The schools in my neighborhood were okay, but there were racial issues in the neighborhood. High school was kind of a mess nearby at the time. It wasn't terrible, but I really wanted to go to a good school. Frankly, I really wanted to get out of Queens, too. I wasn't that happy there. It was like everyone was supposed to be the same.

And I was right about that. When I went to Manhattan, people could be individuals. It was valued and I loved that. It was a social experience as much as anything. I really liked getting into Manhattan every day. But there were ridiculous deals I had to make. I was [inaudible] captain of math team, but math team met at 8:00 in the morning. So that meant leaving really early, and my mother didn't want me to go out in the dark. It was the '70s. There were lots of bad things happening in New York. But the fact was I had to go to school.

So there were compromises to be made, but I got there. I also didn't go until tenth grade. By the time my sister went, I had already paved the way. She started in ninth grade.

Tim Ferriss: You had given your parents the debutante ball with all of the fears and concerns.

Lisa Randall: I've never thought of it as a debutante ball, but that's very lovely.

Tim Ferriss: Probably not the best metaphor, but that's okay. You've written a lot. I want to look at your books to date and key in on some of the phrases that are used and will lead up to the current day. *Warped Passages: Unraveling the Mysteries of the Universe's Hidden Dimensions*. Can you explain why the title and subtitle of that book?

Lisa Randall: I can try. My original thought for a title was *Extra Dimensions: Are You in or Out?* But that was nixed so I had to think of another title. I thought of *Warped Passages* and it's actually a joke that no one gets. The science term warp comes from what happens in a particular geometry [inaudible] dimension of space that I looked up. So the book is framed around ideas about an extra dimension of space beyond the three that we see. Warped refers to the fact that things get scaled differently in the different dimensions. They get resized.

So *Warped Passages* was a little bit of a joke because it was the first book I was writing. I was joking about writing, so "warped passages."

Tim Ferriss: I get it.

Lisa Randall: It was also "warped passages" in the spatial sense. It can have many interpretations. My friend looked at the title and said, "Oh, is that your autobiography?" It was a joke.

Tim Ferriss: Does your editor have any idea that it was an inside joke?

Lisa Randall: No, no. But I was told that the marketing department got ahold of it and said, "Can't you just call the book *Extra Dimensions*?" I was like, "No." I didn't find that a very interesting title. I spent a month trying to think of a better title and then I realized actually *Warped Passages* is a great title. People really liked it so I was happy I kept it. But I did think because it was a nondescript title, or at least could be interpreted differently, I had to explain at least in the subtitle what it was.

It really is about unraveling mysteries of hidden dimensions, both in terms of dimensions of space and also metaphorically understanding what's really out there underlying the universe. So a lot of thought did go into that subtitle as well.

Tim Ferriss: When we talk about hidden dimensions, I'd love to hear you elaborate on that a little bit. I'm reading for the first time *The Time Machine* by H.G. Wells. In the beginning, there's a cocktail conversation and the time traveler is asking people how many dimensions a cube exists in. They say three and he says, "Well, actually it's four. Can a cube exist for an instant?" And then we get into this discussion of time and what not.

That only further piqued my curiosity and interest in chatting with you. When we're talking about hidden dimensions, could you elaborate on what you mean by that?

Lisa Randall: When we talk about dimensions, we have to be careful between dimensions of space and time. Einstein talked about space and time as if they're [inaudible] and in some sense there is a concept of space/time geometry, for example. But space and time are actually different. So when we talk about a fourth dimension, we might mean time but we can also mean a fourth dimension of space. When I talk about a fourth dimension of space, you might say, "Where is it? What is it?" Obviously, it's hidden.

We see three dimensions of space – up/down, forward/back, and left/right. But we don't observe that fourth dimension. That could be either because it's really tiny and hidden from us – you might think of a wire that looks one dimensional even though we know in reality it has more dimensions. But we aren't resolving those necessarily.

In the same way, space can have tiny hidden dimensions. But my collaborator Raman Sundrum and I discovered still another way an extra dimension could be hidden. That's because space is so warped. Space/time can be warped. That's actually what gave rise to the title of *Warped Passages*. Gravity varies so much across an extra dimension of space that its strength is so small and far away from some location that it looks as if there is only three dimensions even though there can be a fourth – even infinite dimensions. It's just that in some sense, gravity doesn't leak out into it. It stays concentrated in three dimensions.

Tim Ferriss: Okay. I'm tempted to ask about *Interstellar*, but I might do that later. Have you seen *Interstellar*, the movie?

Lisa Randall: I have, but let's do that later.

Tim Ferriss: That was not the question. I'll come back to it. The next book, *Knocking on Heaven's Door: How Physics and Scientific Thinking Illuminate the Universe in the Modern World* – both of those are *New York Times* 100 notable books. I'm most interested in the title. Why *Knocking on Heaven's Door*?

Lisa Randall: As anyone who read my first book knows, I remember song lyrics and titles. So it was a play on words.

Tim Ferriss: Guns N' Roses?

Lisa Randall: You can tell someone's age by whether they say Bob Dylan, Guns N' Roses, or they think about dying when they see or hear that title. I wanted to express the way science builds on itself. The idea is that there is a whole body of knowledge we have, but we want to get to the edges. We want to see how we can expand on what we know and go beyond. I like the idea that "knocking on heaven's door" is a way of opening beyond the stuff we know into the realm of the unknown.

In a way, it's so close to what we know that beyond improves upon it. Also, it was a time when science and religion were discussed a lot, so I do actually talk about not just the particular science I do – particle physics and The Large Hadron Collider – but also explaining what science really is. I feel like neither side was giving a good enough explanation so they could talk to each other. I feel like I did a good job because when I gave it to scientific people or to religious people, neither one was completely happy.

