

# Events and the Nature of Time: Max Tegmark

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## Transcript - Long

### Robert Lawrence Kuhn:

Max, we're here in Banff at the FQXI conference, and you've called it if a tree falls, the physics of what happens. What's happening? Lots of trees here. A few of them have fallen. Why is the concept of events so important and how does it relate to our sense of time? We had a conference on time. We didn't talk so much about events. We talked about time. People said it was an illusion or not. Now we're talking about events, so what...how do they articulate?

### Max Tegmark:

I'm fascinated by events because I feel like right at the heart of the toughest mystery we face in physics, we have two diametrically opposite views of thinking, thinking of reality. We can either start with this abstract, timeless, mathematical description of all of reality, where nothing happens, there's just a bunch of coordinates, a bunch of quantum fields, numbers, and relations, and then there's the opposite point of view, the inside view of us observers, where we feel that things happen, time is changing, and how do we connect these two things together? The event is the fundamental building block that Einstein used in his theory to define the thing happening in a certain place, right? But if someone comes and asks me what time is this event happening or what time is it, that's kind of an offensive question to ask me because what is the time? It's as ridiculous to me as asking what is the place? There are lots of places. The person is asking something about what's the place is that we're having this conversation in. This particular...there's nothing special in physics about this particular time, and this is what we wanted to bring all these people together to discuss. How can we take this timeless reality, where nothing, where there are no events labeled, and reconcile it with what we actually experience?

### Robert Lawrence Kuhn:

Are there two opposite views that says that events are sequences of things, happenings that occur within time, or that time is defined by the sequence of events? Now, that sounds like it's a tautology, but those are two radically different ontologies in terms of meaning. Does that make sense?

### Max Tegmark:

Absolutely. So, back in the days of when Einstein's theory of relativity was born, the first picture made a lot of sense, that there was this thing, space, time. Within it, events happen. But now we know that isn't quite right because of quantum mechanics making everything a little bit fuzzy, so at best an event might happen kind of, sort of here, kind of, sort of now. What we've been discussing a lot here in all the quantum gravity talks is that the opposite might be the case. If you start with something, which a priori has neither space nor time, and that both of those ideas are somehow emergent, much like if I have a continuous water, liquid that I'm swimming in, it feels like this nice, continuous substance, but really, it's just a bunch of atoms bouncing around, which make me feel that it's all sort of smooth. Maybe space itself is made up of some sort of building blocks, and maybe in the distant past this, these building blocks were so discombobulated that time lost its meaning, and maybe in the distant future, again, time is going to stop to make sense. Maybe time and space are just an approximation that holds now, and for a while, but in both the past and the future, it just turns into some sort of quantum fuzz.

### Robert Lawrence Kuhn:

How would that happen in the future? I can understand how it would happen in the past when you run everything back together and then...there's so much we don't understand, so I can understand we don't understand, but in the future, things are going to continue to expand, so how can you go back to the fuzz of time?

### Max Tegmark:

It could happen in the future. If we wait long enough, we might have an infinite amount of time if the dark energy stays constant, that everything we know gets diluted away and ultimately you get a sort of heat death situation where you just have a uniform soup of things and nothing is changing anymore, and when you have no more change, then you don't have any clocks because, by definition, things have changed. You have no way of talking about measuring time, talking about time, and it's not clear that even makes sense to say that anything is happening anymore. So time really would lose its meaning if change came to a halt.

### Robert Lawrence Kuhn:

There's a difference, though, between not being able to measure anything...

### Max Tegmark:

That's right.

### Robert Lawrence Kuhn:

...and not being able to, and to say that time doesn't exist anymore, or do they begin to merge together. If you can't measure it, if you can't measure change, does that mean that time isn't there?

### Max Tegmark:

It doesn't imply it, logically, but I think it's quite likely that it is that way, notwithstanding. Since there is no change anyway, built in fundamentally, in Einstein's theory, where time is just the fourth dimension of something that is, right? Spacetime itself doesn't exist in time; the time exists in it. The only way we know how to get the feeling of something happening out of that is to put, to ask how does an observer in here feel? If there are no observers feeling anything, you can't get any experience of time out, then I think time loses its meaning.

### Robert Lawrence Kuhn:

Let me ask you the sociology of the group. We're here at the conference. About 125 physicists, cosmologists, some other scientists. What's the percentage, do you think, who think that time is derivative or illusion or something, other than the traditional understanding?

**Max Tegmark:**

We had a debate about that today, and it was really fascinating to hear that, although there was some support for the idea that there is some sort of fundamental time, most people in the debate actually guessed that, no, time does not exist fundamentally. It's something that emerges only in a certain approximation, so it might very well be, then, that even right now, this approximation is great and tomorrow is going to happen and so on. If you go really far back or really far forward in the future, time will dissolve and totally lose its meaning.

**Robert Lawrence Kuhn:**

What a funny way for reality to be.

**Max Tegmark:**

Yeah. It...I think, in a way, it's a beautiful answer to the question of what happened before the beginning, with nature telling us that, actually...the paradox seeming, that you seem to have, right, that there would always have to be something before isn't the paradox because the whole premise that there always was a well-defined time just breaks down. You go really far back and things just kind of get all fuzzy and timeless, and the same thing in the future. So...

**Robert Lawrence Kuhn:**

You're happy with that world.

**Max Tegmark:**

I would love to understand in more detail, of course, what happens, but I feel that one of the most important lessons we've learned as physicists is that the ground that we thought we were standing on, the things we thought we were holding onto, is very shaky and dissolving under us. Not only are things like solid matter much more approximate than we thought, but even the very fabric of space and time are probably just emergent approximations.