

Answering why-type questions of relativity theories (both special and general)

Applying mathematical logic in the foundations of relativity theories is not a new idea at all, among others, it goes back to such leading mathematicians and philosophers as Hilbert, Reichenbach, Carnap, Gödel, Tarski, Suppes and Friedman.

There are many examples showing the benefits of using axiomatic method in the foundations of mathematics. That motivates the Hungarian school led by Hajnal Andréka and István Németi to apply this method in the foundations of relativity theories (both special and general). This talk is based on the research of this school.

Our school's general aims are to axiomatize relativity theories within pure first-order logic using simple, comprehensible and transparent basic assumptions (axioms); and to prove the surprising predictions (theorems) of relativity theories using a minimal number of convincing axioms.

What we call “reverse thinking” is “backward reasoning,” also called “reverse mathematics.” Via a sample of results in the application of axiomatic method and reverse thinking to special and general relativity theories, we try to show that their application to physics is a promisingly fruitful research area. We also argue that their application will be conducive to finding better and better answers to why-type questions in physics and thus a deeper understanding of our world.

In this talk we are going to consider some possible answers to the following why-type questions of relativity theory:

- “Why can no observer move faster than light?”
- “Why does relativistic mass depend on the speed?”
- “Why does rest mass increase in inelastic collisions?”
- “Why $E = mc^2$?”
- “Why is the aging of inertial observers slower than that of the others?”
- “Why does gravity slow time down?”
- “Why do time and space get interchanged inside the event horizon of black holes?”