In fact, I gave it to someone who runs the MIT parish and he said he read one of my chapters and said, "I hate to admit it, but you're making a lot of sense here." That was what I was the target I was looking for, compromise.

Tim Ferriss: So in this case, was it a definition of science that provoked that response?

Lisa Randall: It was in some sense. I think we had this idea that when we understand the fundamental nature of things we'll understand everything. One of the notions I focused on in this book, which I think is a really useful notion for people to take away, is the idea that an effective theory, the idea that you know what you can see but you don't necessarily know what underlies that. For example, Newton's laws work very well over a definite regime. Unless you get extraordinarily precise, you won't realize that quantum mechanics or relativity is actually more fundamental than Newton's laws.

I remember when I learned in high school about Newton's laws, and then was told they were not really right, I thought, "Why are they teaching it to us?" They're teaching it because it is right, but it's right in a sense of being an effective theory. It's right in the regime that we do it. If I want to predict how to throw a ball or send a rocket to the moon, Newton's law works fine. It's just that if I get into the scale of an atom, then I'm going to need to use quantum mechanics.

So I like this idea that science builds on itself. It doesn't mean the other theories are wrong, but it means they're effective theories. They work over a certain regime. The reason it's important to relate it to the other discussion is because people think, "Well, this can't be right. We'll never answer certain questions." But that's not true. You still need the fundamental elements of matter. Even if I don't yet understand how the brain works, I know fundamentally there are atoms involved and protons communicating electrical forces involved.

It doesn't mean I know all of the answers yet. And it might be that I'll have to look at it at some higher level to get those answers. But it doesn't mean science can't tackle it, but it's tackling it systematically in previous effective theory idea.

Tim Ferriss: I've read that your research has at its heart "the search for fundamental connections in the universe." Can you explain what that means?

Lisa Randall: That's the most recent book where I'm looking for those. Is that what you're referring to?

Tim Ferriss: Yeah. I could set that up by saying a comet struck 66 million years ago that wiped out the dinosaurs and two-thirds of life on the planet. What happened? That was my alternative.

Lisa Randall: Let's first say the title is *Dark Matter and the Dinosaurs: The Astounding Interconnectedness of the Universe*. It refers to both of those things. It refers to the research I'm doing, which is dark matter connecting possibly to the extinction of the dinosaurs.

But the astounding interconnected universe was about – there were two things I wanted to get across in this book. Obviously, I wanted to talk about my research, but also how the different fields of science relate – cosmology, evolution of the universe, the big bang theory, insulation and dark matter. Those ideas can connect onto our galaxy and then our solar system. We have an active solar system with comets and meteors, and how those can be related to life and life's extinction.

All of these amazing continuities of how this all evolved, but also how these basic elements – how nuclear forces – can be relevant for driving plate tectonics, which is drilled into the carbon cycle, which is relevant to life. There are these amazing connections which exist in the universe. How were the elements formed in supernova? I was very excited because I studied fundamental particles, but it's very hard. It's abstract and hard to grasp. But then I can make these concrete connections to things we do experience in our daily lives.

Of course, dark matter and the dinosaurs is sort of the ultimate of that source – that dark matter might ultimately connect to something as important to us as the extinction of the dinosaurs. It allowed for large mammals to dominate, and eventually us. I think these connections and understanding the role all of these play – how dark matter helped form galaxies. All of these things we think are so abstract, what are their concrete manifestations? What are they? That was important.

The other bigger lesson, in some sense, is the history of our planet, our life, at some level. How long did it take to get here and what are the different things that happened? What are the amazing connections and features that were necessary for all of that to happen? I think it's especially relevant in light of the rapidity with which we're changing the planet today. Since the industrial revolution we've had enormous changes to the planet. Before we do it, I wanted us to understand what that means, the context, the things that got us here, and what we need to maintain it.

Tim Ferriss: Okay, I'm going to ask you about dark matter. I have some quotes I enjoyed related to that. First, could you explain the geological tie-in with mountains and nuclear decay?

Lisa Randall: I think most of us now know about plate tectonics, which was actually developed relatively recently. It's the idea the plates are moving over the mantle, which is liquid. What drives that is the fact that there are nuclear decays. Nuclear decays are providing the heat that drives this motion. As you know, plate tectonics have given rise to mountain ranges and volcanoes when things crashed together.

So all of this dynamic stuff that's happening is being fueled, at least partially, by nuclear decay. So that's an amazing connection. Also the carbon cycle is having a part in this emerging disappearance of mountains.

Tim Ferriss: Thank you. I became very interested in dark matter and dark energy about six months ago when I read an article *A First Glimpse of the Hidden Cosmos*, which is written by Timothy Ferris.

Lisa Randall: Yeah, I accidentally emailed him today instead of you. He wrote a blurb for my book. It was very lovely.

Tim Ferriss: He's a great guy. That article was in *National Geographic.* If you could extend to him my sincerest apologies for creating so many issues for him on Google? Everyone misspells my name, so I've created a huge amount of noise related to his name inadvertently. I feel terrible about it. I think I live a few miles from him, so I'd love to take him out for coffee sometime and apologize in person. I tried to track him down at this Exploratorium event to apologize in person but I didn't find him.

In any case, there are a couple of quotes in there. One of them was by astrophysicist Michael Turner on dark energy. "…The most profound mystery in all of science." "Empty space is not empty," is John Archibald Wheeler. The article ended with "scientists are confronted by the embarrassing fact…that this is the largest disparity between theory and observation in the entire history of science."

