

Ten things you might not know about relativity

Dan Styer, Oberlin College, 17 February 2012

1. A moving clock ticks slowly. That is, in the reference frame where the clock moves, that clock ticks off less time than actually elapses. In the clock's own reference frame, it keeps perfectly accurate time.

2. A moving rod is short but, again, in its own reference frame that rod is not short.

3. A moving pair of clocks is not synchronized but, again, in that pair's own reference frame the two clocks *are* synchronized.

4. That's all there is to it. Relativity has a reputation for being complex, arcane, and unfathomable. But items 1, 2, and 3 above contain the entirety of relativity. Unexpected? Yes. Counterintuitive? Yes. Profound? Yes. Complicated? No.

5. These three items have many consequences. They're short and they're simple, but any alteration of such fundamental concepts as space and time are bound to have a lot of consequences. For example . . .

6. Our language works against our understanding of relativity. There is a past tense, a future tense, and a present tense, but there should also be a tense for "maybe in the past, maybe in the future, maybe in the present, depending upon reference frame."

7. If effect always follows cause, then no information can travel faster than light. Some say that this "speed limit" comes from relativity alone, but it requires also the assumption of causality.

8. But despite this speed limit, with fast travel you could reach any distant star within your lifetime. Because while you're traveling to that star, the clock which is your aging will tick slowly.

9. A moving object responds sluggishly to forces, but in that object's own reference frame, it responds to forces in the same way it always has. This is the physical content of the equation $E = mc^2$.

10. Our universe is endlessly surprising, and therefore supremely delicious. I've been studying the implications of items 1, 2, and 3 for thirty-nine years, yet still I stumble upon the unexpected. Relativity continues to surprise and delight me.

If you have questions about our surprising and delicious universe, you'll find many of the answers in my general-audience book *Relativity for the Questioning Mind*.

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Dan Styer is the John and Marianne Schiffer Professor of Physics at Oberlin College. He is author of Relativity for the Questioning Mind and of The Strange World of Quantum Mechanics, for a general audience, as well as many technical physics papers and computer programs. For the benefit of experts, he points out that this list concerns special, not general, relativity. In addition to doing science, Dr. Styer enjoys his family, running, hiking, and restoring his small nature preserve on Ohio's Vermilion River.