

Description of NOVA's *The Fabric of the Cosmos* Time Episode

Ask physicists what time actually is, and the answer might shock you: They have no idea. Even more surprising, the deep sense we have of time passing from present to past may be nothing more than an illusion. How can our understanding of something so familiar be so wrong? In search of answers, Brian Greene takes us on the ultimate time traveling adventure, making the case that the past, present, and future all exist at once. This journey brings us all the way back to the Big Bang, where physicists think the ultimate secrets of time may be hidden. You'll never look at your wristwatch the same way again.

Main Ideas

- Time is a measure of predictable, consistent, repetitive processes (e.g., a year, season, month, day, quartz crystal, cesium atom). Yet while we can measure time, what we're measuring is unclear.
- Einstein's big idea was that space and time are not separate but fused together as "space-time."
- Einstein's key insight is that motion through space affects the passage of time—there is a link between motion and time. This means that time can run at different rates depending on the speed of motion, and that the more you have of one, the less you have of the other.
- Gravity, like motion, can slow time. The stronger the gravity, the more time slows.
- Physics uses equations to describe the universe. Since equations are reversible (i.e., an equation can remain valid using positive or negative values), physicists can make a case that the past, present, and future can all exist at the same time. Still, there's a contradiction between a mathematical interpretation of time, which seems reversible, and everyday experience. Experience suggests that the flow of time is in one direction—toward the future.
- The universe tends to move from order to disorder. When contrasting order with disorder, the more ways there are for disorder to occur (e.g., the greater probability of a stack of papers thrown in the air to land as a scattered mess rather than as an intact stack), the more probable it is that disorder (versus order) will happen. Importantly, disorder increases in one direction of time. This gives rise to the concept of an "arrow of time."
- The Big Bang represents the universe's most ordered state. After that, things grow increasingly disordered, with the universe unwinding ever since. The Big Bang gives us a reason why the universe might look different when we look back in time versus forward, and why the arrow of time runs in one direction.