I was like, "Wow. That's a very strong comment." It's very exciting. What is dark matter? What is dark energy? How are people misusing those terms? I'd love to hear from a pro, which you are, how we should think of these things.

Lisa Randall: We've given them these names that make them sound mysterious, exotic, and even ominous. Dark matter is matter. It interacts with gravity like matter. It comes together into galaxies, for example. But what makes it dark is that it does not interact with light. If light hits dark matter, it just passes through. In fact, millions of dark matter particles are passing through us every second, but we just don't know about them because they interact so feebly. They interact gravitationally with us, but so far as we know, they do not interact with light.

This comes back to the word "dark." I think it might have been better called transparent matter. After all, we see things that are dark; they absorb light. But we don't see dark matter because light just doesn't interact with it. There's a hope that there's a tiny interaction that will help us find it, but so far we've seen no observational evidence of that. It really is just matter.

There is about five times the amount of energy carried into dark matter as ordinary matter. Most people find it interesting because they say, "Wow. Are you telling me most of the matter in the universe isn't the stuff we're made of?" But I think I have exactly the opposite point of view. We're just random. Why should we be as substantial a fraction of the matter in the universe as we are? In fact, why should these two be comparable at all if they're only interacting via gravity?

You might have imagined that there was a trillion times the amount of dark matter, yet the amounts are remarkably comparable. We actually think it might ultimately be a clue as to what dark matter actually is. Just to be clear, it's not quite as embarrassing as everyone is saying. There is actually observational evidence through gravity that this dark matter exists. It does influence things. It does have gravitational effects. It effects the motions of stars and galaxies themselves. So we really –

Tim Ferriss: Or the trajectories of comets or asteroids.

Lisa Randall: Well, if our theory of dark matter is right, it can also affect the trajectory of comets. I'm very happy to talk about that, too.

So it's not that we haven't measured dark matter. We've measured it. We just don't know fundamentally what it is. Is it a particle? Does it have a certain mass? Does it have any interactions at all? Coming back to effecting comets, my proposal with my collaborators is that maybe most of the dark matter doesn't have any interesting interactions other than gravity. But maybe a small fraction – say five percent – does interact. Maybe it even has its interactions with its own light. Just like dark matter doesn't see our light, maybe this dark matter has light that we don't see.

If that's true, it too might've formed a disk just like the Milky Way disk. The ordinary matter forms a Milky Way disk. And maybe the effect of that dark matter's gravitational force is, when the solar system comes through it, it can actually trigger a comet. We can talk more about that if you like.

Tim Ferriss: There are so many things I want to talk about. I know we have some time constraints. This came up in association with your name somehow, and I wanted to ask – looking at our galaxy, why are the outer planets in our solar system bigger than those closer to the sun?

Lisa Randall: That is going to have to do with the heat of the sun. If you're too close to the sun, things like hydrogen are just going to evaporate. The inner planets are rocky. They're made of silicon and things like that, but there isn't as much of the stuff that the inner planets are made up of. What there is gets trapped, but that's it.

The other planets are made up of much more abundant materials like hydrogen. They're in this outer region where they're frozen. So there are the rocky inner planets and frozen outer planets. There is a lot more of that stuff, so that stuff can grow to a much bigger size.

Tim Ferriss: Got it. There are a couple of questions I'd love to ask about distortions or misapplications of physics. I would love to hear some common misuses of physics that make you cringe? For instance, people misunderstanding spooky action at a distance. People say everything has its frequency. There is a lot of woo-woo stuff out there.

Lisa Randall: Well, the one I'm going to say is probably going to turn off half your audience.

Tim Ferriss: Perfect.

Lisa Randall: I can't stand the way people use energy to mean anything they want. Energy is very specific. There are many different forms of energy. For example, energy is conserved. It's not something you can just talk about as in the energy of an object or energy passing through or having good or bad energy. In physics it has a different meaning. It can be converted to mass. It can be converted to other forms of energy, but it really means something very specific. In common usage, energy is used all over the place for whatever anyone wants it to be.

Tim Ferriss: So in physics, what would the definition of energy look like then?

Lisa Randall: I actually don't have a great definition. It's a conserved quantity. If you have a certain energy, it will stay the same.

Tim Ferriss: It sounds like a tricky one. It's kind of like IQ is that which is measured by an IQ test.

Lisa Randall: Yeah, that wasn't a great definition, I will grant you. The problem is the definitions I would come up with are too technical. I'm trying to think of one that I would be to your satisfaction.

Tim Ferriss: No, no.

Lisa Randall: I don't have one off the top of my head.

Tim Ferriss: We can come back to it. That's not a big deal. So anything else come to mind that just drives you nuts?

Lisa Randall: It's a little bit unfair to say this drives me nuts, but there are some questions that come up again and again. For example, if the universe is expanding, what is it expanding into? The answer is, it's not expanding into anything. The universe is all there is. Stuff is just getting bigger. So you can use an analogy. If you were to assume a balloon is all there is – I realize a balloon is blowing up in a room, but imagine a balloon is all there is. And just draw points on the surface of the balloon. When you blow up that balloon, those points will get further apart.

Even though the balloon is all there is, it's getting bigger. That's the way the universe gets bigger. That's all there is, but it is getting bigger. Another misconception is that dark matter doesn't make sense. I think dark matter is one of the simplest modifications of the physics we know. It's just saying that there is some matter that doesn't interact with light. Why should all matter interact with light? After all, the matter we know of is made up of atoms, which do interact with light – or at least is made up of stuff that's charged, mainly protons and electrons.

But why should all matter be made up of protons and electrons? Why can't there be other types of matter that don't interact with light? That's another one. I think there is also this level at which people will almost prefer their romantic notion over understanding. In my books, I try not to make it seem exotic and overly mystical. I just want to say this is what we mean by this and it's not necessarily as confusing as they think. I don't use the words spooky or magical. I just say what it is and what it means functionally.

