

► ISTVÁN AND PÉTER NÉMETHI,

Back and forth between logic and relativity theory. Part I.

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This talk is strongly related to the talk of Hajnal Andréka. In the two talks together, we build up relativity theories (special, general, cosmological) as theories in the sense of mathematical logic, carefully staying all the time in the framework of first order logic. Among others, we intend to provide an easily understandable, logic based introduction to not only special, general and cosmological theories of relativity, but intend to give insight (for the logically minded) to the most exotic and recent developments related to the theory ranging from the recent acceleration of the expanding universe (e.g., exotic matter) through wormholes, timewarps and observational evidence for huge rotating black holes.

Not only logic will be applied to relativity but also applications of general relativity to logic will be mentioned.

A novelty is that we will try to keep the transition to general relativity (GR) from special relativity (SR) simple, streamlined, logically transparent and illuminating. We will introduce Einstein's Principle of Equivalence (EP) and will "derive" GR from SR+EP in a logical way. In more detail, we will build up SR as a purely first-order logic (FOL) theory. Then, by using EP, we build GR on top of SR as a strictly "logical" extension. Both GR and SR will be streamlined, easy to understand theories of FOL.

We will be careful to build up our theories in a "bottom up" way starting from simple observation oriented axioms with clear tangible operational meanings in a step by step manner, in each step assuming only what is needed. In particular, we will avoid assuming, say, the whole of ZFC set theory as part of our axiomatization.

In analogy with the foundation of mathematics (FOM), we aim for elaborating a logic based foundation for GR and its variants. As a guiding line for this, we use the success story of logic in FOM. Besides foundation, we also elaborate a logic based conceptual analysis for the versions of relativity (SR, GR, cosmology etc) being studied. Typically, we look at some famous predictions of relativity and ask ourselves the question why these predictions are believed. We will answer this question by finding those (FOL) axioms of the theory which are responsible for the predictions in question.

We will also indicate how the first steps towards Einstein's famous insight $E = mc^2$ follows purely logically from the simple geometric axioms of our version of SR. Connections with the Einstein Equation will be mentioned, if time permits.

More detail is available on Istvan Nemeti's homepage. The reported work is joint with Judit X. Madarász [1], Gergely Székely [2], and Renáta Tordai.

[1] MADARÁSZ, J. X., *Logic and Relativity (in the light of definability theory)*, PhD Dissertation, Eötvös Loránd University, Budapest, 2002.

[2] SZÉKELY, G., *First-Order Logic Investigation of Relativity Theory with an Emphasis on Accelerated Observers*, PhD Dissertation, Eötvös Loránd University, Budapest, 2009.