Tim Ferriss: It makes me recall a conversation that was in one of Richard Feynman's lectures or *The Joy of Finding Things Out*, a fantastic profile of him done by Nova. He talked about a debate with an artist friend of his who said that, since Feynman was able to break down this flower into its physical components into the atomic and subatomic levels, it lost the beauty. He couldn't appreciate the true beauty. He argued exactly the opposite. It provided a framework through which he could better appreciate the flower, in fact.

Lisa Randall: I would actually argue that it's neither. In *Knocking on Heaven's Door*, I was dealing with this notion of effective theory. It's different ways of looking. I talked about music. It's oscillations of air in your ears which get processed by your brain. And then you can understand what music is at a totally different level. I would say that's effective theory. You're using different ways of describing different problems. You won't even use the same words necessarily because you're talking about it at a different level.

Yes, fundamentally, for there to be music I need air, oscillations, and to be able to process it in my brain. But I don't think that comes anywhere near describing what music is. And I think no one is actually going to be able to describe what music is. You can functionally say what it is, but what it means to me as a person is going to be described at a totally different level. And that doesn't negate the physics interpretation. It's just that I don't think it fully qualifies as explaining it either.

Tim Ferriss: That makes sense.

Lisa Randall: Excellent.

Tim Ferriss: Is the flow of time an illusion?

Lisa Randall: I actually think the flow of time is very real. It might even be the way we define what time is. When I wrote my first book, I was able to come up with an intuitive explanation of almost all the concepts. The whole goal is to describe it without math, but time is really difficult to fundamentally explain. What is the difference between time and space? In technical terms, in the space/time metric in which you do measurements, there's a different sign.

But that doesn't tell you anything intuitively about what it is. I would venture to say we don't fully understand time. One thing time definitely seems to be is something we measure as things evolve and change. I would say it's almost essential to describe what you said in the beginning. If that question bugs me, it only bugs me because we don't understand time any better than we do.

Tim Ferriss: Are there any particular physicists or scientists researching time or have unique perspectives about time?

Lisa Randall: I'd almost say they're more philosophers.

Tim Ferriss: Right.

Lisa Randall: It's not science in the sense that you're not doing predictable theories. You can come up with ideas of time going backwards or forwards, but I'd say the most interesting things have to do with the idea of it being connected to cosmology – a more defined universe going forward and maybe cosmological inflation in the beginning. There were things that happened over time very quickly. Something called [inaudible] increased a lot, which is how many degrees of freedom there are.

I think there is interesting work trying to understand what inflation of our universe really means and how it really started. But again, it borders on philosophy.

Tim Ferriss: Philosophy has always been a contentious subject for a lot of people. But now you have artificial intelligence and utilitarian philosophers being brought in to help people write code. Let's say an autonomous vehicle has to choose between hitting two school children or five grandmas, which does it choose? Some of these thought exercises previously limited to freshman philosophy seminars are suddenly becoming relevant. Are there aspects of philosophy that are becoming more relevant to physics, or is that not the case?

Lisa Randall: Sometimes philosophy helps in framing what might be an interesting question but then physics is going to go ahead doing it the way it does it. There are some interesting discussions on a topic that we don't fully understand. So it's really in the regime where you can question whether we're really making progress in physics. In the realm of moral philosophy, I think that's probably one of the areas where philosophy is interesting. There are interesting moral questions that we do have to address in a lot of the rapid changes that are happening today.

In terms of philosophy and physics, one of the chapters in my new book *Dark Matter and the Dinosaurs*, when I talk about cosmology, I first have a chapter on the big question. I sort of define as philosophy the question that everyone wants to know the answer to what we don't really have definite answers to. It doesn't mean people can't think about them, but it's questions that we might not satisfactorily resolve. What was there before the big bang? What was the big bang? Why do we have something rather than nothing – although I do have a tentative answer to that one.

Tim Ferriss: Let's come back to that. Or we can do it right now. Why something rather than nothing?

Lisa Randall: My answer is that you first of all can't ask the question unless there was something. In my mind at least, nothing is a very unlikely possibility. If you think about it, a zero in a number line is very unlikely. If you do happen to get it, there is usually a reason for it and that also means there's something. It's just very hard to imagine nothing, at least for me, as being the most likely outcome. It seems something is much more likely. I joke that you don't always find what you're looking for but you usually find something.

Tim Ferriss: Yeah, I won't take us off the rails, but I think –

Lisa Randall: That's what happens when you start discussing philosophy and physics. You go off the rails.

Tim Ferriss: This I think we'll do in round two with more wine. I was chatting with a mutual friend of ours and she said you and she have discussed the idea of how science can expand empathy and our ability to see beyond ourselves. I don't want to put words in your mouth, but if that's the case, could you elaborate?

Lisa Randall: I use a lot of analogies in the book related to that. For those who are interested, I have an op-ed coming out in the *Boston Globe* about this. It's a difficult concept to explain, so just bear with me as I try to say it in words that are easier to write almost. When we do physics, it's almost a reaction when we talk about particle physics, and things that are removed from our everyday experience. I taught a freshman seminar where even the students recognized things that are removed from our everyday experience we tend to think of as less real or less important.

If I talk about a quark or a Higgs boson, your reaction is, "That's kind of interesting, but who cares," at some level. It's not what we're encountering in our daily lives. But if you're at the scale of a quark or Higgs boson, that's really important. We're made of ordinary matter so we tend to think of dark matter as not that important. But there is five times as much of it. Furthermore, it helped to develop galaxies. So it's really relevant to the universe.

We do the same thing in social classes. The masses who are building buildings will remember the leaders or the architects, but we forget the people who led to the construction. We'll look at our own society but we'll think of other societies as lesser in some way because they're not ours. If you're in another society, then you think yours is primary.

You have to get outside that perspective. In science, we all know we have to get outside that perspective. We're never going to understand things, or the scale of the universe for that matter. We have to allow ourselves to think of it. I think the same thing applies to social interactions as well. You really have to imagine a different perspective to fully understand.

Tim Ferriss: It seems to me that thinking scientifically involves forming hypothesis and recognizing their hypothesis, but also being aware of and testing your assumptions. I think one of the meta scales on top of all of that is being observant and trying to notice the minute.

Lisa Randall: Absolutely. Noticing the little places where things don't quite fit together and taking them seriously – that's absolutely right. Also, having fresh perspective. When we found the existence of an extra dimension of space we coming at it from particle physics. We weren't people who do primarily general relativity. In fact, we were told that's impossible because there were theorems saying it was wrong. But because we've come at it from a different direction, we've accidentally discovered a solution where we can then go back and see where the fundamental assumption was wrong. What was missed?

The work we're doing on dark matter now, and this idea that there could be a dark matter disk and it could affect astronomy came because we were trying to understand some observation. We were coming at it from a different direction because we weren't astronomers. Sometimes it helps to come at it from a different perspective. We need to be open to what the people in the field say, but to take as valid all the different points of view.

Tim Ferriss: What did you think of *Interstellar*?

Lisa Randall: I thought it was an interesting experiment. The idea was science that was possible but not necessarily likely. But never to have anything that we knew couldn't happen – and I think that was admirable. I think it was admirable to have the characters take science so seriously and try to talk science. I'm not saying I loved all the dialogue, but it was interesting to treat science as if it was just part of everyday vocabulary. I really liked that. It wasn't taken as some other thing; it was just part of their daily lives. I think there were some really interesting ideas that were explored in that movie.

Tim Ferriss: I had heard so many criticisms of the movie and I didn't dig into the details. I really enjoyed it. So that's that. I'm not sure why I felt it necessary to proclaim that.

If I talk to neuroscientists, particularly people who are not behavioral or cognitive focused, but those who are really focused on neuroanatomy and look at lesions and the effects of lesions and so on, they tend not to believe in the afterlife. I've had the opposite experience with physicists – or some consciousness after physical death. I know this is getting out there, but am I totally off base there?

Lisa Randall: I think you're talking to very unrepresentative physicists. There are some who are religious, but I think part of what physics says is how things are tied up to their physical makeup. That is essential. It doesn't mean we understand how everything fits together to give you consciousness, or whatever it is that constitutes a person, but that physical stuff is really important.

I've been in tricky situations where I really feel for people. When working on an extra dimension of space or talking about physics, people really want to believe these things. It'll be heartbreaking. Someone will say, "My sister died really young. I think she's in an extra dimension." I'm very sympathetic to their desire to believe it and to want to believe these things persist. They certainly persist in our memories. But I personally think that things are tied to the physical reality.

It doesn't mean that I overestimate my understanding of it. I don't know that connection. I don't know how it works. But I do think that a fundamental physical reality is essential. If you have a question about that, here's one question I have. It's how a scientist might approach it. My mother passed away a couple of years ago and she really did injure her brain. So she became a very different person. So where is the person in that? If you really want to believe that there is an afterlife, what happened to the person in that state where they're still alive but they've really hurt themselves?

It's a horrible reality to face. It was a horrible thing to watch. But that's the question. If you really want to believe that, you have to be able to answer those questions.

Tim Ferriss: Absolutely. It's a very tough question. I've had Sam Harris on the podcast before and he brings this up in discussions on this very topic. He has no shortage of debates with religious folks as you might imagine.

Lisa Randall: But my goal in having these debates is people actually listen to each other so they can actually come to some level of – but go on.

Tim Ferriss: Understood. I have a question from a reader, Mary Grace. If this question is too time consuming to answer, then you can pass. "I studied pure math in college and one of our favorite things to do was debate with the theoretical physicists on whose major was crazier. Of course, we each thought the others was crazier. I'd like to hear her description of an object – for example, a tennis ball – as it moves through additional dimensions of space."

Lisa Randall: First of all, you have to explain to me what that tennis ball is made of because the tennis balls that I know are made up of things that I know live in three dimensions. One of the things I talk about in *Warped Passages* is the idea of what's called brane, which could be a three-dimensional surface in higher dimensional space. So maybe it's as boring as the ball just stays in the three-dimensions of the brane.

If the ball wants to get off the brane, it has to be made of something that can exist in those other dimensions. But we have very serious observational constraints of what the extra dimensions can look like. So I'll take the copout solution right now, which is not crazy at all. If there is an extra dimension, the tennis ball might not be going there.

Tim Ferriss: Got it. What is the significance of the Higgs boson?

Lisa Randall: I wrote an e-book called –

[Crosstalk]

Tim Ferriss: *Higgs Discovery*.

Lisa Randall: – space. Um-hum. I try to discuss it. The Higgs boson is probably one of the hardest things to explain. But let me just give you a couple of answers. The Higgs boson is experimental evidence that our theory of how particles acquire their mass is correct. So the actually way particles get their mass is not from the Higgs boson itself – which is particle – but from something called Higgs mechanism, which involves something called the Higgs field. These are all different, so it's confusing.

The idea is that throughout space there is a Higgs charge – not actual particles, but a charge. Particles that get mass through the Higgs mechanism essentially interact with that charge. Ones that are heavier attract more and ones that are lighter attract less. The Higgs boson is connected to that field throughout space. So the Higgs boson interacts with heavier particles more and with lighter particles less.

So it does two things for us as scientists. It tells us the idea of the Higgs mechanism isn't [inaudible]. It also gives us some idea of what it was that produced that charge in the first place. It tells us about Higgs field, which is what's spread throughout space. The discovery of the Higgs boson really tells us how elementary particles – things like quartz and electrons – get their mass. They don't just have mass from the get-go. If they did, the theory would make totally nonsensical predictions like probabilities of interactions that [inaudible] as being greater than one.

It really requires some sort of mechanism, and that mechanism is this Higgs mechanism having to do with this charge throughout space. If that seems confusing, it's because it is. It's hard to understand without going through all of the math of it. That's essentially the essence of what is going on.

Tim Ferriss: And now that has been verified, what's the biggest thing physicists are now looking to verify?

Lisa Randall: Physicists is a broad term.

[Crosstalk]

Tim Ferriss: Yeah, I don't know how to –

Lisa Randall: Particle physicists – those people who really study what's happening in the Large Hadron Collider – are looking forward to understanding two things. One is connected to the question of why the Higgs mass is what it is. Without something else around, we would actually expect it to be 60 orders of magnitude heavier – ridiculously heavy. But we know that's not the case. We know what the Higgs boson mass is. The question is, what else is there? It turns out the answer to that question involves some very exotic ideas like extra symmetries of space or the idea of the extra dimension of space I talked about.

The other thing we hope we might get some insight into has to do with dark matter. It could be that a dark matter particle could be produced at the Large Hadron Collider if one of these ideas about what's going on with the Higgs mass is correct. We don't know that's the case, but research is going on to see if we can produce dark matter at the Large Hadron Collider.

Tim Ferriss: This question is from Peter Shaw. I'm going to paraphrase this.

Lisa Randall: Have you been waiting for this all your life, to get a physicist on the line and ask any question you want?

Tim Ferriss: I am fascinated by physicists in inverse proportion to how much I know about it. I know so little about physics, but I'm endlessly fascinated by it. I admire some of the precision and the willingness to deal with messy problems.

Lisa Randall: Well the great thing is, as you know more physics it actually stays interesting.

Tim Ferriss: Yeah. I'm trying to make up for lost time.

Lisa Randall: Back to the future.

Tim Ferriss: During my summer program when I was supposed to be studying physics, I fell in love with this Turkish girl and that was kind of the end of physics.

So the question from Peter Shaw is "why does research into cosmology matter? Theoretical physicists are brilliant, but most modern ones seem to be interested in the cosmos. To the layman, he can't see the direct benefit of this research."

Lisa Randall: Okay, so here's the question I have for your fan. It does matter. I think nothing matters more than understanding what's going on and what the universe is made of and how we got here. Yes, we can maybe find ways to cure disease and live another day. We can perhaps find new sources of energy and be able to power our gadgets more. That's all fun and enjoyable and we think of that as a purpose. But there is another purpose, to really learn, understand, and value things. We have culture and we're human beings.

I know that for many people that might not be the most satisfactory answer. And to those people, I can remind you that in most basic science we didn't know the implications or applications at the time. That doesn't justify [inaudible] I can guarantee that Watson and Crick were not trying to solve cancer when they were exploring DNA.

Tim Ferriss: That's a great example.

Lisa Randall: The fact is basic research matters and it comes down to help us. It also gets people excited about science. I don't think it's coincidence the places that have great science also have good economies and healthcare. There are correlations and it's because people who value these things are valuing what's important.

Tim Ferriss: Our mutual friend also brought up that sometimes you're frustrated about getting people to value basic science versus the sexiness of applied science. Could you define those two? I could take a stab at it, but it would be sloppy. What is the difference between basic science and applied science?

Lisa Randall: Basic science is trying to understand DNA without trying to understand if it can be useful. What will it do for me tomorrow? Applied science is saying that you want to solve a disease. I want to build a computer. Quantum mechanics ultimately gave rise to the electronics revolution in some sense through semiconductors. I can assure you people working on quantum mechanics were not thinking about an iPad. They were thinking about trying to understand how the atom could make sense or how radiation could make sense.

So basic science is just trying to understand how to make sense of what the world if made of and how things work. Applied science is trying to answer the question of your listener or reader. Can you use this to make my life better tomorrow?

Tim Ferriss: In an odd way, I do a lot in the tech world. There are comparable differences among entrepreneurs and tech builders. You have people who try to determine a market, market size, total addressable market, and then build for that. That would, I suppose, be the equivalent of applied science. And then you have the person who is just scratching their own itch. That may be for a particular need or want but it could also just be out of curiosity.

Lisa Randall: And isn't curiosity a great thing? It's just what makes the world worth being in. It's so great.

Tim Ferriss: I totally agree. Let's completely switch gears. I would love to ask you a number of questions that I love to ask. When you think of the word successful, who is the first person who comes to mind and why?

Lisa Randall: It's a really tough question. I really don't know the answer, but I think there are people out there who are just very happy with what they're doing. The successful people I know are always looking for more. I'm sorry. I just don't have one name that comes to mind.

Tim Ferriss: Okay. Let me take a different angle.

Lisa Randall: I think you're successful. How's that?

Tim Ferriss: Oh no. If you only knew.

Lisa Randall: See? That's my point. Everyone who is successful think of all of the things they need to do. In many ways, you're very successful.

Tim Ferriss: I should say the same of you on a much larger scale. In the last five years, when have you felt the most successful?

Lisa Randall: I do think, even those little things that tend to click or you have some idea that you know is going somewhere – this idea of dark matter was very exciting. I don't know if I would consider it a success, but it was very satisfying.

Tim Ferriss: Which was this? I'm sorry.

Lisa Randall: The idea of this dark matter that we're looking at that does have these interactions that can form a disk inside the Milky Way and could be denser. It was interesting to put that all together and realize this did make sense and was something that was relatively unexplored. It was really exciting.

When I'm writing a book, I feel successful. You have a vision of what you want to say. You have a vision of how you want it to fit together. You get some rather complicated ideas across. When I've done that to my satisfaction, in a way I find readable and enjoyable, I feel like that's a success.

When I'm doing a rock climb and do a climb that I thought was going to be too hard, I feel successful. It's these little achievements that make me feel happy.

Tim Ferriss: I wish we had more time to dig into the rock climbing, but we'll have to save that for a follow-up. As a side note, there's an interview I just did with a guy named Jimmy Chin. There's a documentary he's featured in called *Meru*. If you're into climbing, you should definitely check out *Meru*. It's incredible.

Lisa Randall: Great.

Tim Ferriss: It's about this particular climb that has defeated the top climbers for about 30 years. It's fantastic. What is the book that you've given most as a gift?

Lisa Randall: It's probably my books because –

[Crosstalk]

Tim Ferriss: Right. Excluding your own books.

Lisa Randall: Aside from that, I'll give to young girls – I really love the book *I Capture the Castle*. That sounds like an odd choice from a physicist, but I think it's a really lovely book about the importance of art and understanding the world. It's a young adult book by Dodie Smith, but it's lovely.

Tim Ferriss: Awesome. I'll check that out.

Lisa Randall: It's a girls' book in some ways, but it's really a lovely book.

Tim Ferriss: It bugs me that books – and I only figured this out recently – are slotted into young adult. It's not because the books are necessarily intended for adults, but because the main characters are young adults. I had no idea.

Lisa Randall: I didn't realize that either.

Tim Ferriss: Like *The Golden Compass* was slotted into young adult. I look up probably 300 words in that book to just figure out the definitions. But I'm digressing. What are your favorite documentaries or movies that come to mind?

Lisa Randall: I don't want to answer that.

Tim Ferriss: Let me guess. You don't want to answer, so I'm going to say *Kickboxer II*. Is that it?

Lisa Randall: I'm actually forgetting the name, but there was one about the downfall of Wall Street that was really great.

Tim Ferriss: Is it *Too Big to Fail*? Was it the documentary with Matt Damon?

Lisa Randall: No, it wasn't that one. It was an actual documentary without actors in it. I'll remember the name eventually.

Tim Ferriss: We can come back to that. What $100.00 or less purchase has most positively impacted your life in the last six months or year?

Lisa Randall: I'll give you two that are very different. One is probably my new climbing shoes.

Tim Ferriss: What are they?

Lisa Randall: They're just Mythos. It was just really nice to get better soles on my shoes so I could climb better again. The other was probably a silly one. I got a Human Touch dish rack and it just looks so clean and efficient that it encourages me to be neater in my kitchen.

Tim Ferriss: Human Touch.

Lisa Randall: It looks a little bit space age, but I just like the organization of it. It makes me feel happy when I look at it.

Tim Ferriss: That's perfect. That's exactly the kind of thing I'm looking for. What is something you believe that other people think is insane, if anything?

Lisa Randall: My answer to why there's something rather than nothing is probably a little bit unconventional. That's probably the closest I can come to that.

Tim Ferriss: What is super string theory?

Lisa Randall: I'll add something to that. I really like to believe that when people know more they will make more sensible decisions. That probably is insane because we don't always have evidence of that, but especially when trying to explain the kind of science I do – I do think once people understand things, they will value them more. On a very fundamental level, when I first saw the big Redwood Forest, I understood, "Oh, this is why they want to preserve the forests."

Tim Ferriss: Right.

Lisa Randall: You can read about the spotted owl all you want, but when you actually go and experience it – also, when you see politics today, if people really had access to the actual information and not just one side – that probably is insane. There's a lot of evidence that's not true, but I still like to believe that. It's what drives me to do this. I hope that when people know more they will do better things.

Tim Ferriss: I tend to agree. Here is a question from a scientist friend of mine. Lots of interesting work has been done in large programs like string theory and loop quantum gravity that don't yet connect well to the observable universe near current energy limits. What do we need to do to get more mavericks trying different things?

Lisa Randall: I'm not sure I understand the connection between the two parts of the question.

Tim Ferriss: His first part was, "Ask about the great slowdown in particle theory after the standard model got finished around 1973-74, specifically why so much energy has been spent on large programs that have yet to deliver rather than funding individuals who want to try new things."

Lisa Randall: Okay, now I understand better. My reaction to that is to try to work on things where you can make progress. That's why I still work on particle physics but am working on dark matter. I think both theoretically and observationally in ways that I talk a lot about in my book. I think it's really poised to make progress. I think there's a lot going on that can teach us that. One of the rules I have is new ways to look for new phenomenon so we don't miss things with the observations that we do.

I think scientists are people just like everyone else. Everyone likes to see other people doing what they're doing and they think what they're doing is the most important. So people have to be more open minded. Why did Einstein become known? Because Franc read his work and realized it was important – another established physicist read it. We have to really listen to good ideas when we hear them. That takes time and effort, but it is important.

Tim Ferriss: What are the most common misconceptions about you or your field?

Lisa Randall: I think people think I'm scary sometimes and I don't really get that.

Tim Ferriss: Why do people think you're scary?

Lisa Randall: I think it's because anything that's out of the norm is initially scary. It's not like everyone things I'm scary, but you hear there's this one physicist – people assume that you're some foreign being or something. I think there's a little bit of that. I'm probably exaggerating mostly, but I do think people misunderstand who I am a lot. Also, I have this annoying feature of being very direct. I wasn't properly socialized, so I didn't learn all of the proper –

[Crosstalk]

Tim Ferriss: The niceties of society?

Lisa Randall: Yeah. I just don't like wasting time. Can't we just say what we mean here? I think also I can actually argue a point without – I can disagree with a person and still like them. It doesn't reflect on what I'm thinking about the person. I think that's also something very foreign to a lot of people. People take it very personally if you have an argument. I don't mean it personally.

Tim Ferriss: What is super string theory?

Lisa Randall: It's really out there. I talked about particle physics before, so string theorists think that the fundamental nature of matter is not just elementary particles but is actually fundamental string – ocelots that produce the different particles. But fundamentally it's strings and not particles. That would be a whole other hour at least.

Tim Ferriss: Just because somebody I care about wanted me to ask because he's genuinely interested, if super string theory is not falsifiable does that mean it's not worth pursuing?

Lisa Randall: That's tricky. The answer is no. I don't think everyone should work on it, but I do think there are ideas that come out of string theory. It could be tied to other types of problems. Some of the work I did on extra dimensions of space came about because I thinking about ideas from string theory. And some of the implications of our ideas reflect on what can happen in string theory.

String theory is also used to understand black holes, for example. Eventually, there will be experimental tests of that. So you might not test the entire theory, but you can test pieces of it or use it to come up with methods. It's also been used for math. I'm not saying it's the only thing we should do. I do not consider myself a string theorist, although I do stuff that interfaces with it. I prefer to do things that are more directly connected to experiments. I would say that, just like everything else, in America we tend to go in extremes and think everyone has to do or not do something. I think there's a place for it. It shouldn't be everyone doing it, but there is a place for it.

Tim Ferriss: If you could have one billboard anywhere with anything on it, what would it say?

Lisa Randall: Be curious and try to find solutions to problems.

Tim Ferriss: Do you think you can train curiosity? For a school curriculum, is there a way we could better instill or foster curiosity?

Lisa Randall: I think a lot of it has to do with, when people ask questions, taking the questions seriously. That can be tedious and not every question is a good question. But sometimes people ask questions and will get cut off or ignored. That tends to make you not want to ask questions. So people have to listen to each other. If people listen to each other, they'll get more curious and be given more opportunities to explore, to read, and to work on problems. I think people are naturally curious. So the point is not to get rid of the curiosity.

Tim Ferriss: Right. How do we avoid neutering that curiosity perhaps?

Lisa Randall: Right.

Tim Ferriss: What advice would you give to your 30-year-old self?

Lisa Randall: It sounds funny, but I would say not to take myself quite so seriously.

Tim Ferriss: Place that in context. What were you doing at 30?

Lisa Randall: I was a professor at MIT.

Tim Ferriss: When you were a PhD student, what advice would you have given yourself?

Lisa Randall: Not to take myself quite so seriously.

Tim Ferriss: Got it. This has been so much fun. I have one last and then I'm going to point people off to –

Lisa Randall: Uh-oh. Is that a lead up to a question I don't want to answer?

Tim Ferriss: No, not at all. Aside from checking out the book and everything online, do you have any asks or requests for my audience?

Lisa Randall: I'd like to know which explanations that I've given on here or in my book people find helpful.

Tim Ferriss: Great. Where can they let you know?

Lisa Randall: I have a Twitter account. My handle is @lyrarandall. Also, I'd like to know if my book points come across and people understand what I'm trying to explain. Also, with these analogies, do they get them?

Tim Ferriss: Where can people find you online and the book besides on Twitter?

Lisa Randall: The book is on Amazon. I have a Harvard account and I'm in the process of setting up a web account for the book. The only social media thing I do is Twitter right now. But there will be a website soon. Just look for Lisa Randall or *Dark Matter* on the Amazon website.

Tim Ferriss: The book is *Dark Matter and the Dinosaurs: The Astounding Interconnectedness of the Universe*. It is currently number one in paleontology of all things.

Lisa Randall: I love that. It's all preorders now. It comes out next week.

Tim Ferriss: Or, when you're listening to this it might've been out for a year or two. So check it out.

Lisa Randall: Oh, I'm sorry.

Tim Ferriss: That's all right. I have personally made a commitment to get back into reading more about physics. If you want to try psychedelics but aren't going to actually do it and put on a new lens with which to view so-called ordinary life but gain an additional perspective, this is a great way to do it.

Lisa Randall: What a lovely thing to say. Thank you.

Tim Ferriss: Of course. My pleasure. I love this stuff. I need to resolve to actually learn something about it and develop some fundamentals.

Lisa Randall: No more Turkish girls.

Tim Ferriss: I know. I have to avoid the Turkish girls – very distracting. I really appreciate the time. Is there anything else you'd like to share before we end this round one?

Lisa Randall: I think that was quite a lot to share. I find it rewarding. You spend all of this time writing a book, and it's so rewarding to me when people really are interested in understanding these things.

Tim Ferriss: These are some fundamental and basic aspects of reality that you and other physicists are digging into. And like you said, Watson and Crick were not trying to solve cancer. It's easy to miss the longer term implications of a lot of what's being done in basic science. Everyone listening, you can find the links to things we discussed at fourhourworkweek.com/podcast. You can also just go to and click podcast for the notes for this episode and every other episode. Professor Randall, thank you so much for taking the time.

Lisa Randall: Thank you so much for doing this. It's been really fun.

Tim Ferriss: Everyone listening, until next time. Thank you for